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APPLICATION NO.	ISSUE DATE	PATENT NO.	ATTORNEY DOCKET NO.	CONFIRMATION NO.
16/959,352	02/28/2023	11591706	0313221.00022	1067

24573 7590 02/08/2023

K&L Gates LLP-Chicago
P.O. Box 1135
Chicago, IL 60690

ISSUE NOTIFICATION

The projected patent number and issue date are specified above.

Determination of Patent Term Adjustment under 35 U.S.C. 154 (b)
(application filed on or after May 29, 2000)

The Patent Term Adjustment is 0 day(s). Any patent to issue from the above-identified application will include an indication of the adjustment on the front page.

If a Continued Prosecution Application (CPA) was filed in the above-identified application, the filing date that determines Patent Term Adjustment is the filing date of the most recent CPA.

Applicant will be able to obtain more detailed information by accessing the Patent Application Information Retrieval (PAIR) WEB site (http://pair.uspto.gov).

Any questions regarding the Patent Term Extension or Adjustment determination should be directed to the Office of Patent Legal Administration at (571)-272-7702. Questions relating to issue and publication fee payments should be directed to the Application Assistance Unit (AAU) of the Office of Patents Stakeholder Experience (OPSE), Stakeholder Support Division (SSD) at (571)-272-4200.

INVENTOR(s) (Please see PAIR WEB site http://pair.uspto.gov for additional inventors):

Seung Min KIM, Anyang-si, Gyeonggi-do, KOREA, REPUBLIC OF;
Shan Hua JIN, Anyang-si, Gyeonggi-do, KOREA, REPUBLIC OF;

APPLICANT(s) (Please see PAIR WEB site http://pair.uspto.gov for additional applicants):

SK NEXILIS CO., LTD., JEONGEUP-SI, KOREA, REPUBLIC OF;

The United States represents the largest, most dynamic marketplace in the world and is an unparalleled location for business investment, innovation, and commercialization of new technologies. The USA offers tremendous resources and advantages for those who invest and manufacture goods here. Through SelectUSA, our nation works to encourage and facilitate business investment. To learn more about why the USA is the best country in the world to develop technology, manufacture products, and grow your business, visit SelectUSA.gov.

IR103 (Rev. 10/09)

PART B - FEE(S) TRANSMITTAL

Complete and send this form, together with applicable fee(s), by mail or fax, or via EFS-Web.

By mail, send to: Mail Stop ISSUE FEE
Commissioner for Patents
P.O. Box 1450
Alexandria, Virginia 22313-1450

By fax, send to: (571)-273-2885

INSTRUCTIONS: This form should be used for transmitting the ISSUE FEE and PUBLICATION FEE (if required). Blocks 1 through 5 should be completed where appropriate. All further correspondence including the Patent, advance orders and notification of maintenance fees will be mailed to the current correspondence address as indicated unless corrected below or directed otherwise in Block 1, by (a) specifying a new correspondence address; and/or (b) indicating a separate "FEE ADDRESS" for maintenance fee notifications.

CURRENT CORRESPONDENCE ADDRESS (Note: Use Block 1 for any change of address)

24573 7590 12/22/2022

K&L Gates LLP-Chicago
P.O. Box 1135
Chicago, IL 60690

Note: A certificate of mailing can only be used for domestic mailings of the Fee(s) Transmittal. This certificate cannot be used for any other accompanying papers. Each additional paper, such as an assignment or formal drawing, must have its own certificate of mailing or transmission.

Certificate of Mailing or Transmission

I hereby certify that this Fee(s) Transmittal is being deposited with the United States Postal Service with sufficient postage for first class mail in an envelope addressed to the Mail Stop ISSUE FEE address above, or being transmitted to the USPTO via EFS-Web or by facsimile to (571) 273-2885, on the date below.

(Typed or printed name)
(Signature)
(Date)

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
16/959,352	06/30/2020	Seung Min KIM	0313221.00022	1067

TITLE OF INVENTION: ELECTROLYTIC COPPER FOIL HAVING EXCELLENT HANDLING CHARACTERISTICS IN POSTPROCESSING, AND MANUFACTURING METHOD THEREFOR

APPLN. TYPE	ENTITY STATUS	ISSUE FEE DUE	PUBLICATION FEE DUE	PREV. PAID ISSUE FEE	TOTAL FEE(S) DUE	DATE DUE
nonprovisional	UNDISCOUNTED	$1200	$0.00	$0.00	$1200	03/22/2023

EXAMINER	ART UNIT	CLASS-SUBCLASS
DUMBRIS, SETH M	1784	428-606000

1. Change of correspondence address or indication of "Fee Address" (37 CFR 1.363).

❑ Change of correspondence address (or Change of Correspondence Address form PTO/AIA/122 or PTO/SB/122) attached.

❑ "Fee Address" indication (or "Fee Address" Indication form PTO/AIA/47 or PTO/SB/47; Rev 03-02 or more recent) attached. **Use of a Customer Number is required.**

2. For printing on the patent front page, list
(1) The names of up to 3 registered patent attorneys or agents OR, alternatively,
(2) The name of a single firm (having as a member a registered attorney or agent) and the names of up to 2 registered patent attorneys or agents. If no name is listed, no name will be printed.

1 K&L Gates LLP
2
3

3. ASSIGNEE NAME AND RESIDENCE DATA TO BE PRINTED ON THE PATENT (print or type)

PLEASE NOTE: Unless an assignee is identified below, no assignee data will appear on the patent. If an assignee is identified below, the document must have been previously recorded, or filed for recordation, as set forth in 37 CFR 3.11 and 37 CFR 3.81(a). Completion of this form is NOT a substitute for filing an assignment.

(A) NAME OF ASSIGNEE: SK NEXILIS CO., LTD.

(B) RESIDENCE: (CITY and STATE OR COUNTRY): JEONGEUP-SI, JEOLLABUK-DO, REPUBLIC OF KOREA

Please check the appropriate assignee category or categories (will not be printed on the patent) : ❑ Individual ☒ Corporation or other private group entity ❑ Government

4a. Fees submitted: ☒ Issue Fee ❑ Publication Fee (if required) ❑ Advance Order - # of Copies _____

4b. Method of Payment: *(Please first reapply any previously paid fee shown above)*

☒ Electronic Payment via EFS-Web ❑ Enclosed check ❑ Non-electronic payment by credit card (Attach form PTO-2038)

☒ The Director is hereby authorized to charge the required fee(s), any deficiency, or credit any overpayment to Deposit Account No. 02-1818

5. **Change in Entity Status** (from status indicated above)

❑ Applicant certifying micro entity status. See 37 CFR 1.29

❑ Applicant asserting small entity status. See 37 CFR 1.27

❑ Applicant changing to regular undiscounted fee status.

NOTE: Absent a valid certification of Micro Entity Status (see forms PTO/SB/15A and 15B), issue fee payment in the micro entity amount will not be accepted at the risk of application abandonment.
NOTE: If the application was previously under micro entity status, checking this box will be taken to be a notification of loss of entitlement to micro entity status.
NOTE: Checking this box will be taken to be a notification of loss of entitlement to small or micro entity status, as applicable.

NOTE: This form must be signed in accordance with 37 CFR 1.31 and 1.33. See 37 CFR 1.4 for signature requirements and certifications.

Authorized Signature /Matthew S. Dicke/ Date January 23, 2023

Typed or printed name Matthew S. Dicke Registration No. 58819

Electronic Patent Application Fee Transmittal

Application Number:	16959352
Filing Date:	30-Jun-2020
Title of Invention:	ELECTROLYTIC COPPER FOIL HAVING EXCELLENT HANDLING CHARACTERISTICS IN POSTPROCESSING, AND MANUFACTURING METHOD THEREFOR
First Named Inventor/Applicant Name:	Seung Min KIM
Filer:	Matthew S. Dicke/Meg Boinski
Attorney Docket Number:	0313221.00022

Filed as Large Entity

Filing Fees for U.S. National Stage under 35 USC 371

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Basic Filing:				
Pages:				
Claims:				
Miscellaneous-Filing:				
Petition:				
Patent-Appeals-and-Interference:				
Post-Allowance-and-Post-Issuance:				
UTILITY APPL ISSUE FEE	1501	1	1200	1200

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Extension-of-Time:				
Miscellaneous:				
			Total in USD ($)	**1200**

Electronic Acknowledgement Receipt	
EFS ID:	47402994
Application Number:	16959352
International Application Number:	
Confirmation Number:	1067
Title of Invention:	ELECTROLYTIC COPPER FOIL HAVING EXCELLENT HANDLING CHARACTERISTICS IN POSTPROCESSING, AND MANUFACTURING METHOD THEREFOR
First Named Inventor/Applicant Name:	Seung Min KIM
Customer Number:	24573
Filer:	Matthew S. Dicke/US Patent Mail
Filer Authorized By:	Matthew S. Dicke
Attorney Docket Number:	0313221.00022
Receipt Date:	23-JAN-2023
Filing Date:	30-JUN-2020
Time Stamp:	11:02:55
Application Type:	U.S. National Stage under 35 USC 371

Payment information:

Submitted with Payment	yes
Payment Type	DA
Payment was successfully received in RAM	$1200
RAM confirmation Number	E20231MB03463879
Deposit Account	021818
Authorized User	US Patent Mail
The Director of the USPTO is hereby authorized to charge indicated fees and credit any overpayment as follows: 37 CFR 1.17 (Patent application and reexamination processing fees) 37 CFR 1.492 (National application filing, search, and examination fees)	

File Listing:

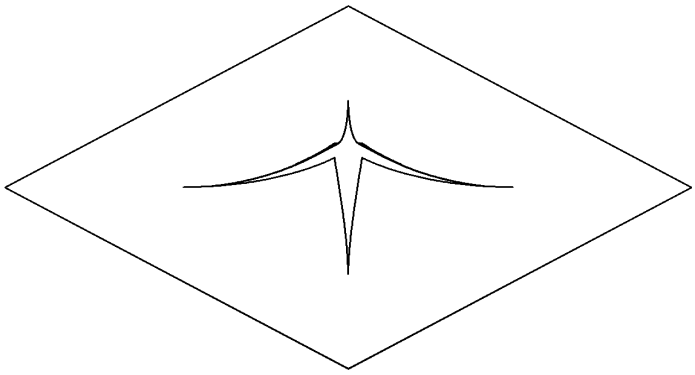
Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1	Issue Fee Payment (PTO-85B)	0313221-00022_IssueFee.pdf	132301 172076c096c6a898df6c23dbd26208cbc7e225f1	no	1
Warnings:					
Information:					
2	Fee Worksheet (SB06)	fee-info.pdf	38209 662fa3741098ea796ef71de5764f796846f282fb	no	2
Warnings:					
Information:					
		Total Files Size (in bytes):	170510		

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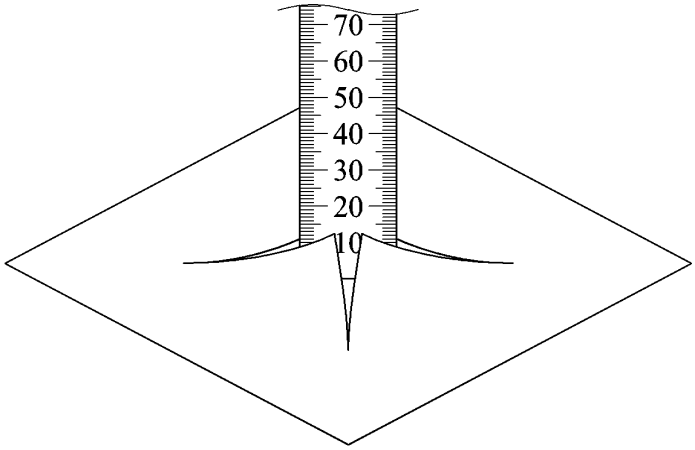
New Applications Under 35 U.S.C. 111
If a new application is being filed and the application includes the necessary components for a filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application.
National Stage of an International Application under 35 U.S.C. 371
If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course.
New International Application Filed with the USPTO as a Receiving Office
If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.

REPLACEMENT SHEET

FIG. 3



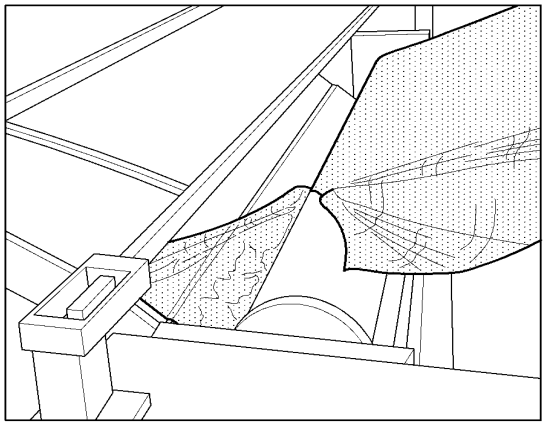
(a)



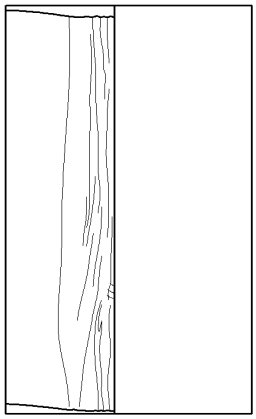
(b)

REPLACEMENT SHEET

FIG. 4



(a)



(b)

Electronic Acknowledgement Receipt	
EFS ID:	47403079
Application Number:	16959352
International Application Number:	
Confirmation Number:	1067
Title of Invention:	ELECTROLYTIC COPPER FOIL HAVING EXCELLENT HANDLING CHARACTERISTICS IN POSTPROCESSING, AND MANUFACTURING METHOD THEREFOR
First Named Inventor/Applicant Name:	Seung Min KIM
Customer Number:	24573
Filer:	Matthew S. Dicke/US Patent Mail
Filer Authorized By:	Matthew S. Dicke
Attorney Docket Number:	0313221.00022
Receipt Date:	20-JAN-2023
Filing Date:	30-JUN-2020
Time Stamp:	15:49:10
Application Type:	U.S. National Stage under 35 USC 371

Payment information:

Submitted with Payment	no

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1	Miscellaneous Incoming Letter	0313221-00022_Notice.pdf	113187 9373089d025cb3bae0ddd84f83b2731a164c11a6	no	3

Warnings:

Information:					
2	Applicant Response to Pre-Exam Formalities Notice	0313221-00022_RespCorrectAppPapers.pdf	84545 d8bca31a2f25aa04de6612189bd283e9a25bf5d3	no	3
Warnings:					
Information:					
3	Drawings-only black and white line drawings	0313221-00022_ReplaceSheets.pdf	52400 a3f79d57b7d80ea69283427c31fbd4e5e69a787e	no	2
Warnings:					
Information:					
		Total Files Size (in bytes):	250132		

This Acknowledgement Receipt evidences receipt on the noted date by the USPTO of the indicated documents, characterized by the applicant, and including page counts, where applicable. It serves as evidence of receipt similar to a Post Card, as described in MPEP 503.

<u>New Applications Under 35 U.S.C. 111</u>
If a new application is being filed and the application includes the necessary components for a filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application.
<u>National Stage of an International Application under 35 U.S.C. 371</u>
If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course.
<u>New International Application Filed with the USPTO as a Receiving Office</u>
If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.

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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
16/959,352	06/30 2020	Seung Min KIM	0313221.00022	1067

24573 7590 01/03/2023

K&L Gates LLP-Chicago
P.O. Box 1135
Chicago, IL 60690

EXAMINER	
DUMBRIS, SETH M	

ART UNIT	PAPER NUMBER
1784	

NOTIFICATION DATE	DELIVERY MODE
01/03/2023	ELECTRONIC

Please find below and/or attached an Office communication concerning this application or proceeding.

The time period for reply, if any, is set in the attached communication.

Notice of the Office communication was sent electronically on above-indicated "Notification Date" to the following e-mail address(es):

USpatentmail@klgates.com

UNITED STATES PATENT AND TRADEMARK OFFICE

Commissioner for Patents
United States Patent and Trademark Office
P.O. Box 1450
Alexandria, VA 22313-1450
www.uspto.gov

Application No. : 16959352
Applicant : Kim
Filing Date : 06/30/2020
Date Mailed : 01/03/2023

NOTICE TO FILE CORRECTED APPLICATION PAPERS

Notice of Allowance Mailed

This application has been accorded an Allowance Date and is being prepared for issuance. The application, however, is incomplete for the reasons below.

Applicant is given two (2) months from the mail date of this Notice within which to respond. This time period for reply is extendable under 37 CFR 1.136(a) for only TWO additional MONTHS.

The informalities requiring correction are indicated in the attachment(s). If the informality pertains to the abstract, specification (including claims) or drawings, the informality must be corrected with an amendment in compliance with 37 CFR 1.121 (or, if the application is a reissue application, 37 CFR 1.173). Such an amendment may be filed after payment of the issue fee if limited to correction of informalities noted herein. See Waiver of 37 CFR 1.312 for Documents Required by the Office of Patent Publication, 1280 Off. Gaz. Patent Office 918 (March 23, 2004). In addition, if the informality is not corrected until after payment of the issue fee, for purposes of 35 U.S.C. 154(b)(1)(iv), "all outstanding requirements" will be considered to have been satisfied when the informality has been corrected. A failure to respond within the above-identified time period will result in the application being ABANDONED.

See attachment(s).

A copy of this notice MUST be returned with the reply. Please address response to "Mail Stop Issue Fee, Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450".

/Julia Walsh/
Publication Branch
Office of Data Management
(571) 272-4200

Application No. 16959352 **Drawings filed: 06/30/2020**

IDENTIFICATION OF DRAWING DEFICIENCIES

- [ ] There is a hole or the image thereof within the illustration. FIG(s)
- [ ] The illustration is penetrated or traversed by a solid or broken line that is not intended to be part of the drawing, such as a dark line caused by a flaw in the copying process. FIG(s)
- [ ] An ink stamp or the image thereof obscures part of the illustration. FIG(s)
- [ ] The drawing is marred by black smudges, obliterations, or fax/copier marks (for example, speckles or dots in a substantial portion of the drawing). FIG(s)
- [ ] Figure numbers are duplicated or missing. FIG(s)
- [ ] Drawing sheet or figure is missing. FIG(s)
- [ ] Numbers, letters, or reference characters in the drawing have been crossed out or are illegibly handwritten. FIG(s)
- [ ] The character of the lines, numbers, and letters is poor. FIG(s)
- [ ] The drawing's background shows that the original drawing was made on graph paper or other paper with a pattern or decoration. FIG(s)
- [ ] The FIG. number label is placed in a location that causes the drawing to be read upside down. FIG(s)
- [ ] Data, a reference number, or part of the drawing is truncated or missing, or a lead line has no reference number. FIG(s)
- [ ] The drawing and/or the FIG. label contain(s) foreign language. FIG(s)
- [X] This utility application contains a photograph of a view that is capable of being illustrated as a line drawing. FIG(s) 3, 4
- [ ] A petition under 37 CFR 1.84(a)(2) to accept color drawings has been granted, but the brief description of the drawings in the specification does not contain (or has not been amended to contain) the paragraph required by 37 CFR 1.84(a)(2)(iii).
- [ ] This reissue application contains added and/or amended drawings that are not labeled as "New" or "Amended" or "Canceled" as required by 37 CFR 1.173(b)(3). FIG(s)
- [ ] This Design reissue application contains a drawing that is labeled as "Canceled" but is not surrounded by brackets, or a drawing that is surrounded by brackets but is not labeled as "Canceled." See 37 CFR 1.173(b)(3). FIG(s)
- [ ] OTHER:
- [ ] COMMENTS:

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Inventor:	Seung Min KIM
Appl. No.:	16/959,352
Conf. No.:	1067
Filing Date:	June 30, 2020
Title:	ELECTROLYTIC COPPER FOIL HAVING EXCELLENT HANDLING CHARACTERISTICS IN POSTPROCESSING, AND MANUFACTURING METHOD THEREFOR
Art Unit:	1784
Examiner:	DUMBRIS, SETH M
Docket No.:	0313221.00022

Mail Stop Missing Parts
Commissioner for Patents
P.O. Box 1450
Alexandria VA 22313-1450

RESPONSE TO NOTICE TO FILE CORRECTED APPLICATION PAPERS

Commissioner:

In response to the Notice to File Corrected Application Papers dated January 3, 2023, please consider the following:

Amendments to the Drawings begin on page 2 of this paper.

Remarks beginning on page 3 of this paper.

Amendments to the Drawings:

Applicant submits herewith Replacement Sheets for Fig. 3 and Fig. 4. No new matter has been added by submission of these Replacement Sheets.

Attachments: 2 Replacement Sheets (Fig. 3 and Fig. 4)

REMARKS

This Response is submitted in reply to the Notice to File Corrected Application Papers dated January 3, 2023 (hereafter "Notice"). The Notice indicated that Fig. 3 and Fig.4 contained a photograph that was capable of being illustrated as a line drawing.

In response, Applicant submits herewith a replacement drawing for Fig. 3 and Fig. 4, which has updated each photograph to a line drawing. Applicant submits that no new matter has been added by way of these amendments.

Accordingly, Applicant believes this to be responsive to the Notice, and thus respectfully requests entry of this Response.

It is believed no fees are due with this response. The Commissioner is hereby authorized to charge deposit account 02-1818 for any fees which are due and owing. If any such charges are applied, please indicate Attorney Docket No. 0313221.00022 on the account statement.

Respectfully submitted,

K&L Gates LLP

BY /Matthew S. Dicke/
Matthew S. Dicke
Reg. No. 58819
Customer No. 24573
Telephone: 312-578-5415

Dated: January 20, 2023

UNITED STATES PATENT AND TRADEMARK OFFICE

UNITED STATES DEPARTMENT OF COMMERCE
United States Patent and Trademark Office
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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
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Applicant : Kim
Filing Date : 06/30/2020
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See attachment(s).

A copy of this notice MUST be returned with the reply. Please address response to "Mail Stop Issue Fee, Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450".

/Julia Walsh/
Publication Branch
Office of Data Management
(571) 272-4200

Application No. 16959352 **Drawings filed: 06/30/2020**

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- [ ] This Design reissue application contains a drawing that is labeled as “Canceled” but is not surrounded by brackets, or a drawing that is surrounded by brackets but is not labeled as “Canceled.” See 37 CFR 1.173(b)(3). FIG(s)
- [ ] OTHER:
- [ ] COMMENTS:

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United States Patent and Trademark Office
Address: COMMISSIONER FOR PATENTS
P.O. Box 1450
Alexandria, Virginia 22313-1450
www.uspto.gov

NOTICE OF ALLOWANCE AND FEE(S) DUE

24573 7590 12/22/2022

K&L Gates LLP-Chicago
P.O. Box 1135
Chicago, IL 60690

EXAMINER
DUMBRIS, SETH M

ART UNIT	PAPER NUMBER
1784	

DATE MAILED: 12/22/2022

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
16/959,352	06/30/2020	Seung Min KIM	0313221.00022	1067

TITLE OF INVENTION: ELECTROLYTIC COPPER FOIL HAVING EXCELLENT HANDLING CHARACTERISTICS IN POSTPROCESSING, AND MANUFACTURING METHOD THEREFOR

APPLN. TYPE	ENTITY STATUS	ISSUE FEE DUE	PUBLICATION FEE DUE	PREV. PAID ISSUE FEE	TOTAL FEE(S) DUE	DATE DUE
nonprovisional	UNDISCOUNTED	$1200	$0.00	$0.00	$1200	03/22/2023

THE APPLICATION IDENTIFIED ABOVE HAS BEEN EXAMINED AND IS ALLOWED FOR ISSUANCE AS A PATENT. PROSECUTION ON THE MERITS IS CLOSED. THIS NOTICE OF ALLOWANCE IS NOT A GRANT OF PATENT RIGHTS. THIS APPLICATION IS SUBJECT TO WITHDRAWAL FROM ISSUE AT THE INITIATIVE OF THE OFFICE OR UPON PETITION BY THE APPLICANT. SEE 37 CFR 1.313 AND MPEP 1308.

THE ISSUE FEE AND PUBLICATION FEE (IF REQUIRED) MUST BE PAID WITHIN THREE MONTHS FROM THE MAILING DATE OF THIS NOTICE OR THIS APPLICATION SHALL BE REGARDED AS ABANDONED. THIS STATUTORY PERIOD CANNOT BE EXTENDED. SEE 35 U.S.C. 151. THE ISSUE FEE DUE INDICATED ABOVE DOES NOT REFLECT A CREDIT FOR ANY PREVIOUSLY PAID ISSUE FEE IN THIS APPLICATION. IF AN ISSUE FEE HAS PREVIOUSLY BEEN PAID IN THIS APPLICATION (AS SHOWN ABOVE), THE RETURN OF PART B OF THIS FORM WILL BE CONSIDERED A REQUEST TO REAPPLY THE PREVIOUSLY PAID ISSUE FEE TOWARD THE ISSUE FEE NOW DUE.

HOW TO REPLY TO THIS NOTICE:

I. Review the ENTITY STATUS shown above. If the ENTITY STATUS is shown as SMALL or MICRO, verify whether entitlement to that entity status still applies.

If the ENTITY STATUS is the same as shown above, pay the TOTAL FEE(S) DUE shown above.

If the ENTITY STATUS is changed from that shown above, on PART B - FEE(S) TRANSMITTAL, complete section number 5 titled "Change in Entity Status (from status indicated above)".

For purposes of this notice, small entity fees are 1/2 the amount of undiscounted fees, and micro entity fees are 1/2 the amount of small entity fees.

II. PART B - FEE(S) TRANSMITTAL, or its equivalent, must be completed and returned to the United States Patent and Trademark Office (USPTO) with your ISSUE FEE and PUBLICATION FEE (if required). If you are charging the fee(s) to your deposit account, section "4b" of Part B - Fee(s) Transmittal should be completed. If an equivalent of Part B is filed, a request to reapply a previously paid issue fee must be clearly made, and delays in processing may occur due to the difficulty in recognizing the paper as an equivalent of Part B.

III. All communications regarding this application must give the application number. Please direct all communications prior to issuance to Mail Stop ISSUE FEE unless advised to the contrary.

IMPORTANT REMINDER: Maintenance fees are due in utility patents issuing on applications filed on or after Dec. 12, 1980. It is patentee's responsibility to ensure timely payment of maintenance fees when due. More information is available at www.uspto.gov/PatentMaintenanceFees.

PART B - FEE(S) TRANSMITTAL

Complete and send this form, together with applicable fee(s), by mail or fax, or via EFS-Web.

By mail, send to: Mail Stop ISSUE FEE
Commissioner for Patents
P.O. Box 1450
Alexandria, Virginia 22313-1450

By fax, send to: (571)-273-2885

INSTRUCTIONS: This form should be used for transmitting the ISSUE FEE and PUBLICATION FEE (if required). Blocks 1 through 5 should be completed where appropriate. All further correspondence including the Patent, advance orders and notification of maintenance fees will be mailed to the current correspondence address as indicated unless corrected below or directed otherwise in Block 1, by (a) specifying a new correspondence address; and/or (b) indicating a separate "FEE ADDRESS" for maintenance fee notifications.

CURRENT CORRESPONDENCE ADDRESS (Note: Use Block 1 for any change of address)

24573 7590 12/22/2022

K&L Gates LLP-Chicago
P.O. Box 1135
Chicago, IL 60690

Note: A certificate of mailing can only be used for domestic mailings of the Fee(s) Transmittal. This certificate cannot be used for any other accompanying papers. Each additional paper, such as an assignment or formal drawing, must have its own certificate of mailing or transmission.

Certificate of Mailing or Transmission

I hereby certify that this Fee(s) Transmittal is being deposited with the United States Postal Service with sufficient postage for first class mail in an envelope addressed to the Mail Stop ISSUE FEE address above, or being transmitted to the USPTO via EFS-Web or by facsimile to (571) 273-2885, on the date below.

(Typed or printed name)
(Signature)
(Date)

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
16/959,352	06/30/2020	Seung Min KIM	0313221.00022	1067

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APPLN. TYPE	ENTITY STATUS	ISSUE FEE DUE	PUBLICATION FEE DUE	PREV. PAID ISSUE FEE	TOTAL FEE(S) DUE	DATE DUE
nonprovisional	UNDISCOUNTED	$1200	$0.00	$0.00	$1200	03/22/2023

EXAMINER	ART UNIT	CLASS-SUBCLASS
DUMBRIS, SETH M	1784	428-606000

1. Change of correspondence address or indication of "Fee Address" (37 CFR 1.363).

❑ Change of correspondence address (or Change of Correspondence Address form PTO/AIA/122 or PTO/SB/122) attached.

❑ "Fee Address" indication (or "Fee Address" Indication form PTO/AIA/47 or PTO/SB/47; Rev 03-02 or more recent) attached. **Use of a Customer Number is required.**

2. For printing on the patent front page, list
(1) The names of up to 3 registered patent attorneys or agents OR, alternatively,
(2) The name of a single firm (having as a member a registered attorney or agent) and the names of up to 2 registered patent attorneys or agents. If no name is listed, no name will be printed.

1 _____
2 _____
3 _____

3. ASSIGNEE NAME AND RESIDENCE DATA TO BE PRINTED ON THE PATENT (print or type)

PLEASE NOTE: Unless an assignee is identified below, no assignee data will appear on the patent. If an assignee is identified below, the document must have been previously recorded, or filed for recordation, as set forth in 37 CFR 3.11 and 37 CFR 3.81(a). Completion of this form is NOT a substitute for filing an assignment.

(A) NAME OF ASSIGNEE (B) RESIDENCE: (CITY and STATE OR COUNTRY)

Please check the appropriate assignee category or categories (will not be printed on the patent) : ❑ Individual ❑ Corporation or other private group entity ❑ Government

4a. Fees submitted: ❑Issue Fee ❑Publication Fee (if required) ❑Advance Order - # of Copies _____

4b. Method of Payment: *(Please first reapply any previously paid fee shown above)*

❑ Electronic Payment via EFS-Web ❑ Enclosed check ❑ Non-electronic payment by credit card (Attach form PTO-2038)

❑ The Director is hereby authorized to charge the required fee(s), any deficiency, or credit any overpayment to Deposit Account No. _____

5. **Change in Entity Status** (from status indicated above)

❑ Applicant certifying micro entity status. See 37 CFR 1.29

❑ Applicant asserting small entity status. See 37 CFR 1.27

❑ Applicant changing to regular undiscounted fee status.

NOTE: Absent a valid certification of Micro Entity Status (see forms PTO/SB/15A and 15B), issue fee payment in the micro entity amount will not be accepted at the risk of application abandonment.
NOTE: If the application was previously under micro entity status, checking this box will be taken to be a notification of loss of entitlement to micro entity status.
NOTE: Checking this box will be taken to be a notification of loss of entitlement to small or micro entity status, as applicable.

NOTE: This form must be signed in accordance with 37 CFR 1.31 and 1.33. See 37 CFR 1.4 for signature requirements and certifications.

Authorized Signature _____ Date _____

Typed or printed name _____ Registration No. _____

UNITED STATES PATENT AND TRADEMARK OFFICE

UNITED STATES DEPARTMENT OF COMMERCE
United States Patent and Trademark Office
Address: COMMISSIONER FOR PATENTS
P.O. Box 1450
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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
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EXAMINER	
DUMBRIS, SETH M	
ART UNIT	PAPER NUMBER
1784	

DATE MAILED: 12/22/2022

Determination of Patent Term Adjustment under 35 U.S.C. 154 (b)
(Applications filed on or after May 29, 2000)

The Office has discontinued providing a Patent Term Adjustment (PTA) calculation with the Notice of Allowance.

Section 1(h)(2) of the AIA Technical Corrections Act amended 35 U.S.C. 154(b)(3)(B)(i) to eliminate the requirement that the Office provide a patent term adjustment determination with the notice of allowance. See Revisions to Patent Term Adjustment, 78 Fed. Reg. 19416, 19417 (Apr. 1, 2013). Therefore, the Office is no longer providing an initial patent term adjustment determination with the notice of allowance. The Office will continue to provide a patent term adjustment determination with the Issue Notification Letter that is mailed to applicant approximately three weeks prior to the issue date of the patent, and will include the patent term adjustment on the patent. Any request for reconsideration of the patent term adjustment determination (or reinstatement of patent term adjustment) should follow the process outlined in 37 CFR 1.705.

Any questions regarding the Patent Term Extension or Adjustment determination should be directed to the Office of Patent Legal Administration at (571)-272-7702. Questions relating to issue and publication fee payments should be directed to the Customer Service Center of the Office of Patent Publication at 1-(888)-786-0101 or (571)-272-4200.

OMB Clearance and PRA Burden Statement for PTOL-85 Part B

The Paperwork Reduction Act (PRA) of 1995 requires Federal agencies to obtain Office of Management and Budget approval before requesting most types of information from the public. When OMB approves an agency request to collect information from the public, OMB (i) provides a valid OMB Control Number and expiration date for the agency to display on the instrument that will be used to collect the information and (ii) requires the agency to inform the public about the OMB Control Number's legal significance in accordance with 5 CFR 1320.5(b).

The information collected by PTOL-85 Part B is required by 37 CFR 1.311. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.14. This collection is estimated to take 30 minutes to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, Virginia 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, Virginia 22313-1450. Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it displays a valid OMB control number.

Privacy Act Statement

The Privacy Act of 1974 (P.L. 93-579) requires that you be given certain information in connection with your submission of the attached form related to a patent application or patent. Accordingly, pursuant to the requirements of the Act, please be advised that: (1) the general authority for the collection of this information is 35 U.S.C. 2(b)(2); (2) furnishing of the information solicited is voluntary; and (3) the principal purpose for which the information is used by the U.S. Patent and Trademark Office is to process and/or examine your submission related to a patent application or patent. If you do not furnish the requested information, the U.S. Patent and Trademark Office may not be able to process and/or examine your submission, which may result in termination of proceedings or abandonment of the application or expiration of the patent.

The information provided by you in this form will be subject to the following routine uses:

1. The information on this form will be treated confidentially to the extent allowed under the Freedom of Information Act (5 U.S.C. 552) and the Privacy Act (5 U.S.C 552a). Records from this system of records may be disclosed to the Department of Justice to determine whether disclosure of these records is required by the Freedom of Information Act.
2. A record from this system of records may be disclosed, as a routine use, in the course of presenting evidence to a court, magistrate, or administrative tribunal, including disclosures to opposing counsel in the course of settlement negotiations.
3. A record in this system of records may be disclosed, as a routine use, to a Member of Congress submitting a request involving an individual, to whom the record pertains, when the individual has requested assistance from the Member with respect to the subject matter of the record.
4. A record in this system of records may be disclosed, as a routine use, to a contractor of the Agency having need for the information in order to perform a contract. Recipients of information shall be required to comply with the requirements of the Privacy Act of 1974, as amended, pursuant to 5 U.S.C. 552a(m).
5. A record related to an International Application filed under the Patent Cooperation Treaty in this system of records may be disclosed, as a routine use, to the International Bureau of the World Intellectual Property Organization, pursuant to the Patent Cooperation Treaty.
6. A record in this system of records may be disclosed, as a routine use, to another federal agency for purposes of National Security review (35 U.S.C. 181) and for review pursuant to the Atomic Energy Act (42 U.S.C. 218(c)).
7. A record from this system of records may be disclosed, as a routine use, to the Administrator, General Services, or his/her designee, during an inspection of records conducted by GSA as part of that agency's responsibility to recommend improvements in records management practices and programs, under authority of 44 U.S.C. 2904 and 2906. Such disclosure shall be made in accordance with the GSA regulations governing inspection of records for this purpose, and any other relevant (i.e., GSA or Commerce) directive. Such disclosure shall not be used to make determinations about individuals.
8. A record from this system of records may be disclosed, as a routine use, to the public after either publication of the application pursuant to 35 U.S.C. 122(b) or issuance of a patent pursuant to 35 U.S.C. 151. Further, a record may be disclosed, subject to the limitations of 37 CFR 1.14, as a routine use, to the public if the record was filed in an application which became abandoned or in which the proceedings were terminated and which application is referenced by either a published application, an application open to public inspection or an issued patent.
9. A record from this system of records may be disclosed, as a routine use, to a Federal, State, or local law enforcement agency, if the USPTO becomes aware of a violation or potential violation of law or regulation.

Notice of Allowability	**Application No.** 16/959,352	**Applicant(s)** KIM et al.	
	Examiner SETH DUMBRIS	**Art Unit** 1784	**AIA (FITF) Status** Yes

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address--

All claims being allowable, PROSECUTION ON THE MERITS IS (OR REMAINS) CLOSED in this application. If not included herewith (or previously mailed), a Notice of Allowance (PTOL-85) or other appropriate communication will be mailed in due course. **THIS NOTICE OF ALLOWABILITY IS NOT A GRANT OF PATENT RIGHTS.** This application is subject to withdrawal from issue at the initiative of the Office or upon petition by the applicant. See 37 CFR 1.313 and MPEP 1308.

1. ☑ This communication is responsive to 05 July 2022; 05 August 2022 ; 05 October 2022.
   ☐ A declaration(s)/affidavit(s) under **37 CFR 1.130(b)** was/were filed on _____.

2. ☐ An election was made by the applicant in response to a restriction requirement set forth during the interview on _____; the restriction requirement and election have been incorporated into this action.

3. ☑ The allowed claim(s) is/are 1-7 and 11-13 . As a result of the allowed claim(s), you may be eligible to benefit from the **Patent Prosecution Highway** program at a participating intellectual property office for the corresponding application. For more information , please see **http://www.uspto.gov/patents/init_events/pph/index.jsp** or send an inquiry to **PPHfeedback@uspto.gov.**

4. ☑ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

   Certified copies:

   a) ☑ All b) ☐ Some* c) ☐ None of the:

   1. ☐ Certified copies of the priority documents have been received.
   2. ☐ Certified copies of the priority documents have been received in Application No. _____ .
   3. ☑ Copies of the certified copies of the priority documents have been received in this national stage application from the International Bureau (PCT Rule 17.2(a)).

   * Certified copies not received: _____ .

Applicant has THREE MONTHS FROM THE "MAILING DATE" of this communication to file a reply complying with the requirements noted below. Failure to timely comply will result in ABANDONMENT of this application.
THIS THREE-MONTH PERIOD IS NOT EXTENDABLE.

5. ☐ CORRECTED DRAWINGS (as "replacement sheets") must be submitted.
   ☐ including changes required by the attached Examiner's Amendment / Comment or in the Office action of Paper No./Mail Date _____ .

   Identifying indicia such as the application number (see 37 CFR 1.84(c)) should be written on the drawings in the front (not the back) of each sheet. Replacement sheet(s) should be labeled as such in the header according to 37 CFR 1.121(d).

6. ☐ DEPOSIT OF and/or INFORMATION about the deposit of BIOLOGICAL MATERIAL must be submitted. Note the attached Examiner's comment regarding REQUIREMENT FOR THE DEPOSIT OF BIOLOGICAL MATERIAL.

Attachment(s)

1. ☐ Notice of References Cited (PTO-892)
2. ☐ Information Disclosure Statements (PTO/SB/08), Paper No./Mail Date _____.
3. ☐ Examiner's Comment Regarding Requirement for Deposit of Biological Material _____.
4. ☐ Interview Summary (PTO-413), Paper No./Mail Date. _____.
5. ☐ Examiner's Amendment/Comment
6. ☑ Examiner's Statement of Reasons for Allowance
7. ☐ Other _____.

/SETH DUMBRIS/
Primary Examiner, Art Unit 1784

DETAILED ACTION

Notice of Pre-AIA or AIA Status

1. The present application, filed on or after March 16, 2013, is being examined under the first inventor to file provisions of the AIA.

Continued Examination Under 37 CFR 1.114

2. A request for continued examination under 37 CFR 1.114, including the fee set forth in 37 CFR 1.17(e), was filed in this application after final rejection. Since this application is eligible for continued examination under 37 CFR 1.114, and the fee set forth in 37 CFR 1.17(e) has been timely paid, the finality of the previous Office action has been withdrawn pursuant to 37 CFR 1.114. Applicant's submission filed on 05 October 2022 has been entered.

Terminal Disclaimer

3. The terminal disclaimer filed on 05 August 2022 disclaiming the terminal portion of any patent granted on this application which would extend beyond the expiration date of **US 10,547,081** has been reviewed and is accepted. The terminal disclaimer has been recorded.

Allowable Subject Matter

4. Claims 1-7 and 11-13 are allowed.

5. The following is an examiner's statement of reasons for allowance: Please see remarks regarding allowability in the Office action 27 December 2021.

6. Any comments considered necessary by applicant must be submitted no later than the payment of the issue fee and, to avoid processing delays, should preferably accompany the issue fee. Such submissions should be clearly labeled "Comments on Statement of Reasons for Allowance."

Response to Arguments

7. Applicant's arguments, see remarks filed 05 October 2022, filed 1-7 and 11-13, with respect to Double Patenting Rejections have been fully considered and are persuasive. The rejection of claims 1-7 and 11-13 has been withdrawn. Applicant has filed the requisite terminal disclaimer over US 10,547,081 obviating the rejection.

8. Applicant's arguments, see remarks, filed 05 July 2022, with respect to 35 USC 112(b) have been fully considered and are persuasive. The rejection of claims 11-13 has been withdrawn. Applicant has amended the claims to remove indefiniteness.

Conclusion

9. Any inquiry concerning this communication or earlier communications from the examiner should be directed to SETH DUMBRIS whose telephone number is (571)272-5105. The examiner can normally be reached M-F 6:00 AM - 3:30 PM.

Examiner interviews are available via telephone, in-person, and video conferencing using a USPTO supplied web-based collaboration tool. To schedule an

interview, applicant is encouraged to use the USPTO Automated Interview Request (AIR) at http://www.uspto.gov/interviewpractice.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Humera Sheikh can be reached on 571-272-0604. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

Information regarding the status of published or unpublished applications may be obtained from Patent Center. Unpublished application information in Patent Center is available to registered users. To file and manage patent submissions in Patent Center, visit: https://patentcenter.uspto.gov. Visit https://www.uspto.gov/patents/apply/patent-center for more information about Patent Center and https://www.uspto.gov/patents/docx for information about filing in DOCX format. For additional questions, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free). If you would like assistance from a USPTO Customer Service Representative, call 800-786-9199 (IN USA OR CANADA) or 571-272-1000.

SETH DUMBRIS
Primary Examiner
Art Unit 1784

/SETH DUMBRIS/
Primary Examiner, Art Unit 1784

Search Notes	Application/Control No.	Applicant(s)/Patent Under Reexamination
	16/959,352	KIM et al.
	Examiner	Art Unit
	SETH DUMBRIS	1784

CPC - Searched*		
Symbol	Date	Examiner

CPC Combination Sets - Searched*		
Symbol	Date	Examiner

US Classification - Searched*			
Class	Subclass	Date	Examiner

* See search history printout included with this form or the SEARCH NOTES box below to determine the scope of the search.

/SETH DUMBRIS/ Primary Examiner, Art Unit 1784	

Search Notes	Application/Control No.	Applicant(s)/Patent Under Reexamination
	16/959,352	KIM et al.
	Examiner	Art Unit
	SETH DUMBRIS	1784

Search Notes		
Search Notes	**Date**	**Examiner**
Inventor, applicant, and assignee searches	12/20/2021	SD
Reviewed IDS's and ISR	12/20/2021	SD
Global Dossier review	12/20/2021	SD
Searched B32B15/01 (text limited)	12/20/2021	SD
Searched C25D1/04; 3/38; 5/34, 48; 7/0614; 21/06 (text limited)	12/20/2021	SD
Searched H01M4/0404, 13, 66, 661, 667; 10/052, 0525; 2004/027 (text limited)	12/20/2021	SD
Searched Y02E60/10 (text limited)	12/20/2021	SD
Searched Y10T428/12431, 12438 (text limited)	12/20/2021	SD
Keyword search of USPat, USPgPub, USOCR, EPO, FPRS, JPO, and DERWENT	12/20/2021	SD
Updated EAST, applicant, inventor, and assignee searches	03/31/2022	SD
Further searched above classifications and databases	03/31/2022	SD
Updated EAST, applicant, inventor, and assignee searches	07/06/2022	SD
Interference search	07/06/2022	SD
PE2E Search by keyword of USPat, USPgPub, USOCR, EPO, FIT, FPRS, JPO, and DERWENT	12/09/2022	SD
Further searched above classifications and databases	12/09/2022	SD
Interference search	12/09/2022	SD

Interference Search			
US Class/CPC Symbol	**US Subclass/CPC Group**	**Date**	**Examiner**
B32B	15/01	12/09/2022	SD
C25D	1/04; 3/38; 5/34, 48; 7/0614; 21/06	12/09/2022	SD
H01M	4/0404, 13, 66, 661, 667; 10/052, 0525; 2004/027	12/09/2022	SD
Y02E	60/10	12/09/2022	SD
Y10T	428/12431, 12438	12/09/2022	SD

/SETH DUMBRIS/ Primary Examiner, Art Unit 1784	

Search Notes	Application/Control No.	Applicant(s)/Patent Under Reexamination
	16/959,352	KIM et al.
	Examiner	Art Unit
	SETH DUMBRIS	1784

/SETH DUMBRIS/ Primary Examiner, Art Unit 1784	

Issue Classification	Application/Control No.	Applicant(s)/Patent Under Reexamination
	16/959,352	KIM et al.
	Examiner	Art Unit
	SETH DUMBRIS	1784

CPC						
Symbol					Type	Version
C25D	/	1	/	04	F	2013-01-01
C25D	/	3	/	38	I	2013-01-01
C25D	/	7	/	0614	I	2013-01-01
H01M	/	4	/	13	I	2013-01-01
H01M	/	4	/	661	I	2013-01-01
H01M	/	10	/	052	A	2013-01-01
Y10T	/	428	/	12431	A	2015-01-15

CPC Combination Sets							
Symbol					Type	Set	Ranking	Version
	/		/					

NONE		Total Claims Allowed:	
(Assistant Examiner)	(Date)	10	
/SETH DUMBRIS/ Primary Examiner, Art Unit 1784	09 December 2022	O.G. Print Claim(s)	O.G. Print Figure
(Primary Examiner)	(Date)	1	2

U.S. Patent and Trademark Office — Part of Paper No.: 20221013

Issue Classification	Application/Control No.	Applicant(s)/Patent Under Reexamination
	16/959,352	KIM et al.
	Examiner	**Art Unit**
	SETH DUMBRIS	1784

INTERNATIONAL CLASSIFICATION					
CLAIMED					
C25D	/	7	/	06	

NON-CLAIMED					
	/		/		

US ORIGINAL CLASSIFICATION	
CLASS	**SUBCLASS**
428	606

CROSS REFERENCES(S)						
CLASS	**SUBCLASS (ONE SUBCLASS PER BLOCK)**					

NONE (Assistant Examiner) (Date)		**Total Claims Allowed:** 10	
/SETH DUMBRIS/ Primary Examiner, Art Unit 1784 (Primary Examiner)	09 December 2022 (Date)	O.G. Print Claim(s) 1	O.G. Print Figure 2

U.S. Patent and Trademark Office — Part of Paper No.: 20221013

Issue Classification	Application/Control No.	Applicant(s)/Patent Under Reexamination
	16/959,352	KIM et al.
	Examiner	Art Unit
	SETH DUMBRIS	1784

☑ Claims renumbered in the same order as presented by applicant ☐ CPA ☑ T.D. ☐ R.1.47

CLAIMS															
Final	Original	Final	Original	Final	Original	Final	Original	Final	Original	Final	Original	Final	Original	Final	Original

NONE (Assistant Examiner)	(Date)	Total Claims Allowed: 10	
/SETH DUMBRIS/ Primary Examiner, Art Unit 1784 (Primary Examiner)	09 December 2022 (Date)	O.G. Print Claim(s) 1	O.G. Print Figure 2

U.S. Patent and Trademark Office Part of Paper No.: 20221013

PE2E SEARCH - Search History (Prior Art)

Ref #	Hits	Search Query	DBs	Default Operator	Plurals	British Equivalents	Time Stamp
L1	12	((("JIN") near3 ("Shan") near3 ("Hua"))).INV.	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2021/11/15 10:01 AM
L2	22	((("LEE") near3 ("An") near3 ("Na"))).INV.	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2021/11/15 10:01 AM
L3	114	((("KIM") near3 ("Seung") near3 ("Min"))).INV.	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2021/11/15 10:01 AM
L4	383	((("JIN") near3 ("Shan" or Hua or "shanhua" or "shan-hua"))).INV.	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2021/11/15 10:02 AM
L5	942	((("LEE") near3 ("An" or Na or "An-Na"))).INV.	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2021/11/15 10:02 AM
L6	18027	((("KIM") near3 ("Seung" or Min or "SeungMin" or "Seung-Min"))).INV.	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2021/11/15 10:03 AM
L7	49	((("JIN") near3 ("Shan" or Hua or "shanhua" or "shan-hua"))).aanm.	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2021/11/15 10:03 AM
L8	110	((("LEE") near3 ("An" or Na or "An-Na"))).aanm.	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2021/11/15 10:03 AM
L9	2032	((("KIM") near3 ("Seung" or Min or "SeungMin" or "Seung-Min"))).aanm.	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2021/11/15 10:03 AM
L10	19281	L1 or L2 or L3 or L4 or L5 or L6 or L7 or L8 or L9	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2021/11/15 10:03 AM
L11	1900	"L11" and ((Cu or copper or "cu-alloy" or "cu-base" or "Cu-based" or "copper-base" or "copper-based" or "copper-alloy") with (foil or foiled or foiling or tape or ribbon or layer or layered or layering or film or filmed or filming or clad or claded or cladded or clading or cladding or coat or coated or coating or electroplate or electroplated or electroplating or electroless or electrolessly or electroform or electroformed or	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2021/11/15 10:03 AM

		electroforming or electrodeposit or electrodeposited or electrodepositing or electrodeposition or "electro-plate" or "electro-plated" or "electro-plating" or "electro-less" or "electro-lessly" or "electro-form" or "electro-formed" or "electro-forming" or "electro-deposit" or "electro-deposited" or "electro-depositing" or "electro-deposition"))					
L12	1930	L10 and ((Cu or copper or "cu-alloy" or "cu-base" or "Cu-based" or "copper-base" or "copper-based" or "copper-alloy") with (foil or foiled or foiling or tape or ribbon or layer or layered or layering or film or filmed or filming or clad or claded or cladded or clading or cladding or coat or coated or coating or electroplate or electroplated or electroplating or electroless or electrolessly or electroform or electroformed or electroforming or electrodeposit or electrodeposited or electrodepositing or electrodeposition or "electro-plate" or "electro-plated" or "electro-plating" or "electro-less" or "electro-lessly" or "electro-form" or "electro-formed" or "electro-forming" or "electro-deposit" or "electro-deposited" or "electro-depositing" or "electro-deposition"))	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2021/11/15 10:04 AM
L13	11	L12 and (("220" or "[220]" or "{220}" or	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2021/11/15 10:06 AM

		"(220)" or "<220>") near5 (texture or coefficient or index or Miller or hkl or "h,k,l"))					
L14	58	((KCF) near3 (tech or technol or technology)).as,aanm.	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2021/11/15 10:24 AM
L15	50	L14 not L13	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2021/11/15 10:24 AM
L16	150158	B32B15/01;C25D1/04;C25D3/38;C25D5/34,48;C25D21/06;H01M4/0404,13,66,661,667;H01M10/052,0525;H01M2004/027;Y02E60/10;Y10T428/12431,12438.cpc.	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2021/11/15 10:53 AM
L17	41417	L16 and ((Cu or copper or "cu-alloy" or "cu-base" or "Cu-based" or "copper-base" or "copper-based" or "copper-alloy") near5 (foil or foiled or foiling or tape or ribbon or layer or layered or layering or film or filmed or filming or clad or claded or cladded or clading or cladding or coat or coated or coating or electroplate or electroplated or electroplating or electroless or electrolessly or electroform or electroformed or electroforming or electrodeposit or electrodeposited or electrodepositing or electrodeposition or "electro-plate" or "electro-plated" or "electro-plating" or "electro-less" or "electro-lessly" or "electro-form" or "electro-formed" or "electro-forming" or "electro-deposit" or "electro-deposited" or "electro-depositing" or "electro-deposition"))	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2021/11/15 11:03 AM
L18	81	L17 and (("220" or "[220]" or "{220}" or	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2021/11/15 11:04 AM

		"(220)" or "<220>") near5 (texture or coefficient or index or Miller or hkl or "h,k,l"))					
L19	71	L18 not (L13 or L15)	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2021/11/15 11:04 AM
L20	90	L17 and (("220" or "[220]" or "{220}" or "(220)" or "<220>") near8 (texture or coefficient or index or Miller or hkl or "h,k,l"))	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2021/11/15 11:20 AM
L21	9	L20 not (L13 or L15 or L19)	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2021/11/15 11:20 AM
L22	34	L16 and (((Cu or copper or "cu-alloy" or "cu-base" or "Cu-based" or "copper-base" or "copper-based" or "copper-alloy") with (foil or foiled or foiling or tape or ribbon or layer or layered or layering or film or filmed or filming or clad or claded or cladded or clading or cladding or coat or coated or coating or electroplate or electroplated or electroplating or electroless or electrolessly or electroform or electroformed or electroforming or electrodeposit or electrodeposited or electrodepositing or electrodeposition or "electro-plate" or "electro-plated" or "electro-plating" or "electro-less" or "electro-lessly" or "electro-form" or "electro-formed" or "electro-forming" or "electro-deposit" or "electro-deposited" or "electro-depositing" or "electro-deposition")) with (("220" or "[220]" or "{220}" or "(220)" or "<220>") with (texture or coefficient or index or Miller or hkl or "h,k,l")))	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2021/11/15 11:21 AM

L23	1	L22 not (L13 or L15 or L19 or L21)	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2021/11/15 11:22 AM
L24	907698	B32B15/01;C25D1/04;C25D3/38;C25D5/34,48;C25D21/06;H01M4/0404,13,66,661,667;H01M10/052,0525;H01M2004/027;Y02E60/10;Y10T428/12431,12438.cpc.	(FPRS; EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2021/11/15 11:22 AM
L25	64	L24 and (((Cu or copper or "cu-alloy" or "cu-base" or "Cu-based" or "copper-base" or "copper-based" or "copper-alloy") with (foil or foiled or foiling or tape or ribbon or layer or layered or layering or film or filmed or filming or clad or claded or cladded or clading or cladding or coat or coated or coating or electroplate or electroplated or electroplating or electroless or electrolessly or electroform or electroformed or electroforming or electrodeposit or electrodeposited or electrodepositing or electrodeposition or "electro-plate" or "electro-plated" or "electro-plating" or "electro-less" or "electro-lessly" or "electro-form" or "electro-formed" or "electro-forming" or "electro-deposit" or "electro-deposited" or "electro-depositing" or "electro-deposition")) with (("220" or "[220]" or "{220}" or "(220)" or "<220>") with (texture or coefficient or index or Miller or hkl or "h,k,l")))	(FPRS; EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2021/11/15 11:22 AM
L26	17447	L24 and ((Cu or copper or "cu-alloy" or "cu-base" or "Cu-based" or "copper-base" or "copper-based" or	(FPRS; EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2021/11/15 11:29 AM

		"copper-alloy") near5 (foil or foiled or foiling or tape or ribbon or layer or layered or layering or film or filmed or filming or clad or claded or cladded or clading or cladding or coat or coated or coating or electroplate or electroplated or electroplating or electroless or electrolessly or electroform or electroformed or electroforming or electrodeposit or electrodeposited or electrodepositing or electrodeposition or "electro-plate" or "electro-plated" or "electro-plating" or "electro-less" or "electro-lessly" or "electro-form" or "electro-formed" or "electro-forming" or "electro-deposit" or "electro-deposited" or "electro-depositing" or "electro-deposition"))					
L27	60	L26 and (("220" or "[220]" or "{220}" or "(220)" or "<220>") near5 (texture or coefficient or index or Miller or hkl or "h,k,l"))	(FPRS; EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2021/11/15 11:29 AM
L28	9	L27 not L25	(FPRS; EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2021/11/15 11:29 AM
L29	73	L26 and (("220" or "[220]" or "{220}" or "(220)" or "<220>") with (texture or coefficient or index or Miller or hkl or "h,k,l"))	(FPRS; EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2021/11/15 11:30 AM
L30	0	L29 not (L25 or L28)	(FPRS; EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2021/11/15 11:30 AM
L31	21626	L24 and ((Cu or copper or "cu-alloy" or "cu-base" or "Cu-based" or "copper-base" or "copper-based" or "copper-alloy") with (foil or foiled or foiling or	(FPRS; EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2021/11/15 11:30 AM

		tape or ribbon or layer or layered or layering or film or filmed or filming or clad or claded or cladded or clading or cladding or coat or coated or coating or electroplate or electroplated or electroplating or electroless or electrolessly or electroform or electroformed or electroforming or electrodeposit or electrodeposited or electrodepositing or electrodeposition or "electro-plate" or "electro-plated" or "electro-plating" or "electro-less" or "electro-lessly" or "electro-form" or "electro-formed" or "electro-forming" or "electro-deposit" or "electro-deposited" or "electro-depositing" or "electro-deposition"))					
L32	74	L31 and (("220" or "[220]" or "{220}" or "(220)" or "<220>") with (texture or coefficient or index or Miller or hkl or "h,k,l"))	(FPRS; EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2021/11/15 11:30 AM
L33	1	L32 not (L25 or L28)	(FPRS; EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2021/11/15 11:31 AM
L34	30	(((Cu or copper or "cu-alloy" or "cu-base" or "Cu-based" or "copper-base" or "copper-based" or "copper-alloy") near5 (foil or foiled or foiling or tape or ribbon or layer or layered or layering or film or filmed or filming or clad or claded or cladded or clading or cladding or coat or coated or coating or electroplate or electroplated or electroplating or electroless or	(FPRS; EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2021/11/15 11:31 AM

		electrolessly or electroform or electroformed or electroforming or electrodeposit or electrodeposited or electrodepositing or electrodeposition or "electro-plate" or "electro-plated" or "electro-plating" or "electro-less" or "electro-lessly" or "electro-form" or "electro-formed" or "electro-forming" or "electro-deposit" or "electro-deposited" or "electro-depositing" or "electro-deposition")) near5 (("220" or "[220]" or "{220}" or "(220)" or "<220>") near5 (texture or coefficient or index or Miller or hkl or "h,k,l")))					
L35	6	L34 not (L25 or L28 or L33)	(FPRS; EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2021/11/15 11:31 AM
L36	123	(((Cu or copper or "cu-alloy" or "cu-base" or "Cu-based" or "copper-base" or "copper-based" or "copper-alloy") with (foil or foiled or foiling or tape or ribbon or layer or layered or layering or film or filmed or filming or clad or claded or cladded or clading or cladding or coat or coated or coating or electroplate or electroplated or electroplating or electroless or electrolessly or electroform or electroformed or electroforming or electrodeposit or electrodeposited or electrodepositing or electrodeposition or "electro-plate" or "electro-plated" or "electro-plating" or "electro-less" or	(FPRS; EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2021/11/15 11:32 AM

		"electro-lessly" or "electro-form" or "electro-formed" or "electro-forming" or "electro-deposit" or "electro-deposited" or "electro-depositing" or "electro-deposition")) with (("220" or "[220]" or "{220}" or "(220)" or "<220>") with (texture or coefficient or index or Miller or hkl or "h,k,l")))					
L37	53	L36 not (L25 or L28 or L33 or L35)	(FPRS; EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2021/11/15 11:32 AM
L38	46	(((Cu or copper or "cu-alloy" or "cu-base" or "Cu-based" or "copper-base" or "copper-based" or "copper-alloy") near5 (foil or foiled or foiling or tape or ribbon or layer or layered or layering or film or filmed or filming or clad or claded or cladded or clading or cladding or coat or coated or coating or electroplate or electroplated or electroplating or electroless or electrolessly or electroform or electroformed or electroforming or electrodeposit or electrodeposited or electrodepositing or electrodeposition or "electro-plate" or "electro-plated" or "electro-plating" or "electro-less" or "electro-lessly" or "electro-form" or "electro-formed" or "electro-forming" or "electro-deposit" or "electro-deposited" or "electro-depositing" or "electro-deposition")) near5 (("220" or "[220]" or "{220}" or "(220)" or "<220>") near5 (texture or coefficient or index or	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2021/11/15 12:17 PM

		Miller or hkl or "h,k,l")))					
L39	22	L38 not (L13 or L15 or L19 or L21 or L23)	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2021/11/15 12:18 PM
L40	112	(((Cu or copper or "cu-alloy" or "cu-base" or "Cu-based" or "copper-base" or "copper-based" or "copper-alloy") with (foil or foiled or foiling or tape or ribbon or layer or layered or layering or film or filmed or filming or clad or claded or cladded or clading or cladding or coat or coated or coating or electroplate or electroplated or electroplating or electroless or electrolessly or electroform or electroformed or electroforming or electrodeposit or electrodeposited or electrodepositing or electrodeposition or "electro-plate" or "electro-plated" or "electro-plating" or "electro-less" or "electro-lessly" or "electro-form" or "electro-formed" or "electro-forming" or "electro-deposit" or "electro-deposited" or "electro-depositing" or "electro-deposition")) with (("220" or "[220]" or "{220}" or "(220)" or "<220>") with (texture or coefficient or index or Miller or hkl or "h,k,l")))	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2021/11/15 12:22 PM
L41	56	L40 not (L13 or L15 or L19 or L21 or L23 or L39)	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2021/11/15 12:22 PM
L42	44	L17 and (("220" or "[220]" or "{220}" or "(220)" or "<220>") near5 (stress))	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2021/11/15 01:19 PM
L43	2	L24 and (("220" or "[220]" or "{220}" or "(220)" or "<220>")	(FPRS; EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2021/11/15 01:21 PM

		near5 (stress))					
L44	3	L24 and (("111" or "[111]" or "{111}" or "(111)" or "<111>") near5 (stress))	(FPRS; EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2021/11/15 01:22 PM
L45	48	L24 and (("200" or "[200]" or "{200}" or "(200)" or "<200>") near5 (stress))	(FPRS; EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2021/11/15 01:23 PM
L46	0	L24 and (("311" or "[311]" or "{311}" or "(311)" or "<311>") near5 (stress))	(FPRS; EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2021/11/15 01:24 PM
L47	89	((Cu or copper or "cu-alloy" or "cu-base" or "Cu-based" or "copper-base" or "copper-based" or "copper-alloy") near5 (foil or foiled or foiling or tape or ribbon or layer or layered or layering or film or filmed or filming or clad or cladded or cladding or clading or cladding or coat or coated or coating or electroplate or electroplated or electroplating or electroless or electrolessly or electroform or electroformed or electroforming or electrodeposit or electrodeposited or electrodepositing or electrodeposition or "electro-plate" or "electro-plated" or "electro-plating" or "electro-less" or "electro-lessly" or "electro-form" or "electro-formed" or "electro-forming" or "electro-deposit" or "electro-deposited" or "electro-depositing" or "electro-deposition")) and (("111" or "[111]" or "{111}" or "(111)" or "<111>" or "200" or "[200]" or "{200}" or "(200)" or "<200>" or "220" or "[220]" or	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2021/11/15 01:27 PM

		"{220}" or "(220)" or "<220>" or "311" or "[311]" or "{311}" or "(311)" or "<311>") near5 (residual near2 stress))					
L48	127	((Cu or copper or "cu-alloy" or "cu-base" or "Cu-based" or "copper-base" or "copper-based" or "copper-alloy") near8 (foil or foiled or foiling or tape or ribbon or layer or layered or layering or film or filmed or filming or clad or claded or cladded or clading or cladding or coat or coated or coating or electroplate or electroplated or electroplating or electroless or electrolessly or electroform or electroformed or electroforming or electrodeposit or electrodeposited or electrodepositing or electrodeposition or "electro-plate" or "electro-plated" or "electro-plating" or "electro-less" or "electro-lessly" or "electro-form" or "electro-formed" or "electro-forming" or "electro-deposit" or "electro-deposited" or "electro-depositing" or "electro-deposition")) and (("111" or "[111]" or "{111}" or "(111)" or "<111>" or "200" or "[200]" or "{200}" or "(200)" or "<200>" or "220" or "[220]" or "{220}" or "(220)" or "<220>" or "311" or "[311]" or "{311}" or "(311)" or "<311>") near8 (residual near2 stress))	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2021/11/15 01:30 PM
L49	38	L48 not L47	(US-PGPUB; USPAT;	OR	ON	ON	2021/11/15

			USOCR)				01:30 PM
L50	257	((Cu or copper or "cu-alloy" or "cu-base" or "Cu-based" or "copper-base" or "copper-based" or "copper-alloy") with (foil or foiled or foiling or tape or ribbon or layer or layered or layering or film or filmed or filming or clad or claded or cladded or clading or cladding or coat or coated or coating or electroplate or electroplated or electroplating or electroless or electrolessly or electroform or electroformed or electroforming or electrodeposit or electrodeposited or electrodepositing or electrodeposition or "electro-plate" or "electro-plated" or "electro-plating" or "electro-less" or "electro-lessly" or "electro-form" or "electro-formed" or "electro-forming" or "electro-deposit" or "electro-deposited" or "electro-depositing" or "electro-deposition")) and (("111" or "[111]" or "{111}" or "(111)" or "<111>" or "200" or "[200]" or "{200}" or "(200)" or "<200>" or "220" or "[220]" or "{220}" or "(220)" or "<220>" or "311" or "[311]" or "{311}" or "(311)" or "<311>") with (residual near2 stress))	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2021/11/15 01:31 PM
L51	130	L50 not (L47 or L49)	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2021/11/15 01:32 PM
L52	23	((Cu or copper or "cu-alloy" or "cu-base" or "Cu-based" or "copper-base" or "copper-based" or "copper-	(FPRS; EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2021/11/15 01:36 PM

		alloy") with (foil or foiled or foiling or tape or ribbon or layer or layered or layering or film or filmed or filming or clad or claded or cladded or clading or cladding or coat or coated or coating or electroplate or electroplated or electroplating or electroless or electrolessly or electroform or electroformed or electroforming or electrodeposit or electrodeposited or electrodepositing or electrodeposition or "electro-plate" or "electro-plated" or "electro-plating" or "electro-less" or "electro-lessly" or "electro-form" or "electro-formed" or "electro-forming" or "electro-deposit" or "electro-deposited" or "electro-depositing" or "electro-deposition")) and (("111" or "[111]" or "{111}" or "(111)" or "<111>" or "200" or "[200]" or "{200}" or "(200)" or "<200>" or "220" or "[220]" or "{220}" or "(220)" or "<220>" or "311" or "[311]" or "{311}" or "(311)" or "<311>") with (residual near2 stress))					
L53	4	(20090095515|20160260980|9209485|9562298).did.	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2021/11/15 01:47 PM
L54	12	((("JIN") near3 ("Shan") near3 ("Hua"))).INV.	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2021/11/16 07:05 AM
L55	22	((("LEE") near3 ("An") near3 ("Na"))).INV.	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2021/11/16 07:05 AM
L56	114	((("KIM") near3 ("Seung") near3 ("Min"))).INV.	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2021/11/16 07:05 AM
L57	383	((("JIN") near3 ("Shan" or Hua or "shanhua" or	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2021/11/16 07:05 AM

		"shan-hua"))).INV.					
L58	944	((("LEE") near3 ("An" or Na or "An-Na"))).INV.	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2021/11/16 07:05 AM
L59	18038	((("KIM") near3 ("Seung" or Min or "SeungMin" or "Seung-Min"))).INV.	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2021/11/16 07:05 AM
L60	49	((("JIN") near3 ("Shan" or Hua or "shanhua" or "shan-hua"))).aanm.	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2021/11/16 07:05 AM
L61	110	((("LEE") near3 ("An" or Na or "An-Na"))).aanm.	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2021/11/16 07:05 AM
L62	2032	((("KIM") near3 ("Seung" or Min or "SeungMin" or "Seung-Min"))).aanm.	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2021/11/16 07:05 AM
L63	19294	L54 or L55 or L56 or L57 or L58 or L59 or L60 or L61 or L62	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2021/11/16 07:05 AM
L64	1930	L63 and ((Cu or copper or "cu-alloy" or "cu-base" or "Cu-based" or "copper-base" or "copper-based" or "copper-alloy") with (foil or foiled or foiling or tape or ribbon or layer or layered or layering or film or filmed or filming or clad or claded or cladded or clading or cladding or coat or coated or coating or electroplate or electroplated or electroplating or electroless or electrolessly or electroform or electroformed or electroforming or electrodeposit or electrodeposited or electrodepositing or electrodeposition or "electro-plate" or "electro-plated" or "electro-plating" or "electro-less" or "electro-lessly" or "electro-form" or "electro-formed" or "electro-forming" or "electro-deposit" or "electro-deposited" or "electro-depositing" or	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2021/11/16 07:05 AM

		"electro-deposition"))					
L65	11	L64 and (("220" or "[220]" or "{220}" or "(220)" or "<220>") near5 (texture or coefficient or index or Miller or hkl or "h,k,l"))	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2021/11/16 07:05 AM
L66	58	((KCF) near3 (tech or technol or technology)).as,aanm.	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2021/11/16 07:15 AM
L67	50	L66 not L65	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2021/11/16 07:15 AM
L68	4	(2015030873|20070098910|20110171491|20200181790|20180062180).did.	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2021/11/16 07:30 AM
L69	150861	B32B15/01;C25D1/04;C25D3/38;C25D5/34,48;C25D7/0614;C25D21/06;H01M4/0404,13,66,661,667;H01M10/052,0525;H01M2004/027;Y02E60/10;Y10T428/12431,12438.cpc.	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2021/11/16 07:37 AM
L70	150231	B32B15/01;C25D1/04;C25D3/38;C25D5/34,48;C25D21/06;H01M4/0404,13,66,661,667;H01M10/052,0525;H01M2004/027;Y02E60/10;Y10T428/12431,12438.cpc.	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2021/11/16 07:38 AM
L71	41443	L70 and ((Cu or copper or "cu-alloy" or "cu-base" or "Cu-based" or "copper-base" or "copper-based" or "copper-alloy") near5 (foil or foiled or foiling or tape or ribbon or layer or layered or layering or film or filmed or filming or clad or claded or cladded or clading or cladding or coat or coated or coating or electroplate or electroplated or electroplating or electroless or electrolessly or electroform or electroformed or electroforming or electrodeposit or electrodeposited or electrodepositing or	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2021/11/16 07:38 AM

		electrodeposition or "electro-plate" or "electro-plated" or "electro-plating" or "electro-less" or "electro-lessly" or "electro-form" or "electro-formed" or "electro-forming" or "electro-deposit" or "electro-deposited" or "electro-depositing" or "electro-deposition"))					
L72	41443	L71 and ((Cu or copper or "cu-alloy" or "cu-base" or "Cu-based" or "copper-base" or "copper-based" or "copper-alloy") near5 (foil or foiled or foiling or tape or ribbon or layer or layered or layering or film or filmed or filming or clad or claded or cladded or clading or cladding or coat or coated or coating or electroplate or electroplated or electroplating or electroless or electrolessly or electroform or electroformed or electroforming or electrodeposit or electrodeposited or electrodepositing or electrodeposition or "electro-plate" or "electro-plated" or "electro-plating" or "electro-less" or "electro-lessly" or "electro-form" or "electro-formed" or "electro-forming" or "electro-deposit" or "electro-deposited" or "electro-depositing" or "electro-deposition"))	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2021/11/16 07:38 AM
L73	41584	L69 and ((Cu or copper or "cu-alloy" or "cu-base" or "Cu-based" or "copper-base" or "copper-based" or "copper-alloy") near5	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2021/11/16 07:39 AM

		(foil or foiled or foiling or tape or ribbon or layer or layered or layering or film or filmed or filming or clad or claded or cladded or clading or cladding or coat or coated or coating or electroplate or electroplated or electroplating or electroless or electrolessly or electroform or electroformed or electroforming or electrodeposit or electrodeposited or electrodepositing or electrodeposition or "electro-plate" or "electro-plated" or "electro-plating" or "electro-less" or "electro-lessly" or "electro-form" or "electro-formed" or "electro-forming" or "electro-deposit" or "electro-deposited" or "electro-depositing" or "electro-deposition"))					
L74	81	L73 and (("220" or "[220]" or "{220}" or "(220)" or "<220>") near5 (texture or coefficient or index or Miller or hkl or "h,k,l"))	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2021/11/16 07:39 AM
L75	72	L74 not (L63 or L65)	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2021/11/16 07:40 AM
L76	90	L73 and (("220" or "[220]" or "{220}" or "(220)" or "<220>") near8 (texture or coefficient or index or Miller or hkl or "h,k,l"))	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2021/11/16 08:08 AM
L77	9	L76 not (L63 or L65 or L75)	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2021/11/16 08:09 AM
L78	144	L73 and (("220" or "[220]" or "{220}" or "(220)" or "<220>") with (texture or coefficient or index or Miller or hkl or "h,k,l"))	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2021/11/16 08:12 AM
L79	53	L78 not (L63 or L65 or L75 or L77)	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2021/11/16 08:13 AM

L80	429	L73 and ((peak near2 density) or PD.u/c.)	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2021/11/16 08:19 AM
L81	36	L73 and (((peak near2 density) or PD.u/c.) near5 (surface))	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2021/11/16 08:23 AM
L82	9	("20020153254"|"20150030873"|"20140342178"|"20160013493"|"20140017564"|"20140170489"|"20130108887"|"20110056840"|"20190078229").PN.	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2021/11/16 08:32 AM
L83	53	L69 and (((peak near2 density) or PD.u/c.) near5 (surface or shiney or shiny or matt or matte or mat or matted))	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2021/11/16 08:34 AM
L84	17	L83 not (L63 or L65 or L75 or L77 or L81)	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2021/11/16 08:34 AM
L85	910615	B32B15/01;C25D1/04;C25D3/38;C25D5/34,48;C25D7/0614;C25D21/06;H01M4/0404,13,66,661,667;H01M10/052,0525;H01M2004/027;Y02E60/10;Y10T428/12431,12438.cpc.	(FPRS; EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2021/11/16 08:39 AM
L86	64	L85 and (((Cu or copper or "cu-alloy" or "cu-base" or "Cu-based" or "copper-base" or "copper-based" or "copper-alloy") with (foil or foiled or foiling or tape or ribbon or layer or layered or layering or film or filmed or filming or clad or claded or cladded or clading or cladding or coat or coated or coating or electroplate or electroplated or electroplating or electroless or electrolessly or electroform or electroformed or electroforming or electrodeposit or electrodeposited or electrodepositing or electrodeposition or "electro-plate" or "electro-plated" or	(FPRS; EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2021/11/16 08:39 AM

		"electro-plating" or "electro-less" or "electro-lessly" or "electro-form" or "electro-formed" or "electro-forming" or "electro-deposit" or "electro-deposited" or "electro-depositing" or "electro-deposition")) with (("220" or "[220]" or "{220}" or "(220)" or "<220>") with (texture or coefficient or index or Miller or hkl or "h,k,l")))					
L87	16	L85 and (((peak near2 density) or PD.u/c.) near5 (surface or shiney or shiny or matt or matte or mat or matted))	(FPRS; EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2021/11/16 08:47 AM
L88	11	(((Cu or copper or "cu-alloy" or "cu-base" or "Cu-based" or "copper-base" or "copper-based" or "copper-alloy") with (foil or foiled or foiling or tape or ribbon or layer or layered or layering or film or filmed or filming or clad or claded or cladded or clading or cladding or coat or coated or coating or electroplate or electroplated or electroplating or electroless or electrolessly or electroform or electroformed or electroforming or electrodeposit or electrodeposited or electrodepositing or electrodeposition or "electro-plate" or "electro-plated" or "electro-plating" or "electro-less" or "electro-lessly" or "electro-form" or "electro-formed" or "electro-forming" or "electro-deposit" or "electro-deposited" or	(FPRS; EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2021/11/16 08:48 AM

		"electro-depositing" or "electro-deposition")) with (("220" or "[220]" or "{220}" or "(220)" or "<220>") with (texture or coefficient or index or Miller or hkl or "h,k,l"))) and (((peak near2 density) or PD.u/c.) near5 (surface or shiney or shiny or matt or matte or mat or matted))					
L89	0	L88 not L87	(FPRS; EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2021/11/16 08:48 AM
L90	12	(((Cu or copper or "cu-alloy" or "cu-base" or "Cu-based" or "copper-base" or "copper-based" or "copper-alloy") with (foil or foiled or foiling or tape or ribbon or layer or layered or layering or film or filmed or filming or clad or claded or cladded or clading or cladding or coat or coated or coating or electroplate or electroplated or electroplating or electroless or electrolessly or electroform or electroformed or electroforming or electrodeposit or electrodeposited or electrodepositing or electrodeposition or "electro-plate" or "electro-plated" or "electro-plating" or "electro-less" or "electro-lessly" or "electro-form" or "electro-formed" or "electro-forming" or "electro-deposit" or "electro-deposited" or "electro-depositing" or "electro-deposition")) with (("220" or "[220]" or "{220}" or "(220)" or "<220>") with (texture or coefficient or index or	(FPRS; EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2021/11/16 08:49 AM

		Miller or hkl or "h,k,l"))) and (((peak near2 density) or PD.u/c.) with (surface or shiney or shiny or matt or matte or mat or matted))					
L91	1	L90 not L87	(FPRS; EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2021/11/16 08:49 AM
L92	18	((Cu or copper or "cu-alloy" or "cu-base" or "Cu-based" or "copper-base" or "copper-based" or "copper-alloy") near5 (foil or foiled or foiling or tape or ribbon or layer or layered or layering or film or filmed or filming or clad or cladded or cladded or clading or cladding or coat or coated or coating or electroplate or electroplated or electroplating or electroless or electrolessly or electroform or electroformed or electroforming or electrodeposit or electrodeposited or electrodepositing or electrodeposition or "electro-plate" or "electro-plated" or "electro-plating" or "electro-less" or "electro-lessly" or "electro-form" or "electro-formed" or "electro-forming" or "electro-deposit" or "electro-deposited" or "electro-depositing" or "electro-deposition")) near5 (((peak near2 density) or PD.u/c.) near5 (surface or shiney or shiny or matt or matte or mat or matted))	(FPRS; EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2021/11/16 08:51 AM
L93	7	L92 not (L87 or L91)	(FPRS; EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2021/11/16 08:51 AM
L94	20	((Cu or copper or "cu-alloy" or "cu-base" or "Cu-based" or "copper-	(FPRS; EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2021/11/16 08:52 AM

		base" or "copper-based" or "copper-alloy") with (foil or foiled or foiling or tape or ribbon or layer or layered or layering or film or filmed or filming or clad or cladded or cladding or clading or cladding or coat or coated or coating or electroplate or electroplated or electroplating or electroless or electrolessly or electroform or electroformed or electroforming or electrodeposit or electrodeposited or electrodepositing or electrodeposition or "electro-plate" or "electro-plated" or "electro-plating" or "electro-less" or "electro-lessly" or "electro-form" or "electro-formed" or "electro-forming" or "electro-deposit" or "electro-deposited" or "electro-depositing" or "electro-deposition")) with (((peak near2 density) or PD.u/c.) near5 (surface or shiney or shiny or matt or matte or mat or matted))					
L95	1	L94 not (L87 or L91 or L93)	(FPRS; EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2021/11/16 08:52 AM
L96	13	((Cu or copper or "cu-alloy" or "cu-base" or "Cu-based" or "copper-base" or "copper-based" or "copper-alloy") near5 (foil or foiled or foiling or tape or ribbon or layer or layered or layering or film or filmed or filming or clad or cladded or cladding or clading or cladding or coat or coated or coating or	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2021/11/16 08:52 AM

		electroplate or electroplated or electroplating or electroless or electrolessly or electroform or electroformed or electroforming or electrodeposit or electrodeposited or electrodepositing or electrodeposition or "electro-plate" or "electro-plated" or "electro-plating" or "electro-less" or "electro-lessly" or "electro-form" or "electro-formed" or "electro-forming" or "electro-deposit" or "electro-deposited" or "electro-depositing" or "electro-deposition")) near5 (((peak near2 density) or PD.u/c.) near5 (surface or shiney or shiny or matt or matte or mat or matted))					
L97	7	L96 not (L63 or L65 or L75 or L77 or L81 or L84)	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2021/11/16 08:53 AM
L98	16	((Cu or copper or "cu-alloy" or "cu-base" or "Cu-based" or "copper-base" or "copper-based" or "copper-alloy") near8 (foil or foiled or foiling or tape or ribbon or layer or layered or layering or film or filmed or filming or clad or claded or cladded or clading or cladding or coat or coated or coating or electroplate or electroplated or electroplating or electroless or electrolessly or electroform or electroformed or electroforming or electrodeposit or electrodeposited or	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2021/11/16 08:57 AM

		electrodepositing or electrodeposition or "electro-plate" or "electro-plated" or "electro-plating" or "electro-less" or "electro-lessly" or "electro-form" or "electro-formed" or "electro-forming" or "electro-deposit" or "electro-deposited" or "electro-depositing" or "electro-deposition")) near8 (((peak near2 density) or PD.u/c.) near5 (surface or shiney or shiny or matt or matte or mat or matted))					
L99	3	L98 not (L63 or L65 or L75 or L77 or L81 or L84 or L97)	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2021/11/16 08:57 AM
L100	22	((Cu or copper or "cu-alloy" or "cu-base" or "Cu-based" or "copper-base" or "copper-based" or "copper-alloy") with (foil or foiled or foiling or tape or ribbon or layer or layered or layering or film or filmed or filming or clad or claded or cladded or clading or cladding or coat or coated or coating or electroplate or electroplated or electroplating or electroless or electrolessly or electroform or electroformed or electroforming or electrodeposit or electrodeposited or electrodepositing or electrodeposition or "electro-plate" or "electro-plated" or "electro-plating" or "electro-less" or "electro-lessly" or "electro-form" or "electro-formed" or "electro-forming" or	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2021/11/16 08:59 AM

		"electro-deposit" or "electro-deposited" or "electro-depositing" or "electro-deposition")) with (((peak near2 density) or PD.u/c.) near5 (surface or shiney or shiny or matt or matte or mat or matted))					
L101	6	L100 not (L63 or L65 or L75 or L77 or L81 or L84 or L97 or L99)	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2021/11/16 09:00 AM
L102	30	(((Cu or copper or "cu-alloy" or "cu-base" or "Cu-based" or "copper-base" or "copper-based" or "copper-alloy") near5 (foil or foiled or foiling or tape or ribbon or layer or layered or layering or film or filmed or filming or clad or cladded or cladding or clading or cladding or coat or coated or coating or electroplate or electroplated or electroplating or electroless or electrolessly or electroform or electroformed or electroforming or electrodeposit or electrodeposited or electrodepositing or electrodeposition or "electro-plate" or "electro-plated" or "electro-plating" or "electro-less" or "electro-lessly" or "electro-form" or "electro-formed" or "electro-forming" or "electro-deposit" or "electro-deposited" or "electro-depositing" or "electro-deposition")) near5 (("220" or "[220]" or "{220}" or "(220)" or "<220>") near5 (texture or coefficient or index or Miller or hkl or "h,k,l")))	(FPRS; EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2021/11/16 09:05 AM
L103	41	(((Cu or copper or "cu-	(FPRS; EPO; JPO;	OR	ON	ON	2021/11/16

		alloy" or "cu-base" or "Cu-based" or "copper-base" or "copper-based" or "copper-alloy") near5 (foil or foiled or foiling or tape or ribbon or layer or layered or layering or film or filmed or filming or clad or cladded or cladded or clading or cladding or coat or coated or coating or electroplate or electroplated or electroplating or electroless or electrolessly or electroform or electroformed or electroforming or electrodeposit or electrodeposited or electrodepositing or electrodeposition or "electro-plate" or "electro-plated" or "electro-plating" or "electro-less" or "electro-lessly" or "electro-form" or "electro-formed" or "electro-forming" or "electro-deposit" or "electro-deposited" or "electro-depositing" or "electro-deposition")) near5 (("220" or "[220]" or "{220}" or "(220)" or "<220>") with (texture or coefficient or index or Miller or hkl or "h,k,l")))	DERWENT; IBM_TDB)				09:13 AM
L104	13	L103 not L102	(FPRS; EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2021/11/16 09:14 AM
L105	123	(((Cu or copper or "cu-alloy" or "cu-base" or "Cu-based" or "copper-base" or "copper-based" or "copper-alloy") with (foil or foiled or foiling or tape or ribbon or layer or layered or layering or film or filmed or filming or clad or cladded or cladded or clading or cladding or coat or	(FPRS; EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2021/11/16 09:19 AM

		coated or coating or electroplate or electroplated or electroplating or electroless or electrolessly or electroform or electroformed or electroforming or electrodeposit or electrodeposited or electrodepositing or electrodeposition or "electro-plate" or "electro-plated" or "electro-plating" or "electro-less" or "electro-lessly" or "electro-form" or "electro-formed" or "electro-forming" or "electro-deposit" or "electro-deposited" or "electro-depositing" or "electro-deposition")) with (("220" or "[220]" or "{220}" or "(220)" or "<220>") with (texture or coefficient or index or Miller or hkl or "h,k,l")))					
L106	80	L105 not (L102 or L104)	(FPRS; EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2021/11/16 09:20 AM
L107	1	("20180062199").did.	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2021/11/16 09:45 AM
L108	46	(((Cu or copper or "cu-alloy" or "cu-base" or "Cu-based" or "copper-base" or "copper-based" or "copper-alloy") near5 (foil or foiled or foiling or tape or ribbon or layer or layered or layering or film or filmed or filming or clad or claded or cladded or clading or cladding or coat or coated or coating or electroplate or electroplated or electroplating or electroless or electrolessly or electroform or electroformed or electroforming or electrodeposit or	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2021/11/16 09:49 AM

		electrodeposited or electrodepositing or electrodeposition or "electro-plate" or "electro-plated" or "electro-plating" or "electro-less" or "electro-lessly" or "electro-form" or "electro-formed" or "electro-forming" or "electro-deposit" or "electro-deposited" or "electro-depositing" or "electro-deposition")) near5 (("220" or "[220]" or "{220}" or "(220)" or "<220>") near5 (texture or coefficient or index or Miller or hkl or "h,k,l")))					
L109	22	L108 not (L63 or L65 or L75 or L77 or L81 or L84 or L97 or L99 or L101)	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2021/11/16 09:49 AM
L110	58	(((Cu or copper or "cu-alloy" or "cu-base" or "Cu-based" or "copper-base" or "copper-based" or "copper-alloy") near8 (foil or foiled or foiling or tape or ribbon or layer or layered or layering or film or filmed or filming or clad or claded or cladded or clading or cladding or coat or coated or coating or electroplate or electroplated or electroplating or electroless or electrolessly or electroform or electroformed or electroforming or electrodeposit or electrodeposited or electrodepositing or electrodeposition or "electro-plate" or "electro-plated" or "electro-plating" or "electro-less" or "electro-lessly" or "electro-form" or "electro-formed" or	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2021/11/16 09:51 AM

		"electro-forming" or "electro-deposit" or "electro-deposited" or "electro-depositing" or "electro-deposition")) near8 (("220" or "[220]" or "{220}" or "(220)" or "<220>") near8 (texture or coefficient or index or Miller or hkl or "h,k,l")))					
L111	10	L110 not (L63 or L65 or L75 or L77 or L81 or L84 or L97 or L99 or L101 or L109)	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2021/11/16 09:52 AM
L112	80	(((Cu or copper or "cu-alloy" or "cu-base" or "Cu-based" or "copper-base" or "copper-based" or "copper-alloy") near12 (foil or foiled or foiling or tape or ribbon or layer or layered or layering or film or filmed or filming or clad or claded or cladded or clading or cladding or coat or coated or coating or electroplate or electroplated or electroplating or electroless or electrolessly or electroform or electroformed or electroforming or electrodeposit or electrodeposited or electrodepositing or electrodeposition or "electro-plate" or "electro-plated" or "electro-plating" or "electro-less" or "electro-lessly" or "electro-form" or "electro-formed" or "electro-forming" or "electro-deposit" or "electro-deposited" or "electro-depositing" or "electro-deposition")) near12 (("220" or "[220]" or "{220}" or "(220)" or "<220>") near12 (texture or coefficient or index or	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2021/11/16 09:53 AM

		Miller or hkl or "h,k,l")))					
L113	17	L112 not (L63 or L65 or L75 or L77 or L81 or L84 or L97 or L99 or L101 or L109 or L111)	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2021/11/16 09:54 AM
L114	12	((("JIN") near3 ("Shan") near3 ("Hua"))).INV.	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2022/03/28 06:21 AM
L115	22	((("LEE") near3 ("An") near3 ("Na"))).INV.	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2022/03/28 06:21 AM
L116	115	((("KIM") near3 ("Seung") near3 ("Min"))).INV.	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2022/03/28 06:21 AM
L117	389	((("JIN") near3 ("Shan" or Hua or "shanhua" or "shan-hua"))).INV.	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2022/03/28 06:21 AM
L118	981	((("LEE") near3 ("An" or Na or "An-Na"))).INV.	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2022/03/28 06:21 AM
L119	18485	((("KIM") near3 ("Seung" or Min or "SeungMin" or "Seung-Min"))).INV.	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2022/03/28 06:21 AM
L120	49	((("JIN") near3 ("Shan" or Hua or "shanhua" or "shan-hua"))).aanm.	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2022/03/28 06:21 AM
L121	110	((("LEE") near3 ("An" or Na or "An-Na"))).aanm.	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2022/03/28 06:21 AM
L122	2041	((("KIM") near3 ("Seung" or Min or "SeungMin" or "Seung-Min"))).aanm.	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2022/03/28 06:21 AM
L123	19784	L114 or L115 or L116 or L117 or L118 or L119 or L120 or L121 or L122	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2022/03/28 06:21 AM
L124	2017	L123 and ((Cu or copper or "cu-alloy" or "cu-base" or "Cu-based" or "copper-base" or "copper-based" or "copper-alloy") with (foil or foiled or foiling or tape or ribbon or layer or layered or layering or film or filmed or filming or clad or claded or cladded or clading or cladding or coat or coated or coating or electroplate or electroplated or electroplating or electroless or electrolessly or electroform or	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2022/03/28 06:21 AM

		electroformed or electroforming or electrodeposit or electrodeposited or electrodepositing or electrodeposition or "electro-plate" or "electro-plated" or "electro-plating" or "electro-less" or "electro-lessly" or "electro-form" or "electro-formed" or "electro-forming" or "electro-deposit" or "electro-deposited" or "electro-depositing" or "electro-deposition"))					
L125	12	L124 and (("220" or "[220]" or "{220}" or "(220)" or "<220>") near5 (texture or coefficient or index or Miller or hkl or "h,k,l"))	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2022/03/28 06:21 AM
L126	58	((KCF) near3 (tech or technol or technology)).as,aanm.	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2022/03/28 06:24 AM
L127	50	L126 not L125	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2022/03/28 06:24 AM
L128	155301	B32B15/01;C25D1/04;C25D3/38;C25D5/34,48;C25D21/06;H01M4/0404,13,66,661,667;H01M10/052,0525;H01M2004/027;Y02E60/10;Y10T428/12431,12438.cpc.	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2022/03/28 06:27 AM
L129	42847	L128 and ((Cu or copper or "cu-alloy" or "cu-base" or "Cu-based" or "copper-base" or "copper-based" or "copper-alloy") near5 (foil or foiled or foiling or tape or ribbon or layer or layered or layering or film or filmed or filming or clad or claded or cladded or clading or cladding or coat or coated or coating or electroplate or electroplated or electroplating or electroless or electrolessly or	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2022/03/28 06:27 AM

		electroform or electroformed or electroforming or electrodeposit or electrodeposited or electrodepositing or electrodeposition or "electro-plate" or "electro-plated" or "electro-plating" or "electro-less" or "electro-lessly" or "electro-form" or "electro-formed" or "electro-forming" or "electro-deposit" or "electro-deposited" or "electro-depositing" or "electro-deposition"))					
L130	82	L129 and (("220" or "[220]" or "{220}" or "(220)" or "<220>") near5 (texture or coefficient or index or Miller or hkl or "h,k,l"))	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2022/03/28 06:27 AM
L131	72	L130 not (L125 or L127)	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2022/03/28 06:27 AM
L132	91	L129 and (("220" or "[220]" or "{220}" or "(220)" or "<220>") near8 (texture or coefficient or index or Miller or hkl or "h,k,l"))	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2022/03/28 06:30 AM
L133	9	L132 not (L125 or L127 or L131)	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2022/03/28 06:30 AM
L134	35	L128 and (((Cu or copper or "cu-alloy" or "cu-base" or "Cu-based" or "copper-base" or "copper-based" or "copper-alloy") with (foil or foiled or foiling or tape or ribbon or layer or layered or layering or film or filmed or filming or clad or claded or cladded or clading or cladding or coat or coated or coating or electroplate or electroplated or electroplating or electroless or electrolessly or electroform or	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2022/03/28 06:31 AM

		electroformed or electroforming or electrodeposit or electrodeposited or electrodepositing or electrodeposition or "electro-plate" or "electro-plated" or "electro-plating" or "electro-less" or "electro-lessly" or "electro-form" or "electro-formed" or "electro-forming" or "electro-deposit" or "electro-deposited" or "electro-depositing" or "electro-deposition")) with (("220" or "[220]" or "{220}" or "(220)" or "<220>") with (texture or coefficient or index or Miller or hkl or "h,k,l")))					
L135	2	L134 not (L125 or L127 or L131 or L133)	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2022/03/28 06:31 AM
L136	945781	B32B15/01;C25D1/04;C25D3/38;C25D5/34,48;C25D21/06;H01M4/0404,13,66,661,667;H01M10/052,0525;H01M2004/027;Y02E60/10;Y10T428/12431,12438.cpc.	(FPRS; EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2022/03/28 06:37 AM
L137	71	L136 and (((Cu or copper or "cu-alloy" or "cu-base" or "Cu-based" or "copper-base" or "copper-based" or "copper-alloy") with (foil or foiled or foiling or tape or ribbon or layer or layered or layering or film or filmed or filming or clad or claded or cladded or clading or cladding or coat or coated or coating or electroplate or electroplated or electroplating or electroless or electrolessly or electroform or electroformed or electroforming or electrodeposit or electrodeposited or	(FPRS; EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2022/03/28 06:37 AM

		electrodepositing or electrodeposition or "electro-plate" or "electro-plated" or "electro-plating" or "electro-less" or "electro-lessly" or "electro-form" or "electro-formed" or "electro-forming" or "electro-deposit" or "electro-deposited" or "electro-depositing" or "electro-deposition")) with (("220" or "[220]" or "{220}" or "(220)" or "<220>") with (texture or coefficient or index or Miller or hkl or "h,k,l")))					
L138	17955	L136 and ((Cu or copper or "cu-alloy" or "cu-base" or "Cu-based" or "copper-base" or "copper-based" or "copper-alloy") near5 (foil or foiled or foiling or tape or ribbon or layer or layered or layering or film or filmed or filming or clad or claded or cladded or clading or cladding or coat or coated or coating or electroplate or electroplated or electroplating or electroless or electrolessly or electroform or electroformed or electroforming or electrodeposit or electrodeposited or electrodepositing or electrodeposition or "electro-plate" or "electro-plated" or "electro-plating" or "electro-less" or "electro-lessly" or "electro-form" or "electro-formed" or "electro-forming" or "electro-deposit" or "electro-deposited" or "electro-depositing" or "electro-deposition"))	(FPRS; EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2022/03/28 06:40 AM

L139	65	L138 and (("220" or "[220]" or "{220}" or "(220)" or "<220>") near5 (texture or coefficient or index or Miller or hkl or "h,k,l"))	(FPRS; EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2022/03/28 06:40 AM
L140	9	L139 not L137	(FPRS; EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2022/03/28 06:40 AM
L141	80	L138 and (("220" or "[220]" or "{220}" or "(220)" or "<220>") with (texture or coefficient or index or Miller or hkl or "h,k,l"))	(FPRS; EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2022/03/28 06:43 AM
L142	0	L141 not (L137 or L140)	(FPRS; EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2022/03/28 06:43 AM
L143	22247	L136 and ((Cu or copper or "cu-alloy" or "cu-base" or "Cu-based" or "copper-base" or "copper-based" or "copper-alloy") with (foil or foiled or foiling or tape or ribbon or layer or layered or layering or film or filmed or filming or clad or claded or cladded or clading or cladding or coat or coated or coating or electroplate or electroplated or electroplating or electroless or electrolessly or electroform or electroformed or electroforming or electrodeposit or electrodeposited or electrodepositing or electrodeposition or "electro-plate" or "electro-plated" or "electro-plating" or "electro-less" or "electro-lessly" or "electro-form" or "electro-formed" or "electro-forming" or "electro-deposit" or "electro-deposited" or "electro-depositing" or "electro-deposition"))	(FPRS; EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2022/03/28 06:43 AM
L144	81	L143 and (("220" or	(FPRS; EPO; JPO;	OR	ON	ON	2022/03/28

		"[220]" or "{220}" or "(220)" or "<220>") with (texture or coefficient or index or Miller or hkl or "h,k,l"))	DERWENT; IBM_TDB)				06:43 AM
L145	1	L144 not (L137 or L140)	(FPRS; EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2022/03/28 06:43 AM
L146	33	(((Cu or copper or "cu-alloy" or "cu-base" or "Cu-based" or "copper-base" or "copper-based" or "copper-alloy") near5 (foil or foiled or foiling or tape or ribbon or layer or layered or layering or film or filmed or filming or clad or claded or cladded or clading or cladding or coat or coated or coating or electroplate or electroplated or electroplating or electroless or electrolessly or electroform or electroformed or electroforming or electrodeposit or electrodeposited or electrodepositing or electrodeposition or "electro-plate" or "electro-plated" or "electro-plating" or "electro-less" or "electro-lessly" or "electro-form" or "electro-formed" or "electro-forming" or "electro-deposit" or "electro-deposited" or "electro-depositing" or "electro-deposition")) near5 (("220" or "[220]" or "{220}" or "(220)" or "<220>") near5 (texture or coefficient or index or Miller or hkl or "h,k,l")))	(FPRS; EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2022/03/28 06:44 AM
L147	7	L146 not (L137 or L140 or L145)	(FPRS; EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2022/03/28 06:44 AM
L148	133	(((Cu or copper or "cu-alloy" or "cu-base" or "Cu-based" or "copper-base" or "copper-based" or "copper-	(FPRS; EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2022/03/28 06:48 AM

		alloy") with (foil or foiled or foiling or tape or ribbon or layer or layered or layering or film or filmed or filming or clad or claded or cladded or clading or cladding or coat or coated or coating or electroplate or electroplated or electroplating or electroless or electrolessly or electroform or electroformed or electroforming or electrodeposit or electrodeposited or electrodepositing or electrodeposition or "electro-plate" or "electro-plated" or "electro-plating" or "electro-less" or "electro-lessly" or "electro-form" or "electro-formed" or "electro-forming" or "electro-deposit" or "electro-deposited" or "electro-depositing" or "electro-deposition")) with (("220" or "[220]" or "{220}" or "(220)" or "<220>") with (texture or coefficient or index or Miller or hkl or "h,k,l")))					
L149	55	L148 not (L137 or L140 or L145 or L147)	(FPRS; EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2022/03/28 06:48 AM
L150	46	(((Cu or copper or "cu-alloy" or "cu-base" or "Cu-based" or "copper-base" or "copper-based" or "copper-alloy") near5 (foil or foiled or foiling or tape or ribbon or layer or layered or layering or film or filmed or filming or clad or claded or cladded or clading or cladding or coat or coated or coating or electroplate or electroplated or electroplating or	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2022/03/28 06:51 AM

		electroless or electrolessly or electroform or electroformed or electroforming or electrodeposit or electrodeposited or electrodepositing or electrodeposition or "electro-plate" or "electro-plated" or "electro-plating" or "electro-less" or "electro-lessly" or "electro-form" or "electro-formed" or "electro-forming" or "electro-deposit" or "electro-deposited" or "electro-depositing" or "electro-deposition")) near5 (("220" or "[220]" or "{220}" or "(220)" or "<220>") near5 (texture or coefficient or index or Miller or hkl or "h,k,l")))					
L151	22	L150 not (L125 or L127 or L131 or L133 or L135)	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2022/03/28 06:51 AM
L152	117	(((Cu or copper or "cu-alloy" or "cu-base" or "Cu-based" or "copper-base" or "copper-based" or "copper-alloy") with (foil or foiled or foiling or tape or ribbon or layer or layered or layering or film or filmed or filming or clad or cladded or cladded or clading or cladding or coat or coated or coating or electroplate or electroplated or electroplating or electroless or electrolessly or electroform or electroformed or electroforming or electrodeposit or electrodeposited or electrodepositing or electrodeposition or "electro-plate" or "electro-plated" or	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2022/03/28 06:53 AM

		"electro-plating" or "electro-less" or "electro-lessly" or "electro-form" or "electro-formed" or "electro-forming" or "electro-deposit" or "electro-deposited" or "electro-depositing" or "electro-deposition")) with (("220" or "[220]" or "{220}" or "(220)" or "<220>") with (texture or coefficient or index or Miller or hkl or "h,k,l")))					
L153	60	L152 not (L125 or L127 or L131 or L133 or L135 or L151)	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2022/03/28 06:53 AM
L154	2	L136 and (("220" or "[220]" or "{220}" or "(220)" or "<220>") near5 (stress))	(FPRS; EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2022/03/28 06:59 AM
L155	3	L136 and (("111" or "[111]" or "{111}" or "(111)" or "<111>") near5 (stress))	(FPRS; EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2022/03/28 07:01 AM
L156	51	L136 and (("200" or "[200]" or "{200}" or "(200)" or "<200>") near5 (stress))	(FPRS; EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2022/03/28 07:07 AM
L157	90	((Cu or copper or "cu-alloy" or "cu-base" or "Cu-based" or "copper-base" or "copper-based" or "copper-alloy") near5 (foil or foiled or foiling or tape or ribbon or layer or layered or layering or film or filmed or filming or clad or claded or cladded or clading or cladding or coat or coated or coating or electroplate or electroplated or electroplating or electroless or electrolessly or electroform or electroformed or electroforming or electrodeposit or electrodeposited or electrodepositing or electrodeposition or	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2022/03/28 07:12 AM

		"electro-plate" or "electro-plated" or "electro-plating" or "electro-less" or "electro-lessly" or "electro-form" or "electro-formed" or "electro-forming" or "electro-deposit" or "electro-deposited" or "electro-depositing" or "electro-deposition")) and (("111" or "[111]" or "{111}" or "(111)" or "<111>" or "200" or "[200]" or "{200}" or "(200)" or "<200>" or "220" or "[220]" or "{220}" or "(220)" or "<220>" or "311" or "[311]" or "{311}" or "(311)" or "<311>") near5 (residual near2 stress))					
L158	130	((Cu or copper or "cu-alloy" or "cu-base" or "Cu-based" or "copper-base" or "copper-based" or "copper-alloy") near8 (foil or foiled or foiling or tape or ribbon or layer or layered or layering or film or filmed or filming or clad or claded or cladded or clading or cladding or coat or coated or coating or electroplate or electroplated or electroplating or electroless or electrolessly or electroform or electroformed or electroforming or electrodeposit or electrodeposited or electrodepositing or electrodeposition or "electro-plate" or "electro-plated" or "electro-plating" or "electro-less" or "electro-lessly" or "electro-form" or "electro-formed" or "electro-forming" or	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2022/03/28 07:24 AM

		"electro-deposit" or "electro-deposited" or "electro-depositing" or "electro-deposition")) and (("111" or "[111]" or "{111}" or "(111)" or "<111>" or "200" or "[200]" or "{200}" or "(200)" or "<200>" or "220" or "[220]" or "{220}" or "(220)" or "<220>" or "311" or "[311]" or "{311}" or "(311)" or "<311>") near8 (residual near2 stress))					
L159	40	L158 not L157	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2022/03/28 07:24 AM
L160	261	((Cu or copper or "cu-alloy" or "cu-base" or "Cu-based" or "copper-base" or "copper-based" or "copper-alloy") with (foil or foiled or foiling or tape or ribbon or layer or layered or layering or film or filmed or filming or clad or claded or cladded or clading or cladding or coat or coated or coating or electroplate or electroplated or electroplating or electroless or electrolessly or electroform or electroformed or electroforming or electrodeposit or electrodeposited or electrodepositing or electrodeposition or "electro-plate" or "electro-plated" or "electro-plating" or "electro-less" or "electro-lessly" or "electro-form" or "electro-formed" or "electro-forming" or "electro-deposit" or "electro-deposited" or "electro-depositing" or "electro-deposition")) and (("111" or "[111]" or	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2022/03/28 07:25 AM

		"{111}" or "(111)" or "<111>" or "200" or "[200]" or "{200}" or "(200)" or "<200>" or "220" or "[220]" or "{220}" or "(220)" or "<220>" or "311" or "[311]" or "{311}" or "(311)" or "<311>") with (residual near2 stress))					
L161	131	L160 not (L157 or L159)	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2022/03/28 07:25 AM
L162	24	((Cu or copper or "cu-alloy" or "cu-base" or "Cu-based" or "copper-base" or "copper-based" or "copper-alloy") with (foil or foiled or foiling or tape or ribbon or layer or layered or layering or film or filmed or filming or clad or cladded or cladding or clading or cladding or coat or coated or coating or electroplate or electroplated or electroplating or electroless or electrolessly or electroform or electroformed or electroforming or electrodeposit or electrodeposited or electrodepositing or electrodeposition or "electro-plate" or "electro-plated" or "electro-plating" or "electro-less" or "electro-lessly" or "electro-form" or "electro-formed" or "electro-forming" or "electro-deposit" or "electro-deposited" or "electro-depositing" or "electro-deposition")) and (("111" or "[111]" or "{111}" or "(111)" or "<111>" or "200" or "[200]" or "{200}" or "(200)" or "<200>" or "220" or "[220]" or "{220}" or "(220)" or	(FPRS; EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2022/03/28 07:32 AM

		"<220>" or "311" or "[311]" or "{311}" or "(311)" or "<311>") with (residual near2 stress))					
L163	12	((("JIN") near3 ("Shan") near3 ("Hua"))).INV.	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2022/03/28 07:35 AM
L164	22	((("LEE") near3 ("An") near3 ("Na"))).INV.	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2022/03/28 07:35 AM
L165	115	((("KIM") near3 ("Seung") near3 ("Min"))).INV.	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2022/03/28 07:35 AM
L166	389	((("JIN") near3 ("Shan" or Hua or "shanhua" or "shan-hua"))).INV.	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2022/03/28 07:35 AM
L167	981	((("LEE") near3 ("An" or Na or "An-Na"))).INV.	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2022/03/28 07:35 AM
L168	18485	((("KIM") near3 ("Seung" or Min or "SeungMin" or "Seung-Min"))).INV.	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2022/03/28 07:35 AM
L169	49	((("JIN") near3 ("Shan" or Hua or "shanhua" or "shan-hua"))).aanm.	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2022/03/28 07:35 AM
L170	110	((("LEE") near3 ("An" or Na or "An-Na"))).aanm.	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2022/03/28 07:35 AM
L171	2041	((("KIM") near3 ("Seung" or Min or "SeungMin" or "Seung-Min"))).aanm.	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2022/03/28 07:35 AM
L172	19784	L163 or L164 or L165 or L166 or L167 or L168 or L169 or L170 or L171	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2022/03/28 07:35 AM
L173	2017	L172 and ((Cu or copper or "cu-alloy" or "cu-base" or "Cu-based" or "copper-base" or "copper-based" or "copper-alloy") with (foil or foiled or foiling or tape or ribbon or layer or layered or layering or film or filmed or filming or clad or claded or cladded or clading or cladding or coat or coated or coating or electroplate or electroplated or electroplating or electroless or electrolessly or electroform or electroformed or	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2022/03/28 07:35 AM

		electroforming or electrodeposit or electrodeposited or electrodepositing or electrodeposition or "electro-plate" or "electro-plated" or "electro-plating" or "electro-less" or "electro-lessly" or "electro-form" or "electro-formed" or "electro-forming" or "electro-deposit" or "electro-deposited" or "electro-depositing" or "electro-deposition"))					
L174	12	L173 and (("220" or "[220]" or "{220}" or "(220)" or "<220>") near5 (texture or coefficient or index or Miller or hkl or "h,k,l"))	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2022/03/28 07:35 AM
L175	58	((KCF) near3 (tech or technol or technology)).as,aanm.	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2022/03/28 07:37 AM
L176	50	L175 not L174	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2022/03/28 07:37 AM
L177	155937	B32B15/01;C25D1/04;C25D3/38;C25D5/34,48;C25D7/0614;C25D21/06;H01M4/0404,13,66,661,667;H01M10/052,0525;H01M2004/027;Y02E60/10;Y10T428/12431,12438.cpc.	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2022/03/28 07:40 AM
L178	42990	L177 and ((Cu or copper or "cu-alloy" or "cu-base" or "Cu-based" or "copper-base" or "copper-based" or "copper-alloy") near5 (foil or foiled or foiling or tape or ribbon or layer or layered or layering or film or filmed or filming or clad or claded or cladded or clading or cladding or coat or coated or coating or electroplate or electroplated or electroplating or electroless or electrolessly or	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2022/03/28 07:40 AM

		electroform or electroformed or electroforming or electrodeposit or electrodeposited or electrodepositing or electrodeposition or "electro-plate" or "electro-plated" or "electro-plating" or "electro-less" or "electro-lessly" or "electro-form" or "electro-formed" or "electro-forming" or "electro-deposit" or "electro-deposited" or "electro-depositing" or "electro-deposition"))					
L179	82	L178 and (("220" or "[220]" or "{220}" or "(220)" or "<220>") near5 (texture or coefficient or index or Miller or hkl or "h,k,l"))	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2022/03/28 07:40 AM
L180	73	L179 not (L172 or L174)	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2022/03/28 07:40 AM
L181	91	L178 and (("220" or "[220]" or "{220}" or "(220)" or "<220>") near8 (texture or coefficient or index or Miller or hkl or "h,k,l"))	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2022/03/28 07:45 AM
L182	9	L181 not (L172 or L174 or L180)	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2022/03/28 07:45 AM
L183	147	L178 and (("220" or "[220]" or "{220}" or "(220)" or "<220>") with (texture or coefficient or index or Miller or hkl or "h,k,l"))	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2022/03/28 07:48 AM
L184	55	L183 not (L172 or L174 or L180 or L182)	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2022/03/28 07:48 AM
L185	447	L178 and ((peak near2 density) or PD.u/c.)	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2022/03/28 07:53 AM
L186	37	L178 and (((peak near2 density) or PD.u/c.) near5 (surface))	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2022/03/28 07:55 AM
L187	54	L177 and (((peak near2 density) or PD.u/c.) near5 (surface or shiney or shiny or matt or matte or mat or matted))	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2022/03/28 07:59 AM
L188	17	L187 not (L172 or L174	(US-PGPUB; USPAT;	OR	ON	ON	2022/03/28

		or L180 or L182 or L186)	USOCR)				07:59 AM
L189	948740	B32B15/01;C25D1/04;C25D3/38;C25D5/34,48;C25D7/0614;C25D21/06;H01M4/0404,13,66,661,667;H01M10/052,0525;H01M2004/027;Y02E60/10;Y10T428/12431,12438.cpc.	(FPRS; EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2022/03/28 08:01 AM
L190	71	L189 and (((Cu or copper or "cu-alloy" or "cu-base" or "Cu-based" or "copper-base" or "copper-based" or "copper-alloy") with (foil or foiled or foiling or tape or ribbon or layer or layered or layering or film or filmed or filming or clad or claded or cladded or clading or cladding or coat or coated or coating or electroplate or electroplated or electroplating or electroless or electrolessly or electroform or electroformed or electroforming or electrodeposit or electrodeposited or electrodepositing or electrodeposition or "electro-plate" or "electro-plated" or "electro-plating" or "electro-less" or "electro-lessly" or "electro-form" or "electro-formed" or "electro-forming" or "electro-deposit" or "electro-deposited" or "electro-depositing" or "electro-deposition")) with (("220" or "[220]" or "{220}" or "(220)" or "<220>") with (texture or coefficient or index or Miller or hkl or "h,k,l")))	(FPRS; EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2022/03/28 08:01 AM
L191	20	L189 and (((peak near2 density) or PD.u/c.) near5 (surface or	(FPRS; EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2022/03/28 08:05 AM

		shiney or shiny or matt or matte or mat or matted))					
L192	15	(((Cu or copper or "cu-alloy" or "cu-base" or "Cu-based" or "copper-base" or "copper-based" or "copper-alloy") with (foil or foiled or foiling or tape or ribbon or layer or layered or layering or film or filmed or filming or clad or claded or cladded or clading or cladding or coat or coated or coating or electroplate or electroplated or electroplating or electroless or electrolessly or electroform or electroformed or electroforming or electrodeposit or electrodeposited or electrodepositing or electrodeposition or "electro-plate" or "electro-plated" or "electro-plating" or "electro-less" or "electro-lessly" or "electro-form" or "electro-formed" or "electro-forming" or "electro-deposit" or "electro-deposited" or "electro-depositing" or "electro-deposition")) with (("220" or "[220]" or "{220}" or "(220)" or "<220>") with (texture or coefficient or index or Miller or hkl or "h,k,l"))) and (((peak near2 density) or PD.u/c.) near5 (surface or shiney or shiny or matt or matte or mat or matted))	(FPRS; EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2022/03/28 08:11 AM
L193	0	L192 not L191	(FPRS; EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2022/03/28 08:11 AM
L194	16	(((Cu or copper or "cu-alloy" or "cu-base" or "Cu-based" or "copper-	(FPRS; EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2022/03/28 08:11 AM

		base" or "copper-based" or "copper-alloy") with (foil or foiled or foiling or tape or ribbon or layer or layered or layering or film or filmed or filming or clad or cladded or cladded or clading or cladding or coat or coated or coating or electroplate or electroplated or electroplating or electroless or electrolessly or electroform or electroformed or electroforming or electrodeposit or electrodeposited or electrodepositing or electrodeposition or "electro-plate" or "electro-plated" or "electro-plating" or "electro-less" or "electro-lessly" or "electro-form" or "electro-formed" or "electro-forming" or "electro-deposit" or "electro-deposited" or "electro-depositing" or "electro-deposition")) with (("220" or "[220]" or "{220}" or "(220)" or "<220>") with (texture or coefficient or index or Miller or hkl or "h,k,l"))) and (((peak near2 density) or PD.u/c.) with (surface or shiney or shiny or matt or matte or mat or matted))					
L195	1	L194 not L191	(FPRS; EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2022/03/28 08:11 AM
L196	22	((Cu or copper or "cu-alloy" or "cu-base" or "Cu-based" or "copper-base" or "copper-based" or "copper-alloy") near5 (foil or foiled or foiling or tape or ribbon or layer or layered or layering or film or filmed or filming	(FPRS; EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2022/03/28 08:12 AM

		or clad or claded or cladded or clading or cladding or coat or coated or coating or electroplate or electroplated or electroplating or electroless or electrolessly or electroform or electroformed or electroforming or electrodeposit or electrodeposited or electrodepositing or electrodeposition or "electro-plate" or "electro-plated" or "electro-plating" or "electro-less" or "electro-lessly" or "electro-form" or "electro-formed" or "electro-forming" or "electro-deposit" or "electro-deposited" or "electro-depositing" or "electro-deposition")) near5 (((peak near2 density) or PD.u/c.) near5 (surface or shiney or shiny or matt or matte or mat or matted))					
L197	7	L196 not (L191 or L195)	(FPRS; EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2022/03/28 08:12 AM
L198	24	((Cu or copper or "cu-alloy" or "cu-base" or "Cu-based" or "copper-base" or "copper-based" or "copper-alloy") with (foil or foiled or foiling or tape or ribbon or layer or layered or layering or film or filmed or filming or clad or claded or cladded or clading or cladding or coat or coated or coating or electroplate or electroplated or electroplating or electroless or electrolessly or electroform or electroformed or	(FPRS; EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2022/03/28 08:16 AM

		electroforming or electrodeposit or electrodeposited or electrodepositing or electrodeposition or "electro-plate" or "electro-plated" or "electro-plating" or "electro-less" or "electro-lessly" or "electro-form" or "electro-formed" or "electro-forming" or "electro-deposit" or "electro-deposited" or "electro-depositing" or "electro-deposition")) with (((peak near2 density) or PD.u/c.) near5 (surface or shiney or shiny or matt or matte or mat or matted))					
L199	1	L198 not (L191 or L195 or L197)	(FPRS; EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2022/03/28 08:16 AM
L200	13	((Cu or copper or "cu-alloy" or "cu-base" or "Cu-based" or "copper-base" or "copper-based" or "copper-alloy") near5 (foil or foiled or foiling or tape or ribbon or layer or layered or layering or film or filmed or filming or clad or claded or cladded or clading or cladding or coat or coated or coating or electroplate or electroplated or electroplating or electroless or electrolessly or electroform or electroformed or electroforming or electrodeposit or electrodeposited or electrodepositing or electrodeposition or "electro-plate" or "electro-plated" or "electro-plating" or "electro-less" or "electro-lessly" or "electro-form" or	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2022/03/28 08:16 AM

		"electro-formed" or "electro-forming" or "electro-deposit" or "electro-deposited" or "electro-depositing" or "electro-deposition")) near5 (((peak near2 density) or PD.u/c.) near5 (surface or shiney or shiny or matt or matte or mat or matted))					
L201	7	L200 not (L172 or L174 or L180 or L182 or L186 or L188)	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2022/03/28 08:16 AM
L202	16	((Cu or copper or "cu-alloy" or "cu-base" or "Cu-based" or "copper-base" or "copper-based" or "copper-alloy") near8 (foil or foiled or foiling or tape or ribbon or layer or layered or layering or film or filmed or filming or clad or claded or cladded or clading or cladding or coat or coated or coating or electroplate or electroplated or electroplating or electroless or electrolessly or electroform or electroformed or electroforming or electrodeposit or electrodeposited or electrodepositing or electrodeposition or "electro-plate" or "electro-plated" or "electro-plating" or "electro-less" or "electro-lessly" or "electro-form" or "electro-formed" or "electro-forming" or "electro-deposit" or "electro-deposited" or "electro-depositing" or "electro-deposition")) near8 (((peak near2 density) or PD.u/c.) near5 (surface or shiney or shiny or matt	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2022/03/28 08:19 AM

		or matte or mat or matted))					
L203	3	L202 not (L172 or L174 or L180 or L182 or L186 or L188 or L201)	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2022/03/28 08:19 AM
L204	22	((Cu or copper or "cu-alloy" or "cu-base" or "Cu-based" or "copper-base" or "copper-based" or "copper-alloy") with (foil or foiled or foiling or tape or ribbon or layer or layered or layering or film or filmed or filming or clad or claded or cladded or clading or cladding or coat or coated or coating or electroplate or electroplated or electroplating or electroless or electrolessly or electroform or electroformed or electroforming or electrodeposit or electrodeposited or electrodepositing or electrodeposition or "electro-plate" or "electro-plated" or "electro-plating" or "electro-less" or "electro-lessly" or "electro-form" or "electro-formed" or "electro-forming" or "electro-deposit" or "electro-deposited" or "electro-depositing" or "electro-deposition")) with (((peak near2 density) or PD.u/c.) near5 (surface or shiney or shiny or matt or matte or mat or matted))	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2022/03/28 08:23 AM
L205	6	L204 not (L172 or L174 or L180 or L182 or L186 or L188 or L201 or L203)	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2022/03/28 08:23 AM
L206	33	(((Cu or copper or "cu-alloy" or "cu-base" or "Cu-based" or "copper-base" or "copper-	(FPRS; EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2022/03/28 08:24 AM

		based" or "copper-alloy") near5 (foil or foiled or foiling or tape or ribbon or layer or layered or layering or film or filmed or filming or clad or claded or cladded or clading or cladding or coat or coated or coating or electroplate or electroplated or electroplating or electroless or electrolessly or electroform or electroformed or electroforming or electrodeposit or electrodeposited or electrodepositing or electrodeposition or "electro-plate" or "electro-plated" or "electro-plating" or "electro-less" or "electro-lessly" or "electro-form" or "electro-formed" or "electro-forming" or "electro-deposit" or "electro-deposited" or "electro-depositing" or "electro-deposition")) near5 (("220" or "[220]" or "{220}" or "(220)" or "<220>") near5 (texture or coefficient or index or Miller or hkl or "h,k,l")))					
L207	45	(((Cu or copper or "cu-alloy" or "cu-base" or "Cu-based" or "copper-base" or "copper-based" or "copper-alloy") near5 (foil or foiled or foiling or tape or ribbon or layer or layered or layering or film or filmed or filming or clad or claded or cladded or clading or cladding or coat or coated or coating or electroplate or electroplated or electroplating or electroless or electrolessly or	(FPRS; EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2022/03/28 08:25 AM

		electroform or electroformed or electroforming or electrodeposit or electrodeposited or electrodepositing or electrodeposition or "electro-plate" or "electro-plated" or "electro-plating" or "electro-less" or "electro-lessly" or "electro-form" or "electro-formed" or "electro-forming" or "electro-deposit" or "electro-deposited" or "electro-depositing" or "electro-deposition")) near5 (("220" or "[220]" or "{220}" or "(220)" or "<220>") with (texture or coefficient or index or Miller or hkl or "h,k,l")))					
L208	14	L207 not L206	(FPRS; EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2022/03/28 08:25 AM
L209	133	(((Cu or copper or "cu-alloy" or "cu-base" or "Cu-based" or "copper-base" or "copper-based" or "copper-alloy") with (foil or foiled or foiling or tape or ribbon or layer or layered or layering or film or filmed or filming or clad or claded or cladded or clading or cladding or coat or coated or coating or electroplate or electroplated or electroplating or electroless or electrolessly or electroform or electroformed or electroforming or electrodeposit or electrodeposited or electrodepositing or electrodeposition or "electro-plate" or "electro-plated" or "electro-plating" or "electro-less" or "electro-lessly" or	(FPRS; EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2022/03/28 08:26 AM

		"electro-form" or "electro-formed" or "electro-forming" or "electro-deposit" or "electro-deposited" or "electro-depositing" or "electro-deposition")) with (("220" or "[220]" or "{220}" or "(220)" or "<220>") with (texture or coefficient or index or Miller or hkl or "h,k,l")))					
L210	86	L209 not (L206 or L208)	(FPRS; EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2022/03/28 08:26 AM
L211	46	(((Cu or copper or "cu-alloy" or "cu-base" or "Cu-based" or "copper-base" or "copper-based" or "copper-alloy") near5 (foil or foiled or foiling or tape or ribbon or layer or layered or layering or film or filmed or filming or clad or claded or cladded or clading or cladding or coat or coated or coating or electroplate or electroplated or electroplating or electroless or electrolessly or electroform or electroformed or electroforming or electrodeposit or electrodeposited or electrodepositing or electrodeposition or "electro-plate" or "electro-plated" or "electro-plating" or "electro-less" or "electro-lessly" or "electro-form" or "electro-formed" or "electro-forming" or "electro-deposit" or "electro-deposited" or "electro-depositing" or "electro-deposition")) near5 (("220" or "[220]" or "{220}" or "(220)" or "<220>") near5 (texture or coefficient or index or Miller or hkl or "h,k,l")))	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2022/03/28 08:30 AM

L212	22	L211 not (L172 or L174 or L180 or L182 or L186 or L188 or L201 or L203 or L205)	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2022/03/28 08:30 AM
L213	58	(((Cu or copper or "cu-alloy" or "cu-base" or "Cu-based" or "copper-base" or "copper-based" or "copper-alloy") near8 (foil or foiled or foiling or tape or ribbon or layer or layered or layering or film or filmed or filming or clad or claded or cladded or clading or cladding or coat or coated or coating or electroplate or electroplated or electroplating or electroless or electrolessly or electroform or electroformed or electroforming or electrodeposit or electrodeposited or electrodepositing or electrodeposition or "electro-plate" or "electro-plated" or "electro-plating" or "electro-less" or "electro-lessly" or "electro-form" or "electro-formed" or "electro-forming" or "electro-deposit" or "electro-deposited" or "electro-depositing" or "electro-deposition")) near8 (("220" or "[220]" or "{220}" or "(220)" or "<220>") near8 (texture or coefficient or index or Miller or hkl or "h,k,l")))	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2022/03/28 08:33 AM
L214	10	L213 not (L172 or L174 or L180 or L182 or L186 or L188 or L201 or L203 or L205 or L212)	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2022/03/28 08:33 AM
L215	80	(((Cu or copper or "cu-alloy" or "cu-base" or "Cu-based" or "copper-base" or "copper-based" or "copper-alloy") near12 (foil or	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2022/03/28 08:34 AM

		foiled or foiling or tape or ribbon or layer or layered or layering or film or filmed or filming or clad or claded or cladded or clading or cladding or coat or coated or coating or electroplate or electroplated or electroplating or electroless or electrolessly or electroform or electroformed or electroforming or electrodeposit or electrodeposited or electrodepositing or electrodeposition or "electro-plate" or "electro-plated" or "electro-plating" or "electro-less" or "electro-lessly" or "electro-form" or "electro-formed" or "electro-forming" or "electro-deposit" or "electro-deposited" or "electro-depositing" or "electro-deposition")) near12 (("220" or "[220]" or "{220}" or "(220)" or "<220>") near12 (texture or coefficient or index or Miller or hkl or "h,k,l")))					
L216	17	L215 not (L172 or L174 or L180 or L182 or L186 or L188 or L201 or L203 or L205 or L212 or L214)	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2022/03/28 08:34 AM
L234	1	"10158119".did.	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2022/03/31 06:54 AM
L235	15	((("JIN") near3 ("Shan") near3 ("Hua"))).INV.	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2022/07/06 08:29 AM
L236	24	((("LEE") near3 ("An") near3 ("Na"))).INV.	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2022/07/06 08:29 AM
L237	123	((("KIM") near3 ("Seung") near3 ("Min"))).INV.	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2022/07/06 08:29 AM
L238	395	((("JIN") near3 ("Shan" or Hua or "shanhua" or "shan-hua"))).INV.	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2022/07/06 08:29 AM
L239	1005	((("LEE") near3 ("An" or	(US-PGPUB; USPAT;	OR	ON	ON	2022/07/06

		Na or "An-Na"))).INV.	USOCR)				08:29 AM
L240	18961	((("KIM") near3 ("Seung" or Min or "SeungMin" or "Seung-Min"))).INV.	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2022/07/06 08:29 AM
L241	49	((("JIN") near3 ("Shan" or Hua or "shanhua" or "shan-hua"))).aanm.	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2022/07/06 08:29 AM
L242	110	((("LEE") near3 ("An" or Na or "An-Na"))).aanm.	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2022/07/06 08:29 AM
L243	2048	((("KIM") near3 ("Seung" or Min or "SeungMin" or "Seung-Min"))).aanm.	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2022/07/06 08:29 AM
L244	20286	L235 or L236 or L237 or L238 or L239 or L240 or L241 or L242 or L243	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2022/07/06 08:29 AM
L245	2103	L244 and ((Cu or copper or "cu-alloy" or "cu-base" or "Cu-based" or "copper-base" or "copper-based" or "copper-alloy") with (foil or foiled or foiling or tape or ribbon or layer or layered or layering or film or filmed or filming or clad or claded or cladded or clading or cladding or coat or coated or coating or electroplate or electroplated or electroplating or electroless or electrolessly or electroform or electroformed or electroforming or electrodeposit or electrodeposited or electrodepositing or electrodeposition or "electro-plate" or "electro-plated" or "electro-plating" or "electro-less" or "electro-lessly" or "electro-form" or "electro-formed" or "electro-forming" or "electro-deposit" or "electro-deposited" or "electro-depositing" or "electro-deposition"))	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2022/07/06 08:29 AM

L246	17	L245 and (("220" or "[220]" or "{220}" or "(220)" or "<220>") near5 (texture or coefficient or index or Miller or hkl or "h,k,l"))	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2022/07/06 08:29 AM
L247	63	((KCF) near3 (tech or technol or technology)).as,aanm.	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2022/07/06 08:37 AM
L248	53	L247 not L246	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2022/07/06 08:37 AM
L249	16	((("JIN") near3 ("Shan") near3 ("Hua"))).INV.	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2022/10/13 10:31 AM
L250	25	((("LEE") near3 ("An") near3 ("Na"))).INV.	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2022/10/13 10:31 AM
L251	124	((("KIM") near3 ("Seung") near3 ("Min"))).INV.	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2022/10/13 10:31 AM
L252	400	((("JIN") near3 ("Shan" or Hua or "shanhua" or "shan-hua"))).INV.	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2022/10/13 10:31 AM
L253	1025	((("LEE") near3 ("An" or Na or "An-Na"))).INV.	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2022/10/13 10:31 AM
L254	19332	((("KIM") near3 ("Seung" or Min or "SeungMin" or "Seung-Min"))).INV.	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2022/10/13 10:31 AM
L255	49	((("JIN") near3 ("Shan" or Hua or "shanhua" or "shan-hua"))).aanm.	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2022/10/13 10:31 AM
L256	110	((("LEE") near3 ("An" or Na or "An-Na"))).aanm.	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2022/10/13 10:31 AM
L257	2055	((("KIM") near3 ("Seung" or Min or "SeungMin" or "Seung-Min"))).aanm.	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2022/10/13 10:31 AM
L258	20681	L235 or L236 or L237 or L238 or L239 or L240 or L241 or L242 or L243	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2022/10/13 10:31 AM
L259	2128	L244 and ((Cu or copper or "cu-alloy" or "cu-base" or "Cu-based" or "copper-base" or "copper-based" or "copper-alloy") with (foil or foiled or foiling or tape or ribbon or layer or layered or layering or film or filmed or filming or clad or claded or cladded or clading or cladding or coat or coated or coating or	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2022/10/13 10:31 AM

		electroplate or electroplated or electroplating or electroless or electrolessly or electroform or electroformed or electroforming or electrodeposit or electrodeposited or electrodepositing or electrodeposition or "electro-plate" or "electro-plated" or "electro-plating" or "electro-less" or "electro-lessly" or "electro-form" or "electro-formed" or "electro-forming" or "electro-deposit" or "electro-deposited" or "electro-depositing" or "electro-deposition"))					
L260	15	L245 and (("220" or "[220]" or "{220}" or "(220)" or "<220>") near5 (texture or coefficient or index or Miller or hkl or "h,k,l"))	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2022/10/13 10:31 AM
L261	0	((KCF) near3 (tech or technol or technology)).as,aanm.	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2022/10/13 10:33 AM
L262	0	L247 not L246	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2022/10/13 10:33 AM
L263	8	((SK) near3 (nexilis)).as,aanm.	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2022/10/13 10:34 AM
L264	166120	B32B15/01;C25D1/04;C25D3/38;C25D5/34,48;C25D7/0614;C25D21/06;H01M4/0404,13,66,661,667;H01M10/052,0525;H01M2004/027;Y02E60/10;Y10T428/12431,12438.cpc.	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2022/10/13 10:36 AM
L265	45385	L177 and ((Cu or copper or "cu-alloy" or "cu-base" or "Cu-based" or "copper-base" or "copper-based" or "copper-alloy") near5 (foil or foiled or foiling or tape or ribbon or layer or layered or layering or film or filmed or filming	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2022/10/13 10:36 AM

		or clad or cladded or cladded or clading or cladding or coat or coated or coating or electroplate or electroplated or electroplating or electroless or electrolessly or electroform or electroformed or electroforming or electrodeposit or electrodeposited or electrodepositing or electrodeposition or "electro-plate" or "electro-plated" or "electro-plating" or "electro-less" or "electro-lessly" or "electro-form" or "electro-formed" or "electro-forming" or "electro-deposit" or "electro-deposited" or "electro-depositing" or "electro-deposition"))					
L266	93	L178 and (("220" or "[220]" or "{220}" or "(220)" or "<220>") near5 (texture or coefficient or index or Miller or hkl or "h,k,l"))	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2022/10/13 10:36 AM
L267	107	L178 and (("220" or "[220]" or "{220}" or "(220)" or "<220>") near8 (texture or coefficient or index or Miller or hkl or "h,k,l"))	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2022/10/13 10:41 AM
L268	189	L178 and (("220" or "[220]" or "{220}" or "(220)" or "<220>") with (texture or coefficient or index or Miller or hkl or "h,k,l"))	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2022/10/13 10:42 AM
L269	51	L177 and (((peak near2 density) or PD.u/c.) near5 (surface or shiney or shiny or matt or matte or mat or matted))	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2022/10/13 10:44 AM
L270	1049352	B32B15/01;C25D1/04;C25D3/38;C25D5/34,48;C25D7/0614;C25D21/06;H01M4/0404,13,66,66	(FPRS; EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2022/10/13 10:46 AM

		1,667;H01M10/052,0525;H01M2004/027;Y02E60/10;Y10T428/12431,12438.cpc.					
L271	92	L189 and (((Cu or copper or "cu-alloy" or "cu-base" or "Cu-based" or "copper-base" or "copper-based" or "copper-alloy") with (foil or foiled or foiling or tape or ribbon or layer or layered or layering or film or filmed or filming or clad or claded or cladded or clading or cladding or coat or coated or coating or electroplate or electroplated or electroplating or electroless or electrolessly or electroform or electroformed or electroforming or electrodeposit or electrodeposited or electrodepositing or electrodeposition or "electro-plate" or "electro-plated" or "electro-plating" or "electro-less" or "electro-lessly" or "electro-form" or "electro-formed" or "electro-forming" or "electro-deposit" or "electro-deposited" or "electro-depositing" or "electro-deposition")) with (("220" or "[220]" or "{220}" or "(220)" or "<220>") with (texture or coefficient or index or Miller or hkl or "h,k,l")))	(FPRS; EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2022/10/13 10:46 AM
L272	23	L189 and (((peak near2 density) or PD.u/c.) near5 (surface or shiney or shiny or matt or matte or mat or matted))	(FPRS; EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2022/10/13 10:48 AM
L273	16	(((Cu or copper or "cu-alloy" or "cu-base" or "Cu-based" or "copper-	(FPRS; EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2022/10/13 10:49 AM

		base" or "copper-based" or "copper-alloy") with (foil or foiled or foiling or tape or ribbon or layer or layered or layering or film or filmed or filming or clad or claded or cladded or clading or cladding or coat or coated or coating or electroplate or electroplated or electroplating or electroless or electrolessly or electroform or electroformed or electroforming or electrodeposit or electrodeposited or electrodepositing or electrodeposition or "electro-plate" or "electro-plated" or "electro-plating" or "electro-less" or "electro-lessly" or "electro-form" or "electro-formed" or "electro-forming" or "electro-deposit" or "electro-deposited" or "electro-depositing" or "electro-deposition")) with (("220" or "[220]" or "{220}" or "(220)" or "<220>") with (texture or coefficient or index or Miller or hkl or "h,k,l"))) and (((peak near2 density) or PD.u/c.) near5 (surface or shiney or shiny or matt or matte or mat or matted))					
L274	0	L192 not L191	(FPRS; EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2022/10/13 10:49 AM
L275	18	(((Cu or copper or "cu-alloy" or "cu-base" or "Cu-based" or "copper-base" or "copper-based" or "copper-alloy") with (foil or foiled or foiling or tape or ribbon or layer or layered or layering or	(FPRS; EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2022/10/13 10:49 AM

		film or filmed or filming or clad or claded or cladded or clading or cladding or coat or coated or coating or electroplate or electroplated or electroplating or electroless or electrolessly or electroform or electroformed or electroforming or electrodeposit or electrodeposited or electrodepositing or electrodeposition or "electro-plate" or "electro-plated" or "electro-plating" or "electro-less" or "electro-lessly" or "electro-form" or "electro-formed" or "electro-forming" or "electro-deposit" or "electro-deposited" or "electro-depositing" or "electro-deposition")) with (("220" or "[220]" or "{220}" or "(220)" or "<220>") with (texture or coefficient or index or Miller or hkl or "h,k,l"))) and (((peak near2 density) or PD.u/c.) with (surface or shiney or shiny or matt or matte or mat or matted))					
L276	2	L194 not L191	(FPRS; EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2022/10/13 10:49 AM
L277	21	((Cu or copper or "cu-alloy" or "cu-base" or "Cu-based" or "copper-base" or "copper-based" or "copper-alloy") near5 (foil or foiled or foiling or tape or ribbon or layer or layered or layering or film or filmed or filming or clad or claded or cladded or clading or cladding or coat or coated or coating or electroplate or electroplated or	(FPRS; EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2022/10/13 10:50 AM

		electroplating or electroless or electrolessly or electroform or electroformed or electroforming or electrodeposit or electrodeposited or electrodepositing or electrodeposition or "electro-plate" or "electro-plated" or "electro-plating" or "electro-less" or "electro-lessly" or "electro-form" or "electro-formed" or "electro-forming" or "electro-deposit" or "electro-deposited" or "electro-depositing" or "electro-deposition")) near5 (((peak near2 density) or PD.u/c.) near5 (surface or shiney or shiny or matt or matte or mat or matted))					
L278	5	L196 not (L191 or L195)	(FPRS; EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2022/10/13 10:50 AM
L279	24	((Cu or copper or "cu-alloy" or "cu-base" or "Cu-based" or "copper-base" or "copper-based" or "copper-alloy") with (foil or foiled or foiling or tape or ribbon or layer or layered or layering or film or filmed or filming or clad or claded or cladded or clading or cladding or coat or coated or coating or electroplate or electroplated or electroplating or electroless or electrolessly or electroform or electroformed or electroforming or electrodeposit or electrodeposited or electrodepositing or electrodeposition or "electro-plate" or	(FPRS; EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2022/10/13 10:51 AM

		"electro-plated" or "electro-plating" or "electro-less" or "electro-lessly" or "electro-form" or "electro-formed" or "electro-forming" or "electro-deposit" or "electro-deposited" or "electro-depositing" or "electro-deposition")) with (((peak near2 density) or PD.u/c.) near5 (surface or shiney or shiny or matt or matte or mat or matted))					
L280	3	L198 not (L191 or L195 or L197)	(FPRS; EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2022/10/13 10:51 AM
L281	13	((Cu or copper or "cu-alloy" or "cu-base" or "Cu-based" or "copper-base" or "copper-based" or "copper-alloy") near5 (foil or foiled or foiling or tape or ribbon or layer or layered or layering or film or filmed or filming or clad or claded or cladded or clading or cladding or coat or coated or coating or electroplate or electroplated or electroplating or electroless or electrolessly or electroform or electroformed or electroforming or electrodeposit or electrodeposited or electrodepositing or electrodeposition or "electro-plate" or "electro-plated" or "electro-plating" or "electro-less" or "electro-lessly" or "electro-form" or "electro-formed" or "electro-forming" or "electro-deposit" or "electro-deposited" or "electro-depositing" or "electro-deposition"))	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2022/10/13 10:51 AM

		near5 (((peak near2 density) or PD.u/c.) near5 (surface or shiney or shiny or matt or matte or mat or matted))					
L282	16	((Cu or copper or "cu-alloy" or "cu-base" or "Cu-based" or "copper-base" or "copper-based" or "copper-alloy") near8 (foil or foiled or foiling or tape or ribbon or layer or layered or layering or film or filmed or filming or clad or claded or cladded or clading or cladding or coat or coated or coating or electroplate or electroplated or electroplating or electroless or electrolessly or electroform or electroformed or electroforming or electrodeposit or electrodeposited or electrodepositing or electrodeposition or "electro-plate" or "electro-plated" or "electro-plating" or "electro-less" or "electro-lessly" or "electro-form" or "electro-formed" or "electro-forming" or "electro-deposit" or "electro-deposited" or "electro-depositing" or "electro-deposition")) near8 (((peak near2 density) or PD.u/c.) near5 (surface or shiney or shiny or matt or matte or mat or matted))	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2022/10/13 10:52 AM
L283	18	((Cu or copper or "cu-alloy" or "cu-base" or "Cu-based" or "copper-base" or "copper-based" or "copper-alloy") with (foil or foiled or foiling or tape or	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2022/10/13 10:53 AM

		ribbon or layer or layered or layering or film or filmed or filming or clad or claded or cladded or clading or cladding or coat or coated or coating or electroplate or electroplated or electroplating or electroless or electrolessly or electroform or electroformed or electroforming or electrodeposit or electrodeposited or electrodepositing or electrodeposition or "electro-plate" or "electro-plated" or "electro-plating" or "electro-less" or "electro-lessly" or "electro-form" or "electro-formed" or "electro-forming" or "electro-deposit" or "electro-deposited" or "electro-depositing" or "electro-deposition")) with (((peak near2 density) or PD.u/c.) near5 (surface or shiney or shiny or matt or matte or mat or matted))					
L284	43	(((Cu or copper or "cu-alloy" or "cu-base" or "Cu-based" or "copper-base" or "copper-based" or "copper-alloy") near5 (foil or foiled or foiling or tape or ribbon or layer or layered or layering or film or filmed or filming or clad or claded or cladded or clading or cladding or coat or coated or coating or electroplate or electroplated or electroplating or electroless or electrolessly or electroform or electroformed or	(FPRS; EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2022/10/13 10:54 AM

		electroforming or electrodeposit or electrodeposited or electrodepositing or electrodeposition or "electro-plate" or "electro-plated" or "electro-plating" or "electro-less" or "electro-lessly" or "electro-form" or "electro-formed" or "electro-forming" or "electro-deposit" or "electro-deposited" or "electro-depositing" or "electro-deposition")) near5 (("220" or "[220]" or "{220}" or "(220)" or "<220>") near5 (texture or coefficient or index or Miller or hkl or "h,k,l")))					
L285	75	(((Cu or copper or "cu-alloy" or "cu-base" or "Cu-based" or "copper-base" or "copper-based" or "copper-alloy") near5 (foil or foiled or foiling or tape or ribbon or layer or layered or layering or film or filmed or filming or clad or claded or cladded or clading or cladding or coat or coated or coating or electroplate or electroplated or electroplating or electroless or electrolessly or electroform or electroformed or electroforming or electrodeposit or electrodeposited or electrodepositing or electrodeposition or "electro-plate" or "electro-plated" or "electro-plating" or "electro-less" or "electro-lessly" or "electro-form" or "electro-formed" or "electro-forming" or "electro-deposit" or "electro-deposited" or	(FPRS; EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2022/10/13 10:55 AM

		"electro-depositing" or "electro-deposition")) near5 (("220" or "[220]" or "{220}" or "(220)" or "<220>") with (texture or coefficient or index or Miller or hkl or "h,k,l")))					
L286	32	L207 not L206	(FPRS; EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2022/10/13 10:55 AM
L287	203	(((Cu or copper or "cu-alloy" or "cu-base" or "Cu-based" or "copper-base" or "copper-based" or "copper-alloy") with (foil or foiled or foiling or tape or ribbon or layer or layered or layering or film or filmed or filming or clad or claded or cladded or clading or cladding or coat or coated or coating or electroplate or electroplated or electroplating or electroless or electrolessly or electroform or electroformed or electroforming or electrodeposit or electrodeposited or electrodepositing or electrodeposition or "electro-plate" or "electro-plated" or "electro-plating" or "electro-less" or "electro-lessly" or "electro-form" or "electro-formed" or "electro-forming" or "electro-deposit" or "electro-deposited" or "electro-depositing" or "electro-deposition")) with (("220" or "[220]" or "{220}" or "(220)" or "<220>") with (texture or coefficient or index or Miller or hkl or "h,k,l")))	(FPRS; EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2022/10/13 11:00 AM
L288	128	L209 not (L206 or L208)	(FPRS; EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2022/10/13 11:00 AM
L289	38	(((Cu or copper or "cu-alloy" or "cu-base" or "Cu-based" or "copper-	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2022/10/13 11:06 AM

		base" or "copper-based" or "copper-alloy") near5 (foil or foiled or foiling or tape or ribbon or layer or layered or layering or film or filmed or filming or clad or claded or cladded or clading or cladding or coat or coated or coating or electroplate or electroplated or electroplating or electroless or electrolessly or electroform or electroformed or electroforming or electrodeposit or electrodeposited or electrodepositing or electrodeposition or "electro-plate" or "electro-plated" or "electro-plating" or "electro-less" or "electro-lessly" or "electro-form" or "electro-formed" or "electro-forming" or "electro-deposit" or "electro-deposited" or "electro-depositing" or "electro-deposition")) near5 (("220" or "[220]" or "{220}" or "(220)" or "<220>") near5 (texture or coefficient or index or Miller or hkl or "h,k,l")))					
L290	51	(((Cu or copper or "cu-alloy" or "cu-base" or "Cu-based" or "copper-base" or "copper-based" or "copper-alloy") near8 (foil or foiled or foiling or tape or ribbon or layer or layered or layering or film or filmed or filming or clad or claded or cladded or clading or cladding or coat or coated or coating or electroplate or electroplated or electroplating or electroless or	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2022/10/13 11:07 AM

		electrolessly or electroform or electroformed or electroforming or electrodeposit or electrodeposited or electrodepositing or electrodeposition or "electro-plate" or "electro-plated" or "electro-plating" or "electro-less" or "electro-lessly" or "electro-form" or "electro-formed" or "electro-forming" or "electro-deposit" or "electro-deposited" or "electro-depositing" or "electro-deposition")) near8 (("220" or "[220]" or "{220}" or "(220)" or "<220>") near8 (texture or coefficient or index or Miller or hkl or "h,k,l")))					
L291	71	(((Cu or copper or "cu-alloy" or "cu-base" or "Cu-based" or "copper-base" or "copper-based" or "copper-alloy") near12 (foil or foiled or foiling or tape or ribbon or layer or layered or layering or film or filmed or filming or clad or claded or cladded or clading or cladding or coat or coated or coating or electroplate or electroplated or electroplating or electroless or electrolessly or electroform or electroformed or electroforming or electrodeposit or electrodeposited or electrodepositing or electrodeposition or "electro-plate" or "electro-plated" or "electro-plating" or "electro-less" or "electro-lessly" or "electro-form" or "electro-formed" or	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2022/10/13 11:08 AM

		"electro-forming" or "electro-deposit" or "electro-deposited" or "electro-depositing" or "electro-deposition")) near12 (("220" or "[220]" or "{220}" or "(220)" or "<220>") near12 (texture or coefficient or index or Miller or hkl or "h,k,l")))					
L292	839830	B32B15/01;C25D1/04;C25D3/38;C25D5/34,48;C25D7/0614;C25D21/06;H01M4/0404,13,66,661,667;H01M10/0525;H01M2004/027;Y02E60/10;Y10T428/12431,12438.cpc.	(FIT (AU, AP, AT, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, OA, RU, SU, WO, MC, MD, MY, NL, NO, NZ, PH, PL, PT, RO, RS, SE, SG, SI, SK, TH, TN, TR, TW, UA, VN))	OR	ON	ON	2022/10/13 11:10 AM
L293	169	L292 AND (((Cu OR copper OR "cu-alloy" OR "cu-base" OR "Cu-based" OR "copper-base" OR "copper-based" OR "copper-alloy") WITH (foil OR foiled OR foiling OR tape OR ribbon OR layer OR layered OR layering OR film OR filmed OR filming OR clad OR claded OR cladded OR clading OR cladding OR coat OR coated OR coating OR electroplate OR electroplated OR electroplating OR electroless OR electrolessly OR electroform OR electroformed OR electroforming OR electrodeposit OR electrodeposited OR electrodepositing OR electrodeposition OR "electro-plate" OR "electro-plated" OR "electro-plating" OR "electro-less" OR "electro-lessly" OR	(FIT (AU, AP, AT, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, OA, RU, SU, WO, MC, MD, MY, NL, NO, NZ, PH, PL, PT, RO, RS, SE, SG, SI, SK, TH, TN, TR, TW, UA, VN))	OR	ON	ON	2022/10/13 11:10 AM

		"electro-form" OR "electro-formed" OR "electro-forming" OR "electro-deposit" OR "electro-deposited" OR "electro-depositing" OR "electro-deposition")) WITH (("220" OR "[220]" OR "{220}" OR "(220)" OR "<220>") WITH (texture OR coefficient OR index OR Miller OR hkl OR "h,k,l")))					
L294	192	L292 AND (((peak near2 density) OR PD.u/c.) near5 (surface OR shiney OR shiny OR matt OR matte OR mat OR matted))	(FIT (AU, AP, AT, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, OA, RU, SU, WO, MC, MD, MY, NL, NO, NZ, PH, PL, PT, RO, RS, SE, SG, SI, SK, TH, TN, TR, TW, UA, VN))	OR	ON	ON	2022/10/13 11:12 AM
L295	143	(((Cu OR copper OR "cu-alloy" OR "cu-base" OR "Cu-based" OR "copper-base" OR "copper-based" OR "copper-alloy") near5 (foil OR foiled OR foiling OR tape OR ribbon OR layer OR layered OR layering OR film OR filmed OR filming OR clad OR claded OR cladded OR clading OR cladding OR coat OR coated OR coating OR electroplate OR electroplated OR electroplating OR electroless OR electrolessly OR electroform OR electroformed OR electroforming OR electrodeposit OR electrodeposited OR electrodepositing OR electrodeposition OR "electro-plate" OR "electro-plated" OR "electro-plating" OR	(FIT (AU, AP, AT, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, OA, RU, SU, WO, MC, MD, MY, NL, NO, NZ, PH, PL, PT, RO, RS, SE, SG, SI, SK, TH, TN, TR, TW, UA, VN))	OR	ON	ON	2022/10/13 11:15 AM

		"electro-less" OR "electro-lessly" OR "electro-form" OR "electro-formed" OR "electro-forming" OR "electro-deposit" OR "electro-deposited" OR "electro-depositing" OR "electro-deposition")) near5 (("220" OR "[220]" OR "{220}" OR "(220)" OR "<220>") near5 (texture OR coefficient OR index OR Miller OR hkl OR "h,k,l")))					
L296	204	(((Cu OR copper OR "cu-alloy" OR "cu-base" OR "Cu-based" OR "copper-base" OR "copper-based" OR "copper-alloy") near8 (foil OR foiled OR foiling OR tape OR ribbon OR layer OR layered OR layering OR film OR filmed OR filming OR clad OR claded OR cladded OR clading OR cladding OR coat OR coated OR coating OR electroplate OR electroplated OR electroplating OR electroless OR electrolessly OR electroform OR electroformed OR electroforming OR electrodeposit OR electrodeposited OR electrodepositing OR electrodeposition OR "electro-plate" OR "electro-plated" OR "electro-plating" OR "electro-less" OR "electro-lessly" OR "electro-form" OR "electro-formed" OR "electro-forming" OR "electro-deposit" OR "electro-deposited" OR "electro-depositing" OR "electro-deposition")) near8 (("220" OR "[220]" OR "{220}" OR "(220)" OR "<220>")	(FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO))	OR	ON	ON	2022/10/13 11:17 AM

		near8 (texture OR coefficient OR index OR Miller OR hkl OR "h,k,l")))					
L297	61	L296 NOT L295	(FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO))	OR	ON	ON	2022/10/13 11:17 AM

PE2E SEARCH - Search History (Interference)

Ref #	Hits	Search Query	DBs	Default Operator	Plurals	British Equivalents	Time Stamp
N217	146924	B32B15/01;C25D1/04;C25D3/38;C25D5/34,48;C25D21/06;H01M4/0404,13,66,661,667;H01M10/052,0525;H01M2004/027;Y02E60/10;Y10T428/12431,12438.cpc.	(US-PGPUB; USPAT)	OR	ON	ON	2022/03/28 08:42 AM
N218	14	N217 and ((((Cu or copper or "cu-alloy" or "cu-base" or "Cu-based" or "copper-base" or "copper-based" or "copper-alloy") near5 (foil or foiled or foiling or tape or ribbon or layer or layered or layering or film or filmed or filming or clad or claded or cladded or clading or cladding or coat or coated or coating or electroplate or electroplated or electroplating or electroless or electrolessly or electroform or electroformed or electroforming or electrodeposit or electrodeposited or electrodepositing or electrodeposition or "electro-plate" or	(US-PGPUB; USPAT)	OR	ON	ON	2022/03/28 08:42 AM

		"electro-plated" or "electro-plating" or "electro-less" or "electro-lessly" or "electro-form" or "electro-formed" or "electro-forming" or "electro-deposit" or "electro-deposited" or "electro-depositing" or "electro-deposition")) near5 (("220" or "[220]" or "{220}" or "(220)" or "<220>") near5 (texture or coefficient or index or Miller or hkl or "h,k,l"))))).clm.					
N219	17	N217 and ((((Cu or copper or "cu-alloy" or "cu-base" or "Cu-based" or "copper-base" or "copper-based" or "copper-alloy") near8 (foil or foiled or foiling or tape or ribbon or layer or layered or layering or film or filmed or filming or clad or claded or cladded or clading or cladding or coat or coated or coating or electroplate or electroplated or electroplating or electroless or electrolessly or electroform or electroformed or electroforming or electrodeposit or electrodeposited or electrodepositing or electrodeposition or "electro-plate" or "electro-plated" or "electro-plating" or "electro-less" or "electro-lessly" or "electro-form" or "electro-formed" or "electro-forming" or "electro-deposit" or "electro-deposited" or "electro-depositing" or "electro-deposition")) near8 (("220" or "[220]" or "{220}" or "(220)" or	(US-PGPUB; USPAT)	OR	ON	ON	2022/03/28 08:45 AM

		"<220>") near5 (texture or coefficient or index or Miller or hkl or "h,k,l")))).clm.					
N220	3	N219 not N218	(US-PGPUB; USPAT)	OR	ON	ON	2022/03/28 08:45 AM
N221	3	N217 and (((Cu or copper or "cu-alloy" or "cu-base" or "Cu-based" or "copper-base" or "copper-based" or "copper-alloy") with (foil or foiled or foiling or tape or ribbon or layer or layered or layering or film or filmed or filming or clad or claded or cladded or clading or cladding or coat or coated or coating or electroplate or electroplated or electroplating or electroless or electrolessly or electroform or electroformed or electroforming or electrodeposit or electrodeposited or electrodepositing or electrodeposition or "electro-plate" or "electro-plated" or "electro-plating" or "electro-less" or "electro-lessly" or "electro-form" or "electro-formed" or "electro-forming" or "electro-deposit" or "electro-deposited" or "electro-depositing" or "electro-deposition")) with (((peak near2 density) or PD.u/c.) near5 (surface or shiney or shiny or matt or matte or mat or matted))).clm.	(US-PGPUB; USPAT)	OR	ON	ON	2022/03/28 08:46 AM
N222	0	N221 not (N218 or N220)	(US-PGPUB; USPAT)	OR	ON	ON	2022/03/28 08:46 AM
N223	7	N217 and (((Cu or copper or "cu-alloy" or "cu-base" or "Cu-based" or "copper-	(US-PGPUB; USPAT)	OR	ON	ON	2022/03/28 08:46 AM

		base" or "copper-based" or "copper-alloy") with (foil or foiled or foiling or tape or ribbon or layer or layered or layering or film or filmed or filming or clad or claded or cladded or clading or cladding or coat or coated or coating or electroplate or electroplated or electroplating or electroless or electrolessly or electroform or electroformed or electroforming or electrodeposit or electrodeposited or electrodepositing or electrodeposition or "electro-plate" or "electro-plated" or "electro-plating" or "electro-less" or "electro-lessly" or "electro-form" or "electro-formed" or "electro-forming" or "electro-deposit" or "electro-deposited" or "electro-depositing" or "electro-deposition")) with (((peak near2 density) or PD.u/c.) with (surface or shiney or shiny or matt or matte or mat or matted))).clm.					
N224	3	N223 not (N218 or N220)	(US-PGPUB; USPAT)	OR	ON	ON	2022/03/28 08:47 AM
N225	14	((((Cu or copper or "cu-alloy" or "cu-base" or "Cu-based" or "copper-base" or "copper-based" or "copper-alloy") near5 (foil or foiled or foiling or tape or ribbon or layer or layered or layering or film or filmed or filming or clad or claded or cladded or clading or cladding or coat or coated or coating or electroplate or	(US-PGPUB; USPAT)	OR	ON	ON	2022/03/28 08:48 AM

		electroplated or electroplating or electroless or electrolessly or electroform or electroformed or electroforming or electrodeposit or electrodeposited or electrodepositing or electrodeposition or "electro-plate" or "electro-plated" or "electro-plating" or "electro-less" or "electro-lessly" or "electro-form" or "electro-formed" or "electro-forming" or "electro-deposit" or "electro-deposited" or "electro-depositing" or "electro-deposition")) near5 (("220" or "[220]" or "{220}" or "(220)" or "<220>") near5 (texture or coefficient or index or Miller or hkl or "h,k,l"))))).clm.					
N226	0	N225 not (N218 or N220 or N224)	(US-PGPUB; USPAT)	OR	ON	ON	2022/03/28 08:49 AM
N227	14	((((Cu or copper or "cu-alloy" or "cu-base" or "Cu-based" or "copper-base" or "copper-based" or "copper-alloy") near8 (foil or foiled or foiling or tape or ribbon or layer or layered or layering or film or filmed or filming or clad or claded or cladded or clading or cladding or coat or coated or coating or electroplate or electroplated or electroplating or electroless or electrolessly or electroform or electroformed or electroforming or electrodeposit or electrodeposited or electrodepositing or electrodeposition or	(US-PGPUB; USPAT)	OR	ON	ON	2022/03/28 08:49 AM

		"electro-plate" or "electro-plated" or "electro-plating" or "electro-less" or "electro-lessly" or "electro-form" or "electro-formed" or "electro-forming" or "electro-deposit" or "electro-deposited" or "electro-depositing" or "electro-deposition")) near5 (("220" or "[220]" or "{220}" or "(220)" or "<220>") near8 (texture or coefficient or index or Miller or hkl or "h,k,l"))))).clm.					
N228	17	((((Cu or copper or "cu-alloy" or "cu-base" or "Cu-based" or "copper-base" or "copper-based" or "copper-alloy") near8 (foil or foiled or foiling or tape or ribbon or layer or layered or layering or film or filmed or filming or clad or claded or cladded or clading or cladding or coat or coated or coating or electroplate or electroplated or electroplating or electroless or electrolessly or electroform or electroformed or electroforming or electrodeposit or electrodeposited or electrodepositing or electrodeposition or "electro-plate" or "electro-plated" or "electro-plating" or "electro-less" or "electro-lessly" or "electro-form" or "electro-formed" or "electro-forming" or "electro-deposit" or "electro-deposited" or "electro-depositing" or "electro-deposition")) near8 (("220" or "[220]" or "{220}" or "(220)" or	(US-PGPUB; USPAT)	OR	ON	ON	2022/03/28 08:49 AM

		"<220>") near8 (texture or coefficient or index or Miller or hkl or "h,k,l")))).clm.					
N229	0	N228 not (N218 or N220 or N224)	(US-PGPUB; USPAT)	OR	ON	ON	2022/03/28 08:50 AM
N230	27	((((Cu or copper or "cu-alloy" or "cu-base" or "Cu-based" or "copper-base" or "copper-based" or "copper-alloy") with (foil or foiled or foiling or tape or ribbon or layer or layered or layering or film or filmed or filming or clad or cladded or cladded or clading or cladding or coat or coated or coating or electroplate or electroplated or electroplating or electroless or electrolessly or electroform or electroformed or electroforming or electrodeposit or electrodeposited or electrodepositing or electrodeposition or "electro-plate" or "electro-plated" or "electro-plating" or "electro-less" or "electro-lessly" or "electro-form" or "electro-formed" or "electro-forming" or "electro-deposit" or "electro-deposited" or "electro-depositing" or "electro-deposition")) with (("220" or "[220]" or "{220}" or "(220)" or "<220>") with (texture or coefficient or index or Miller or hkl or "h,k,l")))).clm.	(US-PGPUB; USPAT)	OR	ON	ON	2022/03/28 08:50 AM
N231	10	N230 not (N218 or N220 or N224)	(US-PGPUB; USPAT)	OR	ON	ON	2022/03/28 08:50 AM
N232	7	(((Cu or copper or "cu-alloy" or "cu-base" or "Cu-based" or "copper-base" or "copper-based" or "copper-	(US-PGPUB; USPAT)	OR	ON	ON	2022/03/28 08:52 AM

		alloy") with (foil or foiled or foiling or tape or ribbon or layer or layered or layering or film or filmed or filming or clad or claded or cladded or clading or cladding or coat or coated or coating or electroplate or electroplated or electroplating or electroless or electrolessly or electroform or electroformed or electroforming or electrodeposit or electrodeposited or electrodepositing or electrodeposition or "electro-plate" or "electro-plated" or "electro-plating" or "electro-less" or "electro-lessly" or "electro-form" or "electro-formed" or "electro-forming" or "electro-deposit" or "electro-deposited" or "electro-depositing" or "electro-deposition")) with (((peak near2 density) or PD.u/c.) with (surface or shiney or shiny or matt or matte or mat or matted))).clm.					
N233	0	N232 not (N218 or N220 or N224 or N231)	(US-PGPUB; USPAT)	OR	ON	ON	2022/03/28 08:52 AM
N249	150515	B32B15/01;C25D1/04;C25D3/38;C25D5/34,48;C25D21/06;H01M4/0404,13,66,661,667;H01M10/052,0525;H01M2004/027;Y02E60/10;Y10T428/12431,12438.cpc.	(US-PGPUB; USPAT)	OR	ON	ON	2022/07/06 08:39 AM
N250	16	N249 and ((((Cu or copper or "cu-alloy" or "cu-base" or "Cu-based" or "copper-base" or "copper-based" or "copper-alloy") near5 (foil or foiled or foiling or tape or ribbon or layer or layered or layering or	(US-PGPUB; USPAT)	OR	ON	ON	2022/07/06 08:39 AM

		film or filmed or filming or clad or claded or cladded or clading or cladding or coat or coated or coating or electroplate or electroplated or electroplating or electroless or electrolessly or electroform or electroformed or electroforming or electrodeposit or electrodeposited or electrodepositing or electrodeposition or "electro-plate" or "electro-plated" or "electro-plating" or "electro-less" or "electro-lessly" or "electro-form" or "electro-formed" or "electro-forming" or "electro-deposit" or "electro-deposited" or "electro-depositing" or "electro-deposition")) near5 (("220" or "[220]" or "{220}" or "(220)" or "<220>") near5 (texture or coefficient or index or Miller or hkl or "h,k,l"))))).clm.					
N251	21	N249 and ((((Cu or copper or "cu-alloy" or "cu-base" or "Cu-based" or "copper-base" or "copper-based" or "copper-alloy") near8 (foil or foiled or foiling or tape or ribbon or layer or layered or layering or film or filmed or filming or clad or claded or cladded or clading or cladding or coat or coated or coating or electroplate or electroplated or electroplating or electroless or electrolessly or electroform or electroformed or electroforming or	(US-PGPUB; USPAT)	OR	ON	ON	2022/07/06 08:40 AM

		electrodeposit or electrodeposited or electrodepositing or electrodeposition or "electro-plate" or "electro-plated" or "electro-plating" or "electro-less" or "electro-lessly" or "electro-form" or "electro-formed" or "electro-forming" or "electro-deposit" or "electro-deposited" or "electro-depositing" or "electro-deposition")) near8 (("220" or "[220]" or "{220}" or "(220)" or "<220>") near5 (texture or coefficient or index or Miller or hkl or "h,k,l"))))).clm.					
N252	5	N251 not N250	(US-PGPUB; USPAT)	OR	ON	ON	2022/07/06 08:40 AM
N253	3	N249 and (((Cu or copper or "cu-alloy" or "cu-base" or "Cu-based" or "copper-base" or "copper-based" or "copper-alloy") with (foil or foiled or foiling or tape or ribbon or layer or layered or layering or film or filmed or filming or clad or claded or cladded or clading or cladding or coat or coated or coating or electroplate or electroplated or electroplating or electroless or electrolessly or electroform or electroformed or electroforming or electrodeposit or electrodeposited or electrodepositing or electrodeposition or "electro-plate" or "electro-plated" or "electro-plating" or "electro-less" or "electro-lessly" or "electro-form" or	(US-PGPUB; USPAT)	OR	ON	ON	2022/07/06 08:41 AM

		"electro-formed" or "electro-forming" or "electro-deposit" or "electro-deposited" or "electro-depositing" or "electro-deposition")) with (((peak near2 density) or PD.u/c.) near5 (surface or shiney or shiny or matt or matte or mat or matted))).clm.					
N254	0	N253 not (N250 or N252)	(US-PGPUB; USPAT)	OR	ON	ON	2022/07/06 08:41 AM
N255	8	N249 and (((Cu or copper or "cu-alloy" or "cu-base" or "Cu-based" or "copper-base" or "copper-based" or "copper-alloy") with (foil or foiled or foiling or tape or ribbon or layer or layered or layering or film or filmed or filming or clad or claded or cladded or clading or cladding or coat or coated or coating or electroplate or electroplated or electroplating or electroless or electrolessly or electroform or electroformed or electroforming or electrodeposit or electrodeposited or electrodepositing or electrodeposition or "electro-plate" or "electro-plated" or "electro-plating" or "electro-less" or "electro-lessly" or "electro-form" or "electro-formed" or "electro-forming" or "electro-deposit" or "electro-deposited" or "electro-depositing" or "electro-deposition")) with (((peak near2 density) or PD.u/c.) with (surface or shiney or shiny or matt or matte	(US-PGPUB; USPAT)	OR	ON	ON	2022/07/06 08:42 AM

		or mat or matted))).clm.					
N256	3	N255 not (N250 or N252)	(US-PGPUB; USPAT)	OR	ON	ON	2022/07/06 08:42 AM
N257	16	((((Cu or copper or "cu-alloy" or "cu-base" or "Cu-based" or "copper-base" or "copper-based" or "copper-alloy") near5 (foil or foiled or foiling or tape or ribbon or layer or layered or layering or film or filmed or filming or clad or claded or cladded or clading or cladding or coat or coated or coating or electroplate or electroplated or electroplating or electroless or electrolessly or electroform or electroformed or electroforming or electrodeposit or electrodeposited or electrodepositing or electrodeposition or "electro-plate" or "electro-plated" or "electro-plating" or "electro-less" or "electro-lessly" or "electro-form" or "electro-formed" or "electro-forming" or "electro-deposit" or "electro-deposited" or "electro-depositing" or "electro-deposition")) near5 (("220" or "[220]" or "{220}" or "(220)" or "<220>") near5 (texture or coefficient or index or Miller or hkl or "h,k,l"))))).clm.	(US-PGPUB; USPAT)	OR	ON	ON	2022/07/06 08:43 AM
N258	0	N257 not (N250 or N252 or N256)	(US-PGPUB; USPAT)	OR	ON	ON	2022/07/06 08:43 AM
N259	21	((((Cu or copper or "cu-alloy" or "cu-base" or "Cu-based" or "copper-base" or "copper-based" or "copper-alloy") near8 (foil or foiled or foiling or tape or ribbon or layer or	(US-PGPUB; USPAT)	OR	ON	ON	2022/07/06 08:44 AM

		layered or layering or film or filmed or filming or clad or claded or cladded or clading or cladding or coat or coated or coating or electroplate or electroplated or electroplating or electroless or electrolessly or electroform or electroformed or electroforming or electrodeposit or electrodeposited or electrodepositing or electrodeposition or "electro-plate" or "electro-plated" or "electro-plating" or "electro-less" or "electro-lessly" or "electro-form" or "electro-formed" or "electro-forming" or "electro-deposit" or "electro-deposited" or "electro-depositing" or "electro-deposition")) near8 (("220" or "[220]" or "{220}" or "(220)" or "<220>") near8 (texture or coefficient or index or Miller or hkl or "h,k,l"))))).clm.					
N260	0	N259 not (N250 or N252 or N256)	(US-PGPUB; USPAT)	OR	ON	ON	2022/07/06 08:44 AM
N261	31	((((Cu or copper or "cu-alloy" or "cu-base" or "Cu-based" or "copper-base" or "copper-based" or "copper-alloy") with (foil or foiled or foiling or tape or ribbon or layer or layered or layering or film or filmed or filming or clad or claded or cladded or clading or cladding or coat or coated or coating or electroplate or electroplated or electroplating or electroless or electrolessly or	(US-PGPUB; USPAT)	OR	ON	ON	2022/07/06 08:44 AM

		electroform or electroformed or electroforming or electrodeposit or electrodeposited or electrodepositing or electrodeposition or "electro-plate" or "electro-plated" or "electro-plating" or "electro-less" or "electro-lessly" or "electro-form" or "electro-formed" or "electro-forming" or "electro-deposit" or "electro-deposited" or "electro-depositing" or "electro-deposition")) with (("220" or "[220]" or "{220}" or "(220)" or "<220>") with (texture or coefficient or index or Miller or hkl or "h,k,l"))))).clm.					
N262	10	N261 not (N250 or N252 or N256)	(US-PGPUB; USPAT)	OR	ON	ON	2022/07/06 08:44 AM
N263	157002	B32B15/01;C25D1/04;C25D3/38;C25D5/34,48;C25D21/06;H01M4/0404,13,66,661,667;H01M10/052,0525;H01M2004/027;Y02E60/10;Y10T428/12431,12438.cpc.	(US-PGPUB; USPAT)	OR	ON	ON	2022/10/13 11:23 AM
N264	15	N249 and ((((Cu or copper or "cu-alloy" or "cu-base" or "Cu-based" or "copper-base" or "copper-based" or "copper-alloy") near5 (foil or foiled or foiling or tape or ribbon or layer or layered or layering or film or filmed or filming or clad or claded or cladded or clading or cladding or coat or coated or coating or electroplate or electroplated or electroplating or electroless or electrolessly or electroform or electroformed or electroforming or	(US-PGPUB; USPAT)	OR	ON	ON	2022/10/13 11:23 AM

		electrodeposit or electrodeposited or electrodepositing or electrodeposition or "electro-plate" or "electro-plated" or "electro-plating" or "electro-less" or "electro-lessly" or "electro-form" or "electro-formed" or "electro-forming" or "electro-deposit" or "electro-deposited" or "electro-depositing" or "electro-deposition")) near5 (("220" or "[220]" or "{220}" or "(220)" or "<220>") near5 (texture or coefficient or index or Miller or hkl or "h,k,l"))))).clm.					
N265	21	N249 and ((((Cu or copper or "cu-alloy" or "cu-base" or "Cu-based" or "copper-base" or "copper-based" or "copper-alloy") near8 (foil or foiled or foiling or tape or ribbon or layer or layered or layering or film or filmed or filming or clad or claded or cladded or clading or cladding or coat or coated or coating or electroplate or electroplated or electroplating or electroless or electrolessly or electroform or electroformed or electroforming or electrodeposit or electrodeposited or electrodepositing or electrodeposition or "electro-plate" or "electro-plated" or "electro-plating" or "electro-less" or "electro-lessly" or "electro-form" or "electro-formed" or "electro-forming" or "electro-deposit" or	(US-PGPUB; USPAT)	OR	ON	ON	2022/10/13 11:25 AM

		"electro-deposited" or "electro-depositing" or "electro-deposition")) near8 (("220" or "[220]" or "{220}" or "(220)" or "<220>") near5 (texture or coefficient or index or Miller or hkl or "h,k,l"))))).clm.					
N266	6	N251 not N250	(US-PGPUB; USPAT)	OR	ON	ON	2022/10/13 11:25 AM
N267	3	N249 and (((Cu or copper or "cu-alloy" or "cu-base" or "Cu-based" or "copper-base" or "copper-based" or "copper-alloy") with (foil or foiled or foiling or tape or ribbon or layer or layered or layering or film or filmed or filming or clad or claded or cladded or clading or cladding or coat or coated or coating or electroplate or electroplated or electroplating or electroless or electrolessly or electroform or electroformed or electroforming or electrodeposit or electrodeposited or electrodepositing or electrodeposition or "electro-plate" or "electro-plated" or "electro-plating" or "electro-less" or "electro-lessly" or "electro-form" or "electro-formed" or "electro-forming" or "electro-deposit" or "electro-deposited" or "electro-depositing" or "electro-deposition")) with (((peak near2 density) or PD.u/c.) near5 (surface or shiney or shiny or matt or matte or mat or matted))).clm.	(US-PGPUB; USPAT)	OR	ON	ON	2022/10/13 11:28 AM
N268	0	N253 not (N250 or	(US-PGPUB; USPAT)	OR	ON	ON	2022/10/13

		N252)					11:28 AM
N269	8	N249 and (((Cu or copper or "cu-alloy" or "cu-base" or "Cu-based" or "copper-base" or "copper-based" or "copper-alloy") with (foil or foiled or foiling or tape or ribbon or layer or layered or layering or film or filmed or filming or clad or claded or cladded or clading or cladding or coat or coated or coating or electroplate or electroplated or electroplating or electroless or electrolessly or electroform or electroformed or electroforming or electrodeposit or electrodeposited or electrodepositing or electrodeposition or "electro-plate" or "electro-plated" or "electro-plating" or "electro-less" or "electro-lessly" or "electro-form" or "electro-formed" or "electro-forming" or "electro-deposit" or "electro-deposited" or "electro-depositing" or "electro-deposition")) with (((peak near2 density) or PD.u/c.) with (surface or shiney or shiny or matt or matte or mat or matted))).clm.	(US-PGPUB; USPAT)	OR	ON	ON	2022/10/13 11:28 AM
N270	3	N255 not (N250 or N252)	(US-PGPUB; USPAT)	OR	ON	ON	2022/10/13 11:28 AM
N271	15	((((Cu or copper or "cu-alloy" or "cu-base" or "Cu-based" or "copper-base" or "copper-based" or "copper-alloy") near5 (foil or foiled or foiling or tape or ribbon or layer or layered or layering or film or filmed or filming	(US-PGPUB; USPAT)	OR	ON	ON	2022/10/13 11:28 AM

		or clad or claded or cladded or clading or cladding or coat or coated or coating or electroplate or electroplated or electroplating or electroless or electrolessly or electroform or electroformed or electroforming or electrodeposit or electrodeposited or electrodepositing or electrodeposition or "electro-plate" or "electro-plated" or "electro-plating" or "electro-less" or "electro-lessly" or "electro-form" or "electro-formed" or "electro-forming" or "electro-deposit" or "electro-deposited" or "electro-depositing" or "electro-deposition")) near5 (("220" or "[220]" or "{220}" or "(220)" or "<220>") near5 (texture or coefficient or index or Miller or hkl or "h,k,l"))))).clm.					
N272	0	N257 not (N250 or N252 or N256)	(US-PGPUB; USPAT)	OR	ON	ON	2022/10/13 11:28 AM
N273	21	((((Cu or copper or "cu-alloy" or "cu-base" or "Cu-based" or "copper-base" or "copper-based" or "copper-alloy") near8 (foil or foiled or foiling or tape or ribbon or layer or layered or layering or film or filmed or filming or clad or claded or cladded or clading or cladding or coat or coated or coating or electroplate or electroplated or electroplating or electroless or electrolessly or electroform or electroformed or	(US-PGPUB; USPAT)	OR	ON	ON	2022/10/13 11:29 AM

		electroforming or electrodeposit or electrodeposited or electrodepositing or electrodeposition or "electro-plate" or "electro-plated" or "electro-plating" or "electro-less" or "electro-lessly" or "electro-form" or "electro-formed" or "electro-forming" or "electro-deposit" or "electro-deposited" or "electro-depositing" or "electro-deposition")) near8 (("220" or "[220]" or "{220}" or "(220)" or "<220>") near8 (texture or coefficient or index or Miller or hkl or "h,k,l"))))).clm.					
N274	0	N259 not (N250 or N252 or N256)	(US-PGPUB; USPAT)	OR	ON	ON	2022/10/13 11:29 AM
N275	34	((((Cu or copper or "cu-alloy" or "cu-base" or "Cu-based" or "copper-base" or "copper-based" or "copper-alloy") with (foil or foiled or foiling or tape or ribbon or layer or layered or layering or film or filmed or filming or clad or claded or cladded or clading or cladding or coat or coated or coating or electroplate or electroplated or electroplating or electroless or electrolessly or electroform or electroformed or electroforming or electrodeposit or electrodeposited or electrodepositing or electrodeposition or "electro-plate" or "electro-plated" or "electro-plating" or "electro-less" or "electro-lessly" or "electro-form" or	(US-PGPUB; USPAT)	OR	ON	ON	2022/10/13 11:29 AM

		"electro-formed" or "electro-forming" or "electro-deposit" or "electro-deposited" or "electro-depositing" or "electro-deposition")) with (("220" or "[220]" or "{220}" or "(220)" or "<220>") with (texture or coefficient or index or Miller or hkl or "h,k,l"))))).clm.					
N276	13	N261 not (N250 or N252 or N256)	(US-PGPUB; USPAT)	OR	ON	ON	2022/10/13 11:29 AM

Bibliographic Data

Application No: 16/959,352

Foreign Priority claimed: ◉ Yes ○ No

35 USC 119 (a-d) conditions met: ☑ Yes ☐ No ☐ Met After Allowance

Verified and Acknowledged: /SETH DUMBRIS/ Examiner's Signature | Initials

Title: ELECTROLYTIC COPPER FOIL HAVING EXCELLENT HANDLING CHARACTERISTICS IN POSTPROCESSING, AND MANUFACTURING METHOD THEREFOR

FILING or 371(c) DATE	CLASS	GROUP ART UNIT	ATTORNEY DOCKET NO.
06/30/2020	428	1784	0313221.00022
RULE			

APPLICANTS

SK NEXILIS CO., LTD., JEONGEUP-SI, KOREA, REPUBLIC OF

INVENTORS

Seung Min KIM, Anyang-si, Gyeonggi-do, KOREA, REPUBLIC OF

Shan Hua JIN, Anyang-si, Gyeonggi-do, KOREA, REPUBLIC OF

CONTINUING DATA

This application is a 371 of PCT/KR2019/001069 01/25/2019

FOREIGN APPLICATIONS

KOREA, REPUBLIC OF KR10-2018-0012179 01/31/2018

IF REQUIRED, FOREIGN LICENSE GRANTED**

10/20/2020

STATE OR COUNTRY

KOREA, REPUBLIC OF

ADDRESS

K&L Gates LLP-Chicago
P.O. Box 1135
Chicago, IL 60690
UNITED STATES

FILING FEE RECEIVED

$1,580

PTO/SB/30EFS (01-22)
Approved for use through 05/31/2024. OMB 0651-0031
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE
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REQUEST FOR CONTINUED EXAMINATION(RCE)TRANSMITTAL
(Submitted Only via EFS-Web)

Application Number	16/959,352	Filing Date	2020-06-30	Docket Number (if applicable)	0313221.00022	Art Unit	1784
First Named Inventor	Seung Min KIM			Examiner Name	DUMBRIS, SETH M		

This is a Request for Continued Examination (RCE) under 37 CFR 1.114 of the above-identified application.
Request for Continued Examination (RCE) practice under 37 CFR 1.114 does not apply to any utility or plant application filed prior to June 8, 1995, or to any design application. The Instruction Sheet for this form is located at WWW.USPTO.GOV

SUBMISSION REQUIRED UNDER 37 CFR 1.114

Note: If the RCE is proper, any previously filed unentered amendments and amendments enclosed with the RCE will be entered in the order in which they were filed unless applicant instructs otherwise. If applicant does not wish to have any previously filed unentered amendment(s) entered, applicant must request non-entry of such amendment(s).

☐ Previously submitted. If a final Office action is outstanding, any amendments filed after the final Office action may be considered as a submission even if this box is not checked.

- ☐ Consider the arguments in the Appeal Brief or Reply Brief previously filed on _____
- ☐ Other _____

☒ Enclosed

- ☐ Amendment/Reply
- ☐ Information Disclosure Statement (IDS)
- ☐ Affidavit(s)/ Declaration(s)
- ☒ Other Request for Consideration of Terminal Disclaimer filed on August 9, 2022

MISCELLANEOUS

☐ Suspension of action on the above-identified application is requested under 37 CFR 1.103(c) for a period of months _____ (Period of suspension shall not exceed 3 months; Fee under 37 CFR 1.17(i) required)

☒ Other Petition for Three-Month Extension of Time (One Month previously paid)

FEES

☒ **The RCE fee under 37 CFR 1.17(e) is required by 37 CFR 1.114 when the RCE is filed.**
The Director is hereby authorized to charge any underpayment of fees, or credit any overpayments, to Deposit Account No 021818

SIGNATURE OF APPLICANT, ATTORNEY, OR AGENT REQUIRED

☒ Patent Practitioner Signature

Applicant Signature

PTO/SB/30EFS (01-22)
Approved for use through 05/31/2024. OMB 0651-0031
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE
Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it contains a valid OMB control number.

Signature of Registered U.S. Patent Practitioner			
Signature	/Matthew S. Dicke/	Date (YYYY-MM-DD)	2022-10-05
Name	Matthew S. Dicke	Registration Number	58819

This collection of information is required by 37 CFR 1.114. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.11 and 1.14. This collection is estimated to take 12 minutes to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450.

If you need assistance in completing the form, call 1-800-PTO-9199 and select option 2.

Privacy Act Statement

The Privacy Act of 1974 (P.L. 93-579) requires that you be given certain information in connection with your submission of the attached form related to a patent application or patent. Accordingly, pursuant to the requirements of the Act, please be advised that: (1) the general authority for the collection of this information is 35 U.S.C. 2(b)(2); (2) furnishing of the information solicited is voluntary; and (3) the principal purpose for which the information is used by the U.S. Patent and Trademark Office is to process and/or examine your submission related to a patent application or patent. If you do not furnish the requested information, the U.S. Patent and Trademark Office may not be able to process and/or examine your submission, which may result in termination of proceedings or abandonment of the application or expiration of the patent.

The information provided by you in this form will be subject to the following routine uses:

1. The information on this form will be treated confidentially to the extent allowed under the Freedom of Information Act (5 U.S.C. 552) and the Privacy Act (5 U.S.C. 552a). Records from this system of records may be disclosed to the Department of Justice to determine whether the Freedom of Information Act requires disclosure of these records.

2. A record from this system of records may be disclosed, as a routine use, in the course of presenting evidence to a court, magistrate, or administrative tribunal, including disclosures to opposing counsel in the course of settlement negotiations.

3. A record in this system of records may be disclosed, as a routine use, to a Member of Congress submitting a request involving an individual, to whom the record pertains, when the individual has requested assistance from the Member with respect to the subject matter of the record.

4. A record in this system of records may be disclosed, as a routine use, to a contractor of the Agency having need for the information in order to perform a contract. Recipients of information shall be required to comply with the requirements of the Privacy Act of 1974, as amended, pursuant to 5 U.S.C. 552a(m).

5. A record related to an International Application filed under the Patent Cooperation Treaty in this system of records may be disclosed, as a routine use, to the International Bureau of the World Intellectual Property Organization, pursuant to the Patent Cooperation Treaty.

6. A record in this system of records may be disclosed, as a routine use, to another federal agency for purposes of National Security review (35 U.S.C. 181) and for review pursuant to the Atomic Energy Act (42 U.S.C. 218(c)).

7. A record from this system of records may be disclosed, as a routine use, to the Administrator, General Services, or his/her designee, during an inspection of records conducted by GSA as part of that agency's responsibility to recommend improvements in records management practices and programs, under authority of 44 U.S.C. 2904 and 2906. Such disclosure shall be made in accordance with the GSA regulations governing inspection of records for this purpose, and any other relevant (i.e., GSA or Commerce) directive. Such disclosure shall not be used to make determinations about individuals.

8. A record from this system of records may be disclosed, as a routine use, to the public after either publication of the application pursuant to 35 U.S.C. 122(b) or issuance of a patent pursuant to 35 U.S.C. 151. Further, a record may be disclosed, subject to the limitations of 37 CFR 1.14, as a routine use, to the public if the record was filed in an application which became abandoned or in which the proceedings were terminated and which application is referenced by either a published application, an application open to public inspections or an issued patent.

9. A record from this system of records may be disclosed, as a routine use, to a Federal, State, or local law enforcement agency, if the USPTO becomes aware of a violation or potential violation of law or regulation.

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Applicant:	Seung Min KIM
Appl. No.:	16/959,352
Conf. No.:	1067
Filed:	June 30, 2020
Title:	ELECTROLYTIC COPPER FOIL HAVING EXCELLENT HANDLING CHARACTERISTICS IN POSTPROCESSING, AND MANUFACTURING METHOD THEREFOR
Art Unit:	1784
Examiner:	DUMBRIS, SETH M
Docket No.:	0313221.00022

SUPPLEMENTAL RESPONSE TO FINAL OFFICE ACTION

VIA ELECTRONIC FILING

Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

Dear Commissioner:

This Response is submitted in reply to the Final Office Action dated April 5, 2022 and further in response to the Advisory Action dated July 18, 2022. On August 5, 2022 Applicant filed the required Terminal Disclaimer, which was approved on August 9, 2022. Applicant is also submitting concurrent herewith a Request for Continued Examination, a Petition for Three-Month Extension of Time (one month having been previously paid) and as such, respectfully requests that the Office allow the above captioned case as the previous claim amendments have overcome the rejections under 35 U.S.C. § 112 and the approved Terminal Disclaimer has overcome the Double Patenting rejection.

Therefore, for at least the reasons provided above, Applicant respectfully submits that all of the pending claims are patentably distinguished over the prior art of record and that this application is currently in condition for allowance. An earnest endeavor has been made to place this application in condition for formal allowance, and such allowance is courteously solicited. If the Examiner has any questions regarding this Response, Applicant respectfully requests that the Examiner contact the undersigned.

Applicant does not believe any further fees are due in connection with this response. However, the Commissioner is authorized to charge any fee that may be required or to credit any overpayment to Deposit Account No. 02-1818. If such a transaction is made, please indicate the Attorney Docket No. 0313221.00022 on the account statement.

Respectfully submitted,

K&L Gates LLP

BY /Matthew S. Dicke/
Matthew S. Dicke
Reg. No. 58,819
Customer No. 29178
312-578-5415

Dated: October 5, 2022

Application Number * 16/959,352 *	Application/Control No. 16/959,352	Applicant(s)/Patent under Reexamination KIM et al.	
	Examiner DUMBRIS, SETH M	Art Unit 1784	

Document Code - DISQ	Internal Document - DO NOT MAIL

TERMINAL DISCLAIMER	☑ APPROVED	☐ DISAPPROVED
Date Filed: 05 August 2022	This patent is subject to a Terminal Disclaimer	

Approved/Disapproved by:
/PAMELA A YOUNG/ Technology Center: OPLC Telephone: (571)272-3622 _____

Electronic Patent Application Fee Transmittal	
Application Number:	16959352
Filing Date:	30-Jun-2020
Title of Invention:	ELECTROLYTIC COPPER FOIL HAVING EXCELLENT HANDLING CHARACTERISTICS IN POSTPROCESSING, AND MANUFACTURING METHOD THEREFOR
First Named Inventor/Applicant Name:	Seung Min KIM
Filer:	Matthew S. Dicke/Meg Boinski
Attorney Docket Number:	0313221.00022
Filed as Large Entity	

Filing Fees for U.S. National Stage under 35 USC 371

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Basic Filing:				
Pages:				
Claims:				
Miscellaneous-Filing:				
Petition:				
Patent-Appeals-and-Interference:				
Post-Allowance-and-Post-Issuance:				
Extension-of-Time:				

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Extension - 3 months with $220 paid	1253	1	1260	1260
Miscellaneous:				
RCE- 1ST REQUEST	1801	1	1360	1360
		Total in USD ($)		**2620**

Electronic Acknowledgement Receipt	
EFS ID:	46757956
Application Number:	16959352
International Application Number:	
Confirmation Number:	1067
Title of Invention:	ELECTROLYTIC COPPER FOIL HAVING EXCELLENT HANDLING CHARACTERISTICS IN POSTPROCESSING, AND MANUFACTURING METHOD THEREFOR
First Named Inventor/Applicant Name:	Seung Min KIM
Customer Number:	24573
Filer:	Matthew S. Dicke/US Patent Mail
Filer Authorized By:	Matthew S. Dicke
Attorney Docket Number:	0313221.00022
Receipt Date:	05-OCT-2022
Filing Date:	30-JUN-2020
Time Stamp:	17:06:43
Application Type:	U.S. National Stage under 35 USC 371

Payment information:

Submitted with Payment	yes
Payment Type	DA
Payment was successfully received in RAM	$2620
RAM confirmation Number	E202205H07054808
Deposit Account	021818
Authorized User	US Patent Mail
The Director of the USPTO is hereby authorized to charge indicated fees and credit any overpayment as follows: 37 CFR 1.492 (National application filing, search, and examination fees) 37 CFR 1.17 (Patent application and reexamination processing fees)	

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1	Extension of Time	00022_EOT.pdf	231719 5908b693df9e9d3e809a23e0f35eed21b8501d49	no	2
Warnings:					
Information:					
2	Request for Continued Examination (RCE)	00022_RCE.pdf	1667253 45610d4b2201f0459b58b61f176529e1e76e39e3	no	3
Warnings:					
Information:					
3	Supplemental Response or Supplemental Amendment	00022_Suppl_Response.pdf	95413 acefa87c90f801b39fee0dcbe391d613736b9704	no	2
Warnings:					
Information:					
4	Miscellaneous Incoming Letter	00022_TerminalDisclaimerApproval.pdf	32690 04ef6989d1a9e0b68dd5bd0ce99bf1a5a8209eac	no	1
Warnings:					
Information:					
5	Fee Worksheet (SB06)	fee-info.pdf	41209 bb73ea0278324457681984 7b549964728478fbe5	no	2
Warnings:					
Information:					
		Total Files Size (in bytes):	2068284		

This Acknowledgement Receipt evidences receipt on the noted date by the USPTO of the indicated documents, characterized by the applicant, and including page counts, where applicable. It serves as evidence of receipt similar to a Post Card, as described in MPEP 503.

New Applications Under 35 U.S.C. 111

If a new application is being filed and the application includes the necessary components for a filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application.

National Stage of an International Application under 35 U.S.C. 371

If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course.

New International Application Filed with the USPTO as a Receiving Office

If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.

PTO/AIA/22 (10-20)
Approved for use through 11/30/2020. OMB 0651-0031
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE
Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it displays a valid OMB control number.

PETITION FOR EXTENSION OF TIME UNDER 37 CFR 1.136(a)

Docket Number (Optional): 0313221.00022

Application Number: 16/959,352

Filed: June 30, 2020

For: ELECTROLYTIC COPPER FOIL HAVING EXCELLENT HANDLING CHARACTERISTICS IN POSTPROCESSING, AND MANUFACTURING METHOD THEREFOR

Art Unit: 1784

Examiner: DUMBRIS, SETH M

This is a request under the provisions of 37 CFR 1.136(a) to extend the period for filing a reply in the above-identified application.

The requested extension and fee are as follows (check time period desired and enter the appropriate fee below):

	Fee	Small Entity Fee	Micro Entity Fee	
☐ One month (37 CFR 1.17(a)(1))	$220	$110	$55	$
☐ Two months (37 CFR 1.17(a)(2))	$640	$320	$160	$
☑ Three months (37 CFR 1.17(a)(3))	$1,480	$740	$370	$ 1480.00
☐ Four months (37 CFR 1.17(a)(4))	$2,320	$1,160	$580	$
☐ Five months (37 CFR 1.17(a)(5))	$3,160	$1,580	$790	$

☐ Applicant asserts small entity status. See 37 CFR 1.27.

☐ Applicant certifies micro entity status. See 37 CFR 1.29.
Form PTO/SB/15A or B or equivalent must either be enclosed or have been submitted previously.

☐ A check in the amount of the fee is enclosed.

☐ Payment by credit card. Form PTO-2038 is attached.

☐ The Director has already been authorized to charge fees in this application to a Deposit Account.

☑ The Director is hereby authorized to charge any fees which may be required, or credit any overpayment, to Deposit Account Number 021818.

☑ Payment made via EFS-Web.

WARNING: Information on this form may become public. Credit card information should not be included on this form. Provide credit card information and authorization on PTO-2038.

I am the

☐ applicant.

☑ attorney or agent of record. Registration number 58819.

☐ attorney or agent acting under 37 CFR 1.34. Registration number _____.

/Matthew S. Dicke/ — Signature

October 5, 2022 — Date

Matthew S. Dicke — Typed or printed name

312-578-5415 — Telephone Number

NOTE: This form must be signed in accordance with 37 CFR 1.33. See 37 CFR 1.4 for signature requirements and certifications. Submit multiple forms if more than one signature is required, see below*.

☐ * Total of _____ forms are submitted.

This collection of information is required by 37 CFR 1.136(a). The information is required to obtain or retain a benefit by the public, which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.11 and 1.14. This collection is estimated to take 6 minutes to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. SEND TO: Mail Stop PCT, Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.

Privacy Act Statement

The **Privacy Act of 1974 (P.L. 93-579)** requires that you be given certain information in connection with your submission of the attached form related to a patent application or patent. Accordingly, pursuant to the requirements of the Act, please be advised that: (1) the general authority for the collection of this information is 35 U.S.C. 2(b)(2); (2) furnishing of the information solicited is voluntary; and (3) the principal purpose for which the information is used by the U.S. Patent and Trademark Office is to process and/or examine your submission related to a patent application or patent. If you do not furnish the requested information, the U.S. Patent and Trademark Office may not be able to process and/or examine your submission, which may result in termination of proceedings or abandonment of the application or expiration of the patent.

The information provided by you in this form will be subject to the following routine uses:

1. The information on this form will be treated confidentially to the extent allowed under the Freedom of Information Act (5 U.S.C. 552) and the Privacy Act (5 U.S.C 552a). Records from this system of records may be disclosed to the Department of Justice to determine whether disclosure of these records is required by the Freedom of Information Act.
2. A record from this system of records may be disclosed, as a routine use, in the course of presenting evidence to a court, magistrate, or administrative tribunal, including disclosures to opposing counsel in the course of settlement negotiations.
3. A record in this system of records may be disclosed, as a routine use, to a Member of Congress submitting a request involving an individual, to whom the record pertains, when the individual has requested assistance from the Member with respect to the subject matter of the record.
4. A record in this system of records may be disclosed, as a routine use, to a contractor of the Agency having need for the information in order to perform a contract. Recipients of information shall be required to comply with the requirements of the Privacy Act of 1974, as amended, pursuant to 5 U.S.C. 552a(m).
5. A record related to an International Application filed under the Patent Cooperation Treaty in this system of records may be disclosed, as a routine use, to the International Bureau of the World Intellectual Property Organization, pursuant to the Patent Cooperation Treaty.
6. A record in this system of records may be disclosed, as a routine use, to another federal agency for purposes of National Security review (35 U.S.C. 181) and for review pursuant to the Atomic Energy Act (42 U.S.C. 218(c)).
7. A record from this system of records may be disclosed, as a routine use, to the Administrator, General Services, or his/her designee, during an inspection of records conducted by GSA as part of that agency's responsibility to recommend improvements in records management practices and programs, under authority of 44 U.S.C. 2904 and 2906. Such disclosure shall be made in accordance with the GSA regulations governing inspection of records for this purpose, and any other relevant (*i.e.*, GSA or Commerce) directive. Such disclosure shall not be used to make determinations about individuals.
8. A record from this system of records may be disclosed, as a routine use, to the public after either publication of the application pursuant to 35 U.S.C. 122(b) or issuance of a patent pursuant to 35 U.S.C. 151. Further, a record may be disclosed, subject to the limitations of 37 CFR 1.14, as a routine use, to the public if the record was filed in an application which became abandoned or in which the proceedings were terminated and which application is referenced by either a published application, an application open to public inspection or an issued patent.
9. A record from this system of records may be disclosed, as a routine use, to a Federal, State, or local law enforcement agency, if the USPTO becomes aware of a violation or potential violation of law or regulation.

UNITED STATES PATENT AND TRADEMARK OFFICE

UNITED STATES DEPARTMENT OF COMMERCE
United States Patent and Trademark Office
Address: COMMISSIONER FOR PATENTS
P.O. Box 1450
Alexandria, Virginia 22313-1450
www.uspto.gov

APPLICATION NUMBER	FILING or 371(c) DATE	GRP ART UNIT	FIL FEE REC'D	ATTY.DOCKET.NO	TOT CLAIMS	IND CLAIMS
16/959,352	06/30/2020	1784	1580	0313221.00022	10	2

CONFIRMATION NO. 1067

CORRECTED FILING RECEIPT

24573
K&L Gates LLP-Chicago
P.O. Box 1135
Chicago, IL 60690

OC000000135898545

Date Mailed: 08/10/2022

Receipt is acknowledged of this non-provisional utility patent application. The application will be taken up for examination in due course. Applicant will be notified as to the results of the examination. Any correspondence concerning the application must include the following identification information: the U.S. APPLICATION NUMBER, FILING DATE, NAME OF FIRST INVENTOR, and TITLE OF INVENTION. Fees transmitted by check or draft are subject to collection.

Please verify the accuracy of the data presented on this receipt. If an error is noted on this Filing Receipt, please submit a written request for a corrected Filing Receipt, including a properly marked-up ADS showing the changes with strike-through for deletions and underlining for additions. If you received a "Notice to File Missing Parts" or other Notice requiring a response for this application, please submit any request for correction to this Filing Receipt with your reply to the Notice. When the USPTO processes the reply to the Notice, the USPTO will generate another Filing Receipt incorporating the requested corrections provided that the request is grantable.

Inventor(s)

Seung Min KIM, Anyang-si, Gyeonggi-do, KOREA, REPUBLIC OF;
Shan Hua JIN, Anyang-si, Gyeonggi-do, KOREA, REPUBLIC OF;

Applicant(s)

SK NEXILIS CO., LTD., JEONGEUP-SI, KOREA, REPUBLIC OF;

Power of Attorney: The patent practitioners associated with Customer Number 24573

Domestic Priority data as claimed by applicant

This application is a 371 of PCT/KR2019/001069 01/25/2019

Foreign Applications (You may be eligible to benefit from the **Patent Prosecution Highway** program at the USPTO. Please see http://www.uspto.gov for more information.)
REPUBLIC OF KOREA 10-2018-0012179 01/31/2018

Permission to Access Application via Priority Document Exchange: Yes

Permission to Access Search Results: Yes

Applicant may provide or rescind an authorization for access using Form PTO/SB/39 or Form PTO/SB/69 as appropriate.

If Required, Foreign Filing License Granted: 10/20/2020

The country code and number of your priority application, to be used for filing abroad under the Paris Convention, is **US 16/959,352**

Projected Publication Date: Not Applicable

Non-Publication Request: No

Early Publication Request: No

Title

ELECTROLYTIC COPPER FOIL HAVING EXCELLENT HANDLING CHARACTERISTICS IN POSTPROCESSING, AND MANUFACTURING METHOD THEREFOR

Preliminary Class

428

Statement under 37 CFR 1.55 or 1.78 for AIA (First Inventor to File) Transition Applications: No

PROTECTING YOUR INVENTION OUTSIDE THE UNITED STATES

Since the rights granted by a U.S. patent extend only throughout the territory of the United States and have no effect in a foreign country, an inventor who wishes patent protection in another country must apply for a patent in a specific country or in regional patent offices. Applicants may wish to consider the filing of an international application under the Patent Cooperation Treaty (PCT). An international (PCT) application generally has the same effect as a regular national patent application in each PCT-member country. The PCT process **simplifies** the filing of patent applications on the same invention in member countries, but **does not result** in a grant of "an international patent" and does not eliminate the need of applicants to file additional documents and fees in countries where patent protection is desired.

Almost every country has its own patent law, and a person desiring a patent in a particular country must make an application for patent in that country in accordance with its particular laws. Since the laws of many countries differ in various respects from the patent law of the United States, applicants are advised to seek guidance from specific foreign countries to ensure that patent rights are not lost prematurely.

Applicants also are advised that in the case of inventions made in the United States, the Director of the USPTO must issue a license before applicants can apply for a patent in a foreign country. The filing of a U.S. patent application serves as a request for a foreign filing license. The application's filing receipt contains further information and guidance as to the status of applicant's license for foreign filing.

Applicants may wish to consult the USPTO booklet, "General Information Concerning Patents" (specifically, the section entitled "Treaties and Foreign Patents") for more information on timeframes and deadlines for filing foreign patent applications. The guide is available either by contacting the USPTO Contact Center at 800-786-9199, or it can be viewed on the USPTO website at http://www.uspto.gov/web/offices/pac/doc/general/index.html.

For information on preventing theft of your intellectual property (patents, trademarks and copyrights), you may wish to consult the U.S. Government website, http://www.stopfakes.gov. Part of a Department of Commerce initiative, this website includes self-help "toolkits" giving innovators guidance on how to protect intellectual property in specific countries such as China, Korea and Mexico. For questions regarding patent enforcement issues, applicants may call the U.S. Government hotline at 1-866-999-HALT (1-866-999-4258).

LICENSE FOR FOREIGN FILING UNDER

Title 35, United States Code, Section 184

Title 37, Code of Federal Regulations, 5.11 & 5.15

GRANTED

The applicant has been granted a license under 35 U.S.C. 184, if the phrase "IF REQUIRED, FOREIGN FILING LICENSE GRANTED" followed by a date appears on this form. Such licenses are issued in all applications where the conditions for issuance of a license have been met, regardless of whether or not a license may be required as set forth in 37 CFR 5.15. The scope and limitations of this license are set forth in 37 CFR 5.15(a) unless an earlier license has been issued under 37 CFR 5.15(b). The license is subject to revocation upon written notification. The date indicated is the effective date of the license, unless an earlier license of similar scope has been granted under 37 CFR 5.13 or 5.14.

This license is to be retained by the licensee and may be used at any time on or after the effective date thereof unless it is revoked. This license is automatically transferred to any related applications(s) filed under 37 CFR 1.53(d). This license is not retroactive.

The grant of a license does not in any way lessen the responsibility of a licensee for the security of the subject matter as imposed by any Government contract or the provisions of existing laws relating to espionage and the national security or the export of technical data. Licensees should apprise themselves of current regulations especially with respect to certain countries, of other agencies, particularly the Office of Defense Trade Controls, Department of State (with respect to Arms, Munitions and Implements of War (22 CFR 121-128)); the Bureau of Industry and Security, Department of Commerce (15 CFR parts 730-774); the Office of Foreign AssetsControl, Department of Treasury (31 CFR Parts 500+) and the Department of Energy.

NOT GRANTED

No license under 35 U.S.C. 184 has been granted at this time, if the phrase "IF REQUIRED, FOREIGN FILING LICENSE GRANTED" DOES NOT appear on this form. Applicant may still petition for a license under 37 CFR 5.12, if a license is desired before the expiration of 6 months from the filing date of the application. If 6 months has lapsed from the filing date of this application and the licensee has not received any indication of a secrecy order under 35 U.S.C. 181, the licensee may foreign file the application pursuant to 37 CFR 5.15(b).

SelectUSA

The United States represents the largest, most dynamic marketplace in the world and is an unparalleled location for business investment, innovation, and commercialization of new technologies. The U.S. offers tremendous resources and advantages for those who invest and manufacture goods here. Through SelectUSA, our nation works to promote and facilitate business investment. SelectUSA provides information assistance to the international investor community; serves as an ombudsman for existing and potential investors; advocates on behalf of U.S. cities, states, and regions competing for global investment; and counsels U.S. economic development organizations on investment attraction best practices. To learn more about why the United States is the best country in the world to develop technology, manufacture products, deliver services, and grow your business, visit http://www.SelectUSA.gov or call +1-202-482-6800.

UNITED STATES PATENT AND TRADEMARK OFFICE

UNITED STATES DEPARTMENT OF COMMERCE
United States Patent and Trademark Office
Address: COMMISSIONER FOR PATENTS
P.O. Box 1450
Alexandria, Virginia 22313-1450
www.uspto.gov

APPLICATION NUMBER	FILING OR 371(C) DATE	FIRST NAMED APPLICANT	ATTY. DOCKET NO./TITLE
16/959,352	06/30/2020	Seung Min KIM	0313221.00022

CONFIRMATION NO. 1067

24573
K&L Gates LLP-Chicago
P.O. Box 1135
Chicago, IL 60690

POA ACCEPTANCE LETTER

OC000000135698543

Date Mailed: 08/10/2022

NOTICE OF ACCEPTANCE OF POWER OF ATTORNEY

This is in response to the Power of Attorney filed 08/05/2022.

The Power of Attorney in this application is accepted. Correspondence in this application will be mailed to the above address as provided by 37 CFR 1.33.

Questions about the contents of this notice and the requirements it sets forth should be directed to the Office of Data Management, Application Assistance Unit, at **(571) 272-4000** or **(571) 272-4200** or **1-888-786-0101**.

/lqchau/

Application Number * 16/959,352 *	Application/Control No. 16/959,352	Applicant(s)/Patent under Reexamination KIM et al.	
	Examiner DUMBRIS, SETH M	Art Unit 1784	

Document Code - DISQ	Internal Document - DO NOT MAIL

TERMINAL DISCLAIMER	☑ APPROVED	☐ DISAPPROVED
Date Filed: 05 August 2022	This patent is subject to a Terminal Disclaimer	

Approved/Disapproved by:
/PAMELA A YOUNG/ Technology Center: OPLC Telephone: (571)272-3622 _____

Doc Code: PA..
Document Description: Power of Attorney

PTO/AIA/82B (07-13)
Approved for use through 03/31/2021. OMB 0651-0035
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE
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POWER OF ATTORNEY BY APPLICANT

I hereby revoke all previous powers of attorney given in the application identified in either the attached transmittal letter or the boxes below.

Application Number	Filing Date

(Note: The boxes above may be left blank if information is provided on form PTO/AIA/82A.)

☑ I hereby appoint the Patent Practitioner(s) associated with the following Customer Number as my/our attorney(s) or agent(s), and to transact all business in the United States Patent and Trademark Office connected therewith for the application referenced in the attached transmittal letter (form PTO/AIA/82A) or identified above: 24573

OR

☐ I hereby appoint Practitioner(s) named in the attached list (form PTO/AIA/82C) as my/our attorney(s) or agent(s), and to transact all business in the United States Patent and Trademark Office connected therewith for the patent application referenced in the attached transmittal letter (form PTO/AIA/82A) or identified above. (Note: Complete form PTO/AIA/82C.)

Please recognize or change the correspondence address for the application identified in the attached transmittal letter or the boxes above to:

☐ The address associated with the above-mentioned Customer Number

OR

☑ The address associated with Customer Number: 24573

OR

☐ Firm or Individual Name					
Address					
City		State		Zip	
Country					
Telephone		Email			

I am the Applicant (if the Applicant is a juristic entity, list the Applicant name in the box):

SK NEXILIS CO., LTD.

☐ Inventor or Joint Inventor (title not required below)

☐ Legal Representative of a Deceased or Legally Incapacitated Inventor (title not required below)

☑ Assignee or Person to Whom the Inventor is Under an Obligation to Assign (provide signer's title if applicant is a juristic entity)

☐ Person Who Otherwise Shows Sufficient Proprietary Interest (e.g., a petition under 37 CFR 1.46(b)(2) was granted in the application or is concurrently being filed with this document) (provide signer's title if applicant is a juristic entity)

SIGNATURE of Applicant for Patent

The undersigned (whose title is supplied below) is authorized to act on behalf of the applicant (e.g., where the applicant is a juristic entity).

Signature	[signature]	Date (Optional)	2021. 6. 14.
Name	AN JOONG KYU		
Title	Chief Technology Officer SK NEXILIS CO., LTD.		

NOTE: Signature - This form must be signed by the applicant in accordance with 37 CFR 1.33. See 37 CFR 1.4 for signature requirements and certifications. If more than one applicant, use multiple forms.

☐ Total of forms are submitted.

This collection of information is required by 37 CFR 1.131, 1.32, and 1.33. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.11 and 1.14. This collection is estimated to take 3 minutes to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

If you need assistance in completing the form, call 1-800-PTO-9199 and select option 2.

Doc Code: R46C.REQ
Document Description: Request under 37 CFR 1.46(c) to correct, update or change the applicant.

PTO/AIA/41 (04-15)
Approved for use through 11/30/2020. OMB 0651-0031
U.S. Patent and Trademark Office, U.S. DEPARTMENT OF COMMERCE
Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it displays a valid OMB control number.

REQUEST TO CORRECT OR UPDATE THE NAME OF THE APPLICANT UNDER 37 CFR 1.46(c)(1), OR CHANGE THE APPLICANT UNDER 37 CFR 1.46(c)(2)
(FOR USE ONLY IN APPLICATIONS FILED ON OR AFTER SEPTEMBER 16, 2012)

Application Number	16/959,352
Filing Date	2020-06-30
First Named Inventor	Seung Min KIM
Art Unit	1784
Examiner Name	DUMBRIS, SETH M
Practitioner Docket Number	0313221.00022

To: Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

Applicant hereby **requests that the name of the applicant be corrected or updated under 37 CFR 1.46(c)(1), or that the applicant be changed under 37 CFR 1.46(c)(2),** in the above-identified application. **Requests under 37 CFR 1.46(c)(1) or (c)(2) cannot be submitted after payment of the issue fee or if the application has been patented.**

Please check the applicable box(es) below.

☐ 1. This request is to **correct or update the name of the applicant** (**under 37 CFR 1.46(c)(1)**) and includes:

☐ An application data sheet (ADS) in accordance with 37 CFR 1.76(c) with the corrected or updated information shown with markings (*e.g.*, underlining for insertions, strikethrough for deletions). A Corrected Web-based ADS may be used.

Note: Requests under 37 CFR 1.46(c)(1) may be filed to correct typographical errors in the name of the § 1.46 applicant, or for updating the name of the § 1.46 applicant (*i.e.*, where there is no change in the applicant itself but just in the applicant's name). See the Manual of Patent Examining Procedure (MPEP) section 605.01.

■ 2. This request is to **change the applicant** (**under 37 CFR 1.46(c)(2)**) and includes:

■ An application data sheet (ADS) in accordance with 37 CFR 1.76(c) that identifies the changes with proper markings (underlining for insertions and strikethrough for deletions). A Corrected Web-based ADS may be used.

■ A Statement Under 37 CFR 3.73(c) (Form PTO/AIA/96 or equivalent). See MPEP 325.

I am the

☐ applicant* ■ attorney or agent of record Registration number 58819 ☐ attorney or agent acting under 37 CFR 1.34 Registration number _____

Signature /Matthew S. Dicke/
Typed or printed name Matthew S. Dicke
Date August 5, 2022

NOTE: This form must be signed in accordance with 37 CFR 1.33. See 37 CFR 1.4 for signature requirements and certifications. *Juristic entities must be represented by a patent practitioner (See 37 CFR 1.31, applicable to any paper filed on or after September 16, 2012 that is presented on behalf of a juristic entity, regardless of application filing date). Submit multiple forms if more than one signature is required, see below**.

☐ ** Total of _____ forms are submitted.

This collection of information is required by 37 CFR 1.36. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.11 and 1.14. This collection is estimated to take 12 minutes to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

If you need assistance in completing the form, call 1-800-PTO-9199 and select option 2.

Privacy Act Statement

The **Privacy Act of 1974 (P.L. 93-579)** requires that you be given certain information in connection with your submission of the attached form related to a patent application or patent. Accordingly, pursuant to the requirements of the Act, please be advised that: (1) the general authority for the collection of this information is 35 U.S.C. 2(b)(2); (2) furnishing of the information solicited is voluntary; and (3) the principal purpose for which the information is used by the U.S. Patent and Trademark Office is to process and/or examine your submission related to a patent application or patent. If you do not furnish the requested information, the U.S. Patent and Trademark Office may not be able to process and/or examine your submission, which may result in termination of proceedings or abandonment of the application or expiration of the patent.

The information provided by you in this form will be subject to the following routine uses:

1. The information on this form will be treated confidentially to the extent allowed under the Freedom of Information Act (5 U.S.C. 552) and the Privacy Act (5 U.S.C 552a). Records from this system of records may be disclosed to the Department of Justice to determine whether disclosure of these records is required by the Freedom of Information Act.
2. A record from this system of records may be disclosed, as a routine use, in the course of presenting evidence to a court, magistrate, or administrative tribunal, including disclosures to opposing counsel in the course of settlement negotiations.
3. A record in this system of records may be disclosed, as a routine use, to a Member of Congress submitting a request involving an individual, to whom the record pertains, when the individual has requested assistance from the Member with respect to the subject matter of the record.
4. A record in this system of records may be disclosed, as a routine use, to a contractor of the Agency having need for the information in order to perform a contract. Recipients of information shall be required to comply with the requirements of the Privacy Act of 1974, as amended, pursuant to 5 U.S.C. 552a(m).
5. A record related to an International Application filed under the Patent Cooperation Treaty in this system of records may be disclosed, as a routine use, to the International Bureau of the World Intellectual Property Organization, pursuant to the Patent Cooperation Treaty.
6. A record in this system of records may be disclosed, as a routine use, to another federal agency for purposes of National Security review (35 U.S.C. 181) and for review pursuant to the Atomic Energy Act (42 U.S.C. 218(c)).
7. A record from this system of records may be disclosed, as a routine use, to the Administrator, General Services, or his/her designee, during an inspection of records conducted by GSA as part of that agency's responsibility to recommend improvements in records management practices and programs, under authority of 44 U.S.C. 2904 and 2906. Such disclosure shall be made in accordance with the GSA regulations governing inspection of records for this purpose, and any other relevant (*i.e.*, GSA or Commerce) directive. Such disclosure shall not be used to make determinations about individuals.
8. A record from this system of records may be disclosed, as a routine use, to the public after either publication of the application pursuant to 35 U.S.C. 122(b) or issuance of a patent pursuant to 35 U.S.C. 151. Further, a record may be disclosed, subject to the limitations of 37 CFR 1.14, as a routine use, to the public if the record was filed in an application which became abandoned or in which the proceedings were terminated and which application is referenced by either a published application, an application open to public inspection or an issued patent.
9. A record from this system of records may be disclosed, as a routine use, to a Federal, State, or local law enforcement agency, if the USPTO becomes aware of a violation or potential violation of law or regulation.

PTO/AIA/14 (02-18)
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Application Data Sheet 37 CFR 1.76	Attorney Docket Number	0313221.00022
	Application Number	
Title of Invention	ELECTROLYTIC COPPER FOIL HAVING EXCELLENT HANDLING CHARACTERISTICS IN POSTPROCESSING, AND MANUFACTURING METHOD THEREFOR	

The application data sheet is part of the provisional or nonprovisional application for which it is being submitted. The following form contains the bibliographic data arranged in a format specified by the United States Patent and Trademark Office as outlined in 37 CFR 1.76.
This document may be completed electronically and submitted to the Office in electronic format using the Electronic Filing System (EFS) or the document may be printed and included in a paper filed application.

Secrecy Order 37 CFR 5.2:

☐ Portions or all of the application associated with this Application Data Sheet may fall under a Secrecy Order pursuant to 37 CFR 5.2 (Paper filers only. Applications that fall under Secrecy Order may not be filed electronically.)

Inventor Information:

Inventor 1 Remove

Legal Name

Prefix	Given Name	Middle Name	Family Name	Suffix
	Seung	Min	KIM	

Residence Information (Select One) ○ US Residency ◉ Non US Residency ○ Active US Military Service

City	Anyang-si, Gyeonggi-do	Country of Residence	KR

Mailing Address of Inventor:

Address 1	4F., 39, LS-ro 116beon-gil, Dongan-gu		
Address 2			
City	Anyang-si, Gyeonggi-do	**State/Province**	
Postal Code	14118	**Country**	KR

Inventor 2 Remove

Legal Name

Prefix	Given Name	Middle Name	Family Name	Suffix
	Shan	Hua	JIN	

Residence Information (Select One) ○ US Residency ◉ Non US Residency ○ Active US Military Service

City	Anyang-si, Gyeonggi-do	Country of Residence	KR

Mailing Address of Inventor:

Address 1	4F., 39, LS-ro 116beon-gil, Dongan-gu		
Address 2			
City	Anyang-si, Gyeonggi-do	**State/Province**	
Postal Code	14118	**Country**	KR

All Inventors Must Be Listed - Additional Inventor Information blocks may be generated within this form by selecting the **Add** button. Add

Correspondence Information:

PTO/AIA/14 (02-18)
Approved for use through 11/30/2020. OMB 0651-0032
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE
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Application Data Sheet 37 CFR 1.76	Attorney Docket Number	0313221.00022
	Application Number	
Title of Invention	ELECTROLYTIC COPPER FOIL HAVING EXCELLENT HANDLING CHARACTERISTICS IN POSTPROCESSING, AND MANUFACTURING METHOD THEREFOR	

Enter either Customer Number or complete the Correspondence Information section below. For further information see 37 CFR 1.33(a).			
☐ **An Address is being provided for the correspondence Information of this application.**			
Customer Number	24573		
Email Address	chicago.patents@klgates.com	Add Email	Remove Email

Application Information:

Title of the Invention	ELECTROLYTIC COPPER FOIL HAVING EXCELLENT HANDLING CHARACTERISTICS IN POSTPROCESSING, AND MANUFACTURING METHOD THEREFOR		
Attorney Docket Number	0313221.00022	**Small Entity Status Claimed**	☐
Application Type	Nonprovisional		
Subject Matter	Utility		
Total Number of Drawing Sheets (if any)	2	**Suggested Figure for Publication (if any)**	

Filing By Reference:

Only complete this section when filing an application by reference under 35 U.S.C. 111(c) and 37 CFR 1.57(a). Do not complete this section if application papers including a specification and any drawings are being filed. Any domestic benefit or foreign priority information must be provided in the appropriate section(s) below (i.e., "Domestic Benefit/National Stage Information" and "Foreign Priority Information").

For the purposes of a filing date under 37 CFR 1.53(b), the description and any drawings of the present application are replaced by this reference to the previously filed application, subject to conditions and requirements of 37 CFR 1.57(a).

Application number of the previously filed application	Filing date (YYYY-MM-DD)	Intellectual Property Authority or Country

Publication Information:

☐ Request Early Publication (Fee required at time of Request 37 CFR 1.219)

☐ **Request Not to Publish.** I hereby request that the attached application not be published under 35 U.S.C. 122(b) and certify that the invention disclosed in the attached application **has not and will not** be the subject of an application filed in another country, or under a multilateral international agreement, that requires publication at eighteen months after filing.

Representative Information:

Representative information should be provided for all practitioners having a power of attorney in the application. Providing this information in the Application Data Sheet does not constitute a power of attorney in the application (see 37 CFR 1.32).
Either enter Customer Number or complete the Representative Name section below. If both sections are completed the customer Number will be used for the Representative Information during processing.

Please Select One:	◉ Customer Number	○ US Patent Practitioner	○ Limited Recognition (37 CFR 11.9)
Customer Number	24573		

Application Data Sheet 37 CFR 1.76	Attorney Docket Number	0313221.00022
	Application Number	
Title of Invention	ELECTROLYTIC COPPER FOIL HAVING EXCELLENT HANDLING CHARACTERISTICS IN POSTPROCESSING, AND MANUFACTURING METHOD THEREFOR	

Domestic Benefit/National Stage Information:

This section allows for the applicant to either claim benefit under 35 U.S.C. 119(e), 120, 121, 365(c), or 386(c) or indicate National Stage entry from a PCT application. Providing benefit claim information in the Application Data Sheet constitutes the specific reference required by 35 U.S.C. 119(e) or 120, and 37 CFR 1.78.
When referring to the current application, please leave the "Application Number" field blank.

Prior Application Status			Remove
Application Number	Continuity Type	Prior Application Number	Filing or 371(c) Date (YYYY-MM-DD)
	a 371 of international	PCT/KR2019/001069	2019-01-25

Additional Domestic Benefit/National Stage Data may be generated within this form by selecting the **Add** button.

Foreign Priority Information:

This section allows for the applicant to claim priority to a foreign application. Providing this information in the application data sheet constitutes the claim for priority as required by 35 U.S.C. 119(b) and 37 CFR 1.55. When priority is claimed to a foreign application that is eligible for retrieval under the priority document exchange program (PDX)[i] the information will be used by the Office to automatically attempt retrieval pursuant to 37 CFR 1.55(i)(1) and (2). Under the PDX program, applicant bears the ultimate responsibility for ensuring that a copy of the foreign application is received by the Office from the participating foreign intellectual property office, or a certified copy of the foreign priority application is filed, within the time period specified in 37 CFR 1.55(g)(1).

			Remove
Application Number	Country[i]	Filing Date (YYYY-MM-DD)	Access Code[i] (if applicable)
10-2018-0012179	KR	2018-01-31	

Additional Foreign Priority Data may be generated within this form by selecting the **Add** button.

Statement under 37 CFR 1.55 or 1.78 for AIA (First Inventor to File) Transition Applications

☐ This application (1) claims priority to or the benefit of an application filed before March 16, 2013 and (2) also contains, or contained at any time, a claim to a claimed invention that has an effective filing date on or after March 16, 2013.
NOTE: By providing this statement under 37 CFR 1.55 or 1.78, this application, with a filing date on or after March 16, 2013, will be examined under the first inventor to file provisions of the AIA.

Application Data Sheet 37 CFR 1.76	Attorney Docket Number	0313221.00022
	Application Number	
Title of Invention	ELECTROLYTIC COPPER FOIL HAVING EXCELLENT HANDLING CHARACTERISTICS IN POSTPROCESSING, AND MANUFACTURING METHOD THEREFOR	

Authorization or Opt-Out of Authorization to Permit Access:

When this Application Data Sheet is properly signed and filed with the application, applicant has provided written authority to permit a participating foreign intellectual property (IP) office access to the instant application-as-filed (see paragraph A in subsection 1 below) and the European Patent Office (EPO) access to any search results from the instant application (see paragraph B in subsection 1 below).

Should applicant choose not to provide an authorization identified in subsection 1 below, applicant **must opt-out** of the authorization by checking the corresponding box A or B or both in subsection 2 below.

NOTE: This section of the Application Data Sheet is **ONLY** reviewed and processed with the **INITIAL** filing of an application. After the initial filing of an application, an Application Data Sheet cannot be used to provide or rescind authorization for access by a foreign IP office(s). Instead, Form PTO/SB/39 or PTO/SB/69 must be used as appropriate.

1. Authorization to Permit Access by a Foreign Intellectual Property Office(s)

A. Priority Document Exchange (PDX) - Unless box A in subsection 2 (opt-out of authorization) is checked, the undersigned hereby **grants the USPTO authority** to provide the European Patent Office (EPO), the Japan Patent Office (JPO), the Korean Intellectual Property Office (KIPO), the State Intellectual Property Office of the People's Republic of China (SIPO), the World Intellectual Property Organization (WIPO), and any other foreign intellectual property office participating with the USPTO in a bilateral or multilateral priority document exchange agreement in which a foreign application claiming priority to the instant patent application is filed, access to: (1) the instant patent application-as-filed and its related bibliographic data, (2) any foreign or domestic application to which priority or benefit is claimed by the instant application and its related bibliographic data, and (3) the date of filing of this Authorization. See 37 CFR 1.14(h)(1).

B. Search Results from U.S. Application to EPO - Unless box B in subsection 2 (opt-out of authorization) is checked, the undersigned hereby **grants the USPTO authority** to provide the EPO access to the bibliographic data and search results from the instant patent application when a European patent application claiming priority to the instant patent application is filed. See 37 CFR 1.14(h)(2).

The applicant is reminded that the EPO's Rule 141(1) EPC (European Patent Convention) requires applicants to submit a copy of search results from the instant application without delay in a European patent application that claims priority to the instant application.

2. Opt-Out of Authorizations to Permit Access by a Foreign Intellectual Property Office(s)

☐ A. Applicant **DOES NOT** authorize the USPTO to permit a participating foreign IP office access to the instant application-as-filed. If this box is checked, the USPTO will not be providing a participating foreign IP office with any documents and information identified in subsection 1A above.

☐ B. Applicant **DOES NOT** authorize the USPTO to transmit to the EPO any search results from the instant patent application. If this box is checked, the USPTO will not be providing the EPO with search results from the instant application.

NOTE: Once the application has published or is otherwise publicly available, the USPTO may provide access to the application in accordance with 37 CFR 1.14.

PTO/AIA/14 (02-18)
Approved for use through 11/30/2020. OMB 0651-0032
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE
Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it contains a valid OMB control number.

Application Data Sheet 37 CFR 1.76	Attorney Docket Number	0313221.00022
	Application Number	
Title of Invention	ELECTROLYTIC COPPER FOIL HAVING EXCELLENT HANDLING CHARACTERISTICS IN POSTPROCESSING, AND MANUFACTURING METHOD THEREFOR	

Applicant Information:

Providing assignment information in this section does not substitute for compliance with any requirement of part 3 of Title 37 of CFR to have an assignment recorded by the Office.

Applicant 1

If the applicant is the inventor (or the remaining joint inventor or inventors under 37 CFR 1.45), this section should not be completed. The information to be provided in this section is the name and address of the legal representative who is the applicant under 37 CFR 1.43; or the name and address of the assignee, person to whom the inventor is under an obligation to assign the invention, or person who otherwise shows sufficient proprietary interest in the matter who is the applicant under 37 CFR 1.46. If the applicant is an applicant under 37 CFR 1.46 (assignee, person to whom the inventor is obligated to assign, or person who otherwise shows sufficient proprietary interest) together with one or more joint inventors, then the joint inventor or inventors who are also the applicant should be identified in this section.

Clear

◉ Assignee	○ Legal Representative under 35 U.S.C. 117	○ Joint Inventor
○ Person to whom the inventor is obligated to assign.	○ Person who shows sufficient proprietary interest	

If applicant is the legal representative, indicate the authority to file the patent application, the inventor is:

Name of the Deceased or Legally Incapacitated Inventor:

If the Applicant is an Organization check here. ☒

Organization Name	~~KCF Technologies Co., Ltd.~~ SK NEXILIS CO., LTD.		
Mailing Address Information For Applicant:			
Address 1	~~4F., 39, LS-ro 116beon-gil, Dongan-gu~~ 2, 3SANDAN 2-GIL, BUK-MYEON		
Address 2			
City	~~Anyang-si, Gyeonggi-do~~ JEONGEUP-SI, JEOLLABUK-DO	**State/Province**	
Country	KR	Postal Code	14118
Phone Number		Fax Number	
Email Address			

Additional Applicant Data may be generated within this form by selecting the Add button.

Assignee Information including Non-Applicant Assignee Information:

Providing assignment information in this section does not substitute for compliance with any requirement of part 3 of Title 37 of CFR to have an assignment recorded by the Office.

PTO/AIA/14 (02-18)
Approved for use through 11/30/2020. OMB 0651-0032
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE
Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it contains a valid OMB control number.

Application Data Sheet 37 CFR 1.76	Attorney Docket Number	0313221.00022
	Application Number	
Title of Invention	ELECTROLYTIC COPPER FOIL HAVING EXCELLENT HANDLING CHARACTERISTICS IN POSTPROCESSING, AND MANUFACTURING METHOD THEREFOR	

Assignee 1

Complete this section if assignee information, including non-applicant assignee information, is desired to be included on the patent application publication. An assignee-applicant identified in the "Applicant Information" section will appear on the patent application publication as an applicant. For an assignee-applicant, complete this section only if identification as an assignee is also desired on the patent application publication.

If the Assignee or Non-Applicant Assignee is an Organization check here. ☐

Prefix	**Given Name**	Middle Name	**Family Name**	Suffix

Mailing Address Information For Assignee including Non-Applicant Assignee:

Address 1			
Address 2			
City		**State/Province**	
Country		Postal Code	
Phone Number		Fax Number	
Email Address			

Additional Assignee or Non-Applicant Assignee Data may be generated within this form by selecting the Add button.

Signature:

NOTE: This Application Data Sheet must be signed in accordance with 37 CFR 1.33(b). **However, if this Application Data Sheet is submitted with the INITIAL filing of the application and either box A or B is not checked in subsection 2 of the "Authorization or Opt-Out of Authorization to Permit Access" section, then this form must also be signed in accordance with 37 CFR 1.14(c).**

This Application Data Sheet **must** be signed by a patent practitioner if one or more of the applicants is a **juristic entity** (e.g., corporation or association). If the applicant is two or more joint inventors, this form must be signed by a patent practitioner, **all** joint inventors who are the applicant, or one or more joint inventor-applicants who have been given power of attorney (e.g., see USPTO Form PTO/AIA/81) on behalf of **all** joint inventor-applicants.

See 37 CFR 1.4(d) for the manner of making signatures and certifications.

Signature	/Matthew S. Dicke/			Date (YYYY-MM-DD)	2022-08-05
First Name	Matthew S.	Last Name	Dicke	Registration Number	58819

Additional Signature may be generated within this form by selecting the Add button.

PTO/AIA/14 (02-18)
Approved for use through 11/30/2020. OMB 0651-0032
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE
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Application Data Sheet 37 CFR 1.76	Attorney Docket Number	0313221.00022
	Application Number	
Title of Invention	ELECTROLYTIC COPPER FOIL HAVING EXCELLENT HANDLING CHARACTERISTICS IN POSTPROCESSING, AND MANUFACTURING METHOD THEREFOR	

This collection of information is required by 37 CFR 1.76. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.14. This collection is estimated to take 23 minutes to complete, including gathering, preparing, and submitting the completed application data sheet form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

Privacy Act Statement

The Privacy Act of 1974 (P.L. 93-579) requires that you be given certain information in connection with your submission of the attached form related to a patent application or patent. Accordingly, pursuant to the requirements of the Act, please be advised that: (1) the general authority for the collection of this information is 35 U.S.C. 2(b)(2); (2) furnishing of the information solicited is voluntary; and (3) the principal purpose for which the information is used by the U.S. Patent and Trademark Office is to process and/or examine your submission related to a patent application or patent. If you do not furnish the requested information, the U.S. Patent and Trademark Office may not be able to process and/or examine your submission, which may result in termination of proceedings or abandonment of the application or expiration of the patent.

The information provided by you in this form will be subject to the following routine uses:

1 The information on this form will be treated confidentially to the extent allowed under the Freedom of Information Act (5 U.S.C. 552) and the Privacy Act (5 U.S.C. 552a). Records from this system of records may be disclosed to the Department of Justice to determine whether the Freedom of Information Act requires disclosure of these records.

2. A record from this system of records may be disclosed, as a routine use, in the course of presenting evidence to a court, magistrate, or administrative tribunal, including disclosures to opposing counsel in the course of settlement negotiations.

3 A record in this system of records may be disclosed, as a routine use, to a Member of Congress submitting a request involving an individual, to whom the record pertains, when the individual has requested assistance from the Member with respect to the subject matter of the record.

4. A record in this system of records may be disclosed, as a routine use, to a contractor of the Agency having need for the information in order to perform a contract. Recipients of information shall be required to comply with the requirements of the Privacy Act of 1974, as amended, pursuant to 5 U.S.C. 552a(m).

5. A record related to an International Application filed under the Patent Cooperation Treaty in this system of records may be disclosed, as a routine use, to the International Bureau of the World Intellectual Property Organization, pursuant to the Patent CooperationTreaty.

6. A record in this system of records may be disclosed, as a routine use, to another federal agency for purposes of National Security review (35 U.S.C. 181) and for review pursuant to the Atomic Energy Act (42 U.S.C. 218(c)).

7. A record from this system of records may be disclosed, as a routine use, to the Administrator, General Services, or his/her designee, during an inspection of records conducted by GSA as part of that agency's responsibility to recommend improvements in records management practices and programs, under authority of 44 U.S.C. 2904 and 2906. Such disclosure shall be made in accordance with the GSA regulations governing inspection of records for this purpose, and any other relevant (i.e., GSA or Commerce) directive. Such disclosure shall not be used to make determinations about individuals.

8. A record from this system of records may be disclosed, as a routine use, to the public after either publication of the application pursuant to 35 U.S.C. 122(b) or issuance of a patent pursuant to 35 U.S.C. 151. Further, a record may be disclosed, subject to the limitations of 37 CFR 1.14, as a routine use, to the public if the record was filed in an application which became abandoned or in which the proceedings were terminated and which application is referenced by either a published application, an application open to public inspections or an issued patent.

9. A record from this system of records may be disclosed, as a routine use, to a Federal, State, or local law enforcement agency, if the USPTO becomes aware of a violation or potential violation of law or regulation.

PTO/SB/26 (08-08)
Approved for use through 09/30/2008. OMB 0651-0031
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE
Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it displays a valid OMB control number.

TERMINAL DISCLAIMER TO OBVIATE A DOUBLE PATENTING REJECTION OVER A "PRIOR" PATENT	Docket Number (Optional) 0313221.00022

In re Application of: Seung Min KIM

Application No.: 16/959,352

Filed: June 30, 2020

For: ELECTROLYTIC COPPER FOIL HAVING EXCELLENT HANDLING CHARACTERISTICS IN POSTPROCESSING, AND MANUFACTURING METHOD THEREFOR

The owner*, SK NEXILIS CO., LTD., of 100 percent interest in the instant application hereby disclaims, except as provided below, the terminal part of the statutory term of any patent granted on the instant application which would extend beyond the expiration date of the full statutory term **prior patent** No. 10,547,081 as the term of said prior patent is defined in 35 U.S.C. 154 and 173, and as the term of said **prior patent** is presently shortened by any terminal disclaimer. The owner hereby agrees that any patent so granted on the instant application shall be enforceable only for and during such period that it and the **prior patent** are commonly owned. This agreement runs with any patent granted on the instant application and is binding upon the grantee, its successors or assigns.

In making the above disclaimer, the owner does not disclaim the terminal part of the term of any patent granted on the instant application that would extend to the expiration date of the full statutory term as defined in 35 U.S.C. 154 and 173 of the **prior patent**, "as the term of said **prior patent** is presently shortened by any terminal disclaimer," in the event that said **prior patent** later:

expires for failure to pay a maintenance fee;
is held unenforceable;
is found invalid by a court of competent jurisdiction;
is statutorily disclaimed in whole or terminally disclaimed under 37 CFR 1.321;
has all claims canceled by a reexamination certificate;
is reissued; or
is in any manner terminated prior to the expiration of its full statutory term as presently shortened by any terminal disclaimer.

Check either box 1 or 2 below, if appropriate.

1. ☑ For submissions on behalf of a business/organization (e.g., corporation, partnership, university, government agency, etc.), the undersigned is empowered to act on behalf of the business/organization.

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

2. ☑ The undersigned is an attorney or agent of record. Reg. No. 58819

/Matthew S. Dicke/ — August 5, 2022
Signature — Date

Matthew S. Dicke
Typed or printed name

312-578-5415
Telephone Number

☐ Terminal disclaimer fee under 37 CFR 1.20(d) included.

WARNING: Information on this form may become public. Credit card information should not be included on this form. Provide credit card information and authorization on PTO-2038.

*Statement under 37 CFR 3.73(b) is required if terminal disclaimer is signed by the assignee (owner).
Form PTO/SB/96 may be used for making this certification. See MPEP § 324.

This collection of information is required by 37 CFR 1.321. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.11 and 1.14. This collection is estimated to take 12 minutes to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

If you need assistance in completing the form, call 1-800-PTO-9199 and select option 2.

Privacy Act Statement

The **Privacy Act of 1974 (P.L. 93-579)** requires that you be given certain information in connection with your submission of the attached form related to a patent application or patent. Accordingly, pursuant to the requirements of the Act, please be advised that: (1) the general authority for the collection of this information is 35 U.S.C. 2(b)(2); (2) furnishing of the information solicited is voluntary; and (3) the principal purpose for which the information is used by the U.S. Patent and Trademark Office is to process and/or examine your submission related to a patent application or patent. If you do not furnish the requested information, the U.S. Patent and Trademark Office may not be able to process and/or examine your submission, which may result in termination of proceedings or abandonment of the application or expiration of the patent.

The information provided by you in this form will be subject to the following routine uses:

1. The information on this form will be treated confidentially to the extent allowed under the Freedom of Information Act (5 U.S.C. 552) and the Privacy Act (5 U.S.C 552a). Records from this system of records may be disclosed to the Department of Justice to determine whether disclosure of these records is required by the Freedom of Information Act.
2. A record from this system of records may be disclosed, as a routine use, in the course of presenting evidence to a court, magistrate, or administrative tribunal, including disclosures to opposing counsel in the course of settlement negotiations.
3. A record in this system of records may be disclosed, as a routine use, to a Member of Congress submitting a request involving an individual, to whom the record pertains, when the individual has requested assistance from the Member with respect to the subject matter of the record.
4. A record in this system of records may be disclosed, as a routine use, to a contractor of the Agency having need for the information in order to perform a contract. Recipients of information shall be required to comply with the requirements of the Privacy Act of 1974, as amended, pursuant to 5 U.S.C. 552a(m).
5. A record related to an International Application filed under the Patent Cooperation Treaty in this system of records may be disclosed, as a routine use, to the International Bureau of the World Intellectual Property Organization, pursuant to the Patent Cooperation Treaty.
6. A record in this system of records may be disclosed, as a routine use, to another federal agency for purposes of National Security review (35 U.S.C. 181) and for review pursuant to the Atomic Energy Act (42 U.S.C. 218(c)).
7. A record from this system of records may be disclosed, as a routine use, to the Administrator, General Services, or his/her designee, during an inspection of records conducted by GSA as part of that agency's responsibility to recommend improvements in records management practices and programs, under authority of 44 U.S.C. 2904 and 2906. Such disclosure shall be made in accordance with the GSA regulations governing inspection of records for this purpose, and any other relevant (*i.e.*, GSA or Commerce) directive. Such disclosure shall not be used to make determinations about individuals.
8. A record from this system of records may be disclosed, as a routine use, to the public after either publication of the application pursuant to 35 U.S.C. 122(b) or issuance of a patent pursuant to 35 U.S.C. 151. Further, a record may be disclosed, subject to the limitations of 37 CFR 1.14, as a routine use, to the public if the record was filed in an application which became abandoned or in which the proceedings were terminated and which application is referenced by either a published application, an application open to public inspection or an issued patent.
9. A record from this system of records may be disclosed, as a routine use, to a Federal, State, or local law enforcement agency, if the USPTO becomes aware of a violation or potential violation of law or regulation.

Electronic Patent Application Fee Transmittal

Application Number:	16959352
Filing Date:	30-Jun-2020
Title of Invention:	ELECTROLYTIC COPPER FOIL HAVING EXCELLENT HANDLING CHARACTERISTICS IN POSTPROCESSING, AND MANUFACTURING METHOD THEREFOR
First Named Inventor/Applicant Name:	Seung Min KIM
Filer:	Matthew S. Dicke/Meg Boinski
Attorney Docket Number:	0313221.00022

Filed as Large Entity

Filing Fees for U.S. National Stage under 35 USC 371

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Basic Filing:				
Pages:				
Claims:				
Miscellaneous-Filing:				
Petition:				
Patent-Appeals-and-Interference:				
Post-Allowance-and-Post-Issuance:				
Extension-of-Time:				

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Extension - 1 month with $0 paid	1251	1	220	220
Miscellaneous:				
			Total in USD ($)	**220**

Electronic Acknowledgement Receipt	
EFS ID:	46352330
Application Number:	16959352
International Application Number:	
Confirmation Number:	1067
Title of Invention:	ELECTROLYTIC COPPER FOIL HAVING EXCELLENT HANDLING CHARACTERISTICS IN POSTPROCESSING, AND MANUFACTURING METHOD THEREFOR
First Named Inventor/Applicant Name:	Seung Min KIM
Customer Number:	24573
Filer:	Matthew S. Dicke/US Patent Mail
Filer Authorized By:	Matthew S. Dicke
Attorney Docket Number:	0313221.00022
Receipt Date:	05-AUG-2022
Filing Date:	30-JUN-2020
Time Stamp:	16:17:23
Application Type:	U.S. National Stage under 35 USC 371

Payment information:

Submitted with Payment	yes
Payment Type	DA
Payment was successfully received in RAM	$220
RAM confirmation Number	E202285G17452273
Deposit Account	021818
Authorized User	US Patent Mail
The Director of the USPTO is hereby authorized to charge indicated fees and credit any overpayment as follows: 37 CFR 1.17 (Patent application and reexamination processing fees) 37 CFR 1.492 (National application filing, search, and examination fees)	

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1	Extension of Time	00022_EOT.pdf	173471 1e66d43a9f19edb3852f05e807911cf89c66287d	no	2
Warnings:					
Information:					
2	Assignee showing of ownership per 37 CFR 3.73	00022_373_Statement.pdf	192752 435a2a1b78ffb641eb5ad6cc0d3b62b6255c1a2b	no	3
Warnings:					
Information:					
3	Power of Attorney	00022_POA_SK_NEXELIS.pdf	71562 c4b770660256bd2864b8c5ca46826b0463d8c02c	no	1
Warnings:					
Information:					
4	Request under 37CFR1.46(c) to correct, update, change applicant	00022_REQ_1_46.pdf	204769 6499c126d2a01712e48f77726272bf7e930e541e	no	2
Warnings:					
Information:					
5	Application Data Sheet	00022_SupplADS-ToFile.pdf	148681 bec4cf5c4b3c90078824b435dd7ac51c32a3c211	no	8
Warnings:					
Information:					
This is not an USPTO supplied ADS fillable form					
6	Terminal Disclaimer Filed	00022_TD.pdf	160461 b2eb098d7b2d8edcba15663b31c4ca65ec359b46	no	2
Warnings:					

Information:					
7	Fee Worksheet (SB06)	fee-info.pdf	38682 becc12e76cd95eba8d6dc32e6370ad47c02c8d0c	no	2
Warnings:					
Information:					
			Total Files Size (in bytes):	990378	

This Acknowledgement Receipt evidences receipt on the noted date by the USPTO of the indicated documents, characterized by the applicant, and including page counts, where applicable. It serves as evidence of receipt similar to a Post Card, as described in MPEP 503.

New Applications Under 35 U.S.C. 111

If a new application is being filed and the application includes the necessary components for a filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application.

National Stage of an International Application under 35 U.S.C. 371

If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course.

New International Application Filed with the USPTO as a Receiving Office

If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.

PTO/AIA/22 (10-20)
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PETITION FOR EXTENSION OF TIME UNDER 37 CFR 1.136(a)

Docket Number (Optional): 0313221.00022

Application Number: 16/959,352

Filed: June 30, 2020

For: ELECTROLYTIC COPPER FOIL HAVING EXCELLENT HANDLING CHARACTERISTICS IN POSTPROCESSING, AND MANUFACTURING METHOD THEREFOR

Art Unit: 1784

Examiner: DUMBRIS, SETH M

This is a request under the provisions of 37 CFR 1.136(a) to extend the period for filing a reply in the above-identified application.

The requested extension and fee are as follows (check time period desired and enter the appropriate fee below):

	Fee	Small Entity Fee	Micro Entity Fee	
☑ One month (37 CFR 1.17(a)(1))	$220	$110	$55	$ 220.00
☐ Two months (37 CFR 1.17(a)(2))	$640	$320	$160	$
☐ Three months (37 CFR 1.17(a)(3))	$1,480	$740	$370	$
☐ Four months (37 CFR 1.17(a)(4))	$2,320	$1,160	$580	$
☐ Five months (37 CFR 1.17(a)(5))	$3,160	$1,580	$790	$

☐ Applicant asserts small entity status. See 37 CFR 1.27.

☐ Applicant certifies micro entity status. See 37 CFR 1.29.
Form PTO/SB/15A or B or equivalent must either be enclosed or have been submitted previously.

☐ A check in the amount of the fee is enclosed.

☐ Payment by credit card. Form PTO-2038 is attached.

☐ The Director has already been authorized to charge fees in this application to a Deposit Account.

☑ The Director is hereby authorized to charge any fees which may be required, or credit any overpayment, to Deposit Account Number 021818.

☑ Payment made via EFS-Web.

WARNING: Information on this form may become public. Credit card information should not be included on this form. Provide credit card information and authorization on PTO-2038.

I am the

☐ applicant.

☑ attorney or agent of record. Registration number 58819.

☐ attorney or agent acting under 37 CFR 1.34. Registration number _____.

/Matthew S. Dicke/ — Signature

August 5, 2022 — Date

Matthew S. Dicke — Typed or printed name

312-578-5415 — Telephone Number

NOTE: This form must be signed in accordance with 37 CFR 1.33. See 37 CFR 1.4 for signature requirements and certifications. Submit multiple forms if more than one signature is required, see below*.

☐ * Total of _____ forms are submitted.

This collection of information is required by 37 CFR 1.136(a). The information is required to obtain or retain a benefit by the public, which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.11 and 1.14. This collection is estimated to take 6 minutes to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. SEND TO: Mail Stop PCT, Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.

Privacy Act Statement

The **Privacy Act of 1974 (P.L. 93-579)** requires that you be given certain information in connection with your submission of the attached form related to a patent application or patent. Accordingly, pursuant to the requirements of the Act, please be advised that: (1) the general authority for the collection of this information is 35 U.S.C. 2(b)(2); (2) furnishing of the information solicited is voluntary; and (3) the principal purpose for which the information is used by the U.S. Patent and Trademark Office is to process and/or examine your submission related to a patent application or patent. If you do not furnish the requested information, the U.S. Patent and Trademark Office may not be able to process and/or examine your submission, which may result in termination of proceedings or abandonment of the application or expiration of the patent.

The information provided by you in this form will be subject to the following routine uses:

1. The information on this form will be treated confidentially to the extent allowed under the Freedom of Information Act (5 U.S.C. 552) and the Privacy Act (5 U.S.C 552a). Records from this system of records may be disclosed to the Department of Justice to determine whether disclosure of these records is required by the Freedom of Information Act.
2. A record from this system of records may be disclosed, as a routine use, in the course of presenting evidence to a court, magistrate, or administrative tribunal, including disclosures to opposing counsel in the course of settlement negotiations.
3. A record in this system of records may be disclosed, as a routine use, to a Member of Congress submitting a request involving an individual, to whom the record pertains, when the individual has requested assistance from the Member with respect to the subject matter of the record.
4. A record in this system of records may be disclosed, as a routine use, to a contractor of the Agency having need for the information in order to perform a contract. Recipients of information shall be required to comply with the requirements of the Privacy Act of 1974, as amended, pursuant to 5 U.S.C. 552a(m).
5. A record related to an International Application filed under the Patent Cooperation Treaty in this system of records may be disclosed, as a routine use, to the International Bureau of the World Intellectual Property Organization, pursuant to the Patent Cooperation Treaty.
6. A record in this system of records may be disclosed, as a routine use, to another federal agency for purposes of National Security review (35 U.S.C. 181) and for review pursuant to the Atomic Energy Act (42 U.S.C. 218(c)).
7. A record from this system of records may be disclosed, as a routine use, to the Administrator, General Services, or his/her designee, during an inspection of records conducted by GSA as part of that agency's responsibility to recommend improvements in records management practices and programs, under authority of 44 U.S.C. 2904 and 2906. Such disclosure shall be made in accordance with the GSA regulations governing inspection of records for this purpose, and any other relevant (*i.e.*, GSA or Commerce) directive. Such disclosure shall not be used to make determinations about individuals.
8. A record from this system of records may be disclosed, as a routine use, to the public after either publication of the application pursuant to 35 U.S.C. 122(b) or issuance of a patent pursuant to 35 U.S.C. 151. Further, a record may be disclosed, subject to the limitations of 37 CFR 1.14, as a routine use, to the public if the record was filed in an application which became abandoned or in which the proceedings were terminated and which application is referenced by either a published application, an application open to public inspection or an issued patent.
9. A record from this system of records may be disclosed, as a routine use, to a Federal, State, or local law enforcement agency, if the USPTO becomes aware of a violation or potential violation of law or regulation.

PTO/AIA/96 (08-12)
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U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE
Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it displays a valid OMB control number.

STATEMENT UNDER 37 CFR 3.73(c)

Applicant/Patent Owner: SK NEXILIS CO., LTD.

Application No./Patent No.: 16/959,352 Filed/Issue Date: June 30, 2020

Titled: ELECTROLYTIC COPPER FOIL HAVING EXCELLENT HANDLING CHARACTERISTICS IN POSTPROCESSING, AND MANUFACTURING METHOD THEREFOR

SK NEXILIS CO., LTD., a corporation

(Name of Assignee) (Type of Assignee, e.g., corporation, partnership, university, government agency, etc.)

states that, for the patent application/patent identified above, it is (choose **one** of options 1, 2, 3 or 4 below):

1. ☑ The assignee of the entire right, title, and interest.

2. ☐ An assignee of less than the entire right, title, and interest (check applicable box):

   ☐ The extent (by percentage) of its ownership interest is _____%. Additional Statement(s) by the owners holding the balance of the interest must be submitted to account for 100% of the ownership interest.

   ☐ There are unspecified percentages of ownership. The other parties, including inventors, who together own the entire right, title and interest are:

   Additional Statement(s) by the owner(s) holding the balance of the interest must be submitted to account for the entire right, title, and interest.

3. ☐ The assignee of an undivided interest in the entirety (a complete assignment from one of the joint inventors was made). The other parties, including inventors, who together own the entire right, title, and interest are:

   Additional Statement(s) by the owner(s) holding the balance of the interest must be submitted to account for the entire right, title, and interest.

4. ☐ The recipient, via a court proceeding or the like (*e.g.*, bankruptcy, probate), of an undivided interest in the entirety (a complete transfer of ownership interest was made). The certified document(s) showing the transfer is attached.

The interest identified in option 1, 2 or 3 above (not option 4) is evidenced by either (choose **one** of options A or B below):

A. ☐ An assignment from the inventor(s) of the patent application/patent identified above. The assignment was recorded in the United States Patent and Trademark Office at Reel _____, Frame _____, or for which a copy thereof is attached.

B. ☑ A chain of title from the inventor(s), of the patent application/patent identified above, to the current assignee as follows:

1. From: KIM, SEUNG MIN; JIN, SHAN HUA To: KCF TECHNOLOGIES CO., LTD.

   The document was recorded in the United States Patent and Trademark Office at
   Reel 053591, Frame 0041, or for which a copy thereof is attached.

2. From: KCF TECHNOLOGIES CO., LTD. To: SK NEXILIS CO., LTD.

   The document was recorded in the United States Patent and Trademark Office at
   Reel 055693, Frame 0699, or for which a copy thereof is attached.

This collection of information is required by 37 CFR 3.73(b). The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.11 and 1.14. This collection is estimated to take 12 minutes to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

If you need assistance in completing the form, call 1-800-PTO-9199 and select option 2.

PTO/AIA/96 (08-12)
Approved for use through 11/30/2020. OMB 0651-0031
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Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it displays a valid OMB control number.

STATEMENT UNDER 37 CFR 3.73(c)

3. From: _____ To: _____

The document was recorded in the United States Patent and Trademark Office at

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4. From: _____ To: _____

The document was recorded in the United States Patent and Trademark Office at

Reel _____, Frame _____, or for which a copy thereof is attached.

5. From: _____ To: _____

The document was recorded in the United States Patent and Trademark Office at

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6. From: _____ To: _____

The document was recorded in the United States Patent and Trademark Office at

Reel _____, Frame _____, or for which a copy thereof is attached.

☐ Additional documents in the chain of title are listed on a supplemental sheet(s).

☑ As required by 37 CFR 3.73(c)(1)(i), the documentary evidence of the chain of title from the original owner to the assignee was, or concurrently is being, submitted for recordation pursuant to 37 CFR 3.11.

[NOTE: A separate copy (i.e., a true copy of the original assignment document(s)) must be submitted to Assignment Division in accordance with 37 CFR Part 3, to record the assignment in the records of the USPTO. See MPEP 302.08]

The undersigned (whose title is supplied below) is authorized to act on behalf of the assignee.

/Matthew S. Dicke/	August 5, 2022
Signature	Date
Matthew S. Dicke	58819
Printed or Typed Name	Title or Registration Number

[Page 2 of 2]

Privacy Act Statement

The **Privacy Act of 1974 (P.L. 93-579)** requires that you be given certain information in connection with your submission of the attached form related to a patent application or patent. Accordingly, pursuant to the requirements of the Act, please be advised that: (1) the general authority for the collection of this information is 35 U.S.C. 2(b)(2); (2) furnishing of the information solicited is voluntary; and (3) the principal purpose for which the information is used by the U.S. Patent and Trademark Office is to process and/or examine your submission related to a patent application or patent. If you do not furnish the requested information, the U.S. Patent and Trademark Office may not be able to process and/or examine your submission, which may result in termination of proceedings or abandonment of the application or expiration of the patent.

The information provided by you in this form will be subject to the following routine uses:

1. The information on this form will be treated confidentially to the extent allowed under the Freedom of Information Act (5 U.S.C. 552) and the Privacy Act (5 U.S.C 552a). Records from this system of records may be disclosed to the Department of Justice to determine whether disclosure of these records is required by the Freedom of Information Act.
2. A record from this system of records may be disclosed, as a routine use, in the course of presenting evidence to a court, magistrate, or administrative tribunal, including disclosures to opposing counsel in the course of settlement negotiations.
3. A record in this system of records may be disclosed, as a routine use, to a Member of Congress submitting a request involving an individual, to whom the record pertains, when the individual has requested assistance from the Member with respect to the subject matter of the record.
4. A record in this system of records may be disclosed, as a routine use, to a contractor of the Agency having need for the information in order to perform a contract. Recipients of information shall be required to comply with the requirements of the Privacy Act of 1974, as amended, pursuant to 5 U.S.C. 552a(m).
5. A record related to an International Application filed under the Patent Cooperation Treaty in this system of records may be disclosed, as a routine use, to the International Bureau of the World Intellectual Property Organization, pursuant to the Patent Cooperation Treaty.
6. A record in this system of records may be disclosed, as a routine use, to another federal agency for purposes of National Security review (35 U.S.C. 181) and for review pursuant to the Atomic Energy Act (42 U.S.C. 218(c)).
7. A record from this system of records may be disclosed, as a routine use, to the Administrator, General Services, or his/her designee, during an inspection of records conducted by GSA as part of that agency's responsibility to recommend improvements in records management practices and programs, under authority of 44 U.S.C. 2904 and 2906. Such disclosure shall be made in accordance with the GSA regulations governing inspection of records for this purpose, and any other relevant (*i.e.*, GSA or Commerce) directive. Such disclosure shall not be used to make determinations about individuals.
8. A record from this system of records may be disclosed, as a routine use, to the public after either publication of the application pursuant to 35 U.S.C. 122(b) or issuance of a patent pursuant to 35 U.S.C. 151. Further, a record may be disclosed, subject to the limitations of 37 CFR 1.14, as a routine use, to the public if the record was filed in an application which became abandoned or in which the proceedings were terminated and which application is referenced by either a published application, an application open to public inspection or an issued patent.
9. A record from this system of records may be disclosed, as a routine use, to a Federal, State, or local law enforcement agency, if the USPTO becomes aware of a violation or potential violation of law or regulation.

UNITED STATES PATENT AND TRADEMARK OFFICE

UNITED STATES DEPARTMENT OF COMMERCE
United States Patent and Trademark Office
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P.O. Box 1450
Alexandria, Virginia 22313-1450
www.uspto.gov

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
16/959,352	06/30/2020	Seung Min KIM	0313221.00022	1067

24573 7590 07/18/2022

K&L Gates LLP-Chicago
P.O. Box 1135
Chicago, IL 60690

EXAMINER
DUMBRIS, SETH M

ART UNIT	PAPER NUMBER
1784	

NOTIFICATION DATE	DELIVERY MODE
07/18/2022	ELECTRONIC

Please find below and/or attached an Office communication concerning this application or proceeding.

The time period for reply, if any, is set in the attached communication.

Notice of the Office communication was sent electronically on above-indicated "Notification Date" to the following e-mail address(es):

USpatentmail@klgates.com

Advisory Action Before the Filing of an Appeal Brief	**Application No.** 16/959,352	**Applicant(s)** KIM et al.	
	Examiner SETH DUMBRIS	**Art Unit** 1784	**AIA (FITF) Status** Yes

--The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

THE REPLY FILED 05 July 2022 FAILS TO PLACE THIS APPLICATION IN CONDITION FOR ALLOWANCE.

NO NOTICE OF APPEAL FILED

1. ☑ The reply was filed after a final rejection. No Notice of Appeal has been filed. To avoid abandonment of this application, applicant must timely file one of the following replies: (1) an amendment, affidavit, or other evidence, which places the application in condition for allowance; (2) a Notice of Appeal (with appeal fee) in compliance with 37 CFR 41.31; or (3) a Request for Continued Examination (RCE) in compliance with 37 CFR 1.114 if this is a utility or plant application. Note that RCEs are not permitted in design applications. The reply must be filed within one of the following time periods:
   a) ☑ The period for reply expires 3 months from the mailing date of the final rejection.
   b) ☐ The period for reply expires on: (1) the mailing date of this Advisory Action; or (2) the date set forth in the final rejection, whichever is later. In no event, however, will the statutory period for reply expire later than SIX MONTHS from the mailing date of the final rejection.
   c) ☐ A prior Advisory Action was mailed more than 3 months after the mailing date of the final rejection in response to a first after-final reply filed within 2 months of the mailing date of the final rejection.The current period for reply expires ____ months from the mailing date of *the prior Advisory Action* or SIX MONTHS from the mailing date of the final rejection, whichever is earlier.
   Examiner Note: If box 1 is checked, check either box (a), (b) or (c). ONLY CHECK BOX (b) WHEN THIS ADVISORY ACTION IS THE FIRST RESPONSE TO APPLICANTS FIRST AFTER-FINAL REPLY WHICH WAS FILED WITHIN TWO MONTHS OF THE FINAL REJECTION. ONLY CHECK BOX (c) IN THE LIMITED SITUATION SET FORTH UNDER BOX (c). See MPEP 706.07(f).

Extensions of time may be obtained under 37 CFR 1.136(a). The date on which the petition under 37 CFR 1.136(a) and the appropriate extension fee have been filed is the date for purposes of determining the period of extension and the corresponding amount of the fee. The appropriate extension fee under 37 CFR 1.17(a) is calculated from: (1) the expiration date of the shortened statutory period for reply originally set in the final Office action; or (2) as set forth in (b) or (c) above, if checked. Any reply received by the Office later than three months after the mailing date of the final rejection, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

NOTICE OF APPEAL

2. ☐ The Notice of Appeal was filed on _____. A brief in compliance with 37 CFR 41.37 must be filed within two months of the date of filing the Notice of Appeal (37 CFR 41.37(a)), or any extension thereof (37 CFR 41.37(e)), to avoid dismissal of the appeal. Since a Notice of Appeal has been filed, any reply must be filed within the time period set forth in 37CFR 41.37(a).

AMENDMENTS

3. ☐ The proposed amendments filed after a final rejection, but prior to the date of filing a brief, will not be entered because
   a) ☐ They raise new issues that would require further consideration and/or search (see NOTE below);
   b) ☐ They raise the issue of new matter (see NOTE below);
   c) ☐ They are not deemed to place the application in better form for appeal by materially reducing or simplifying the issues for appeal; and/or
   d) ☐ They present additional claims without canceling a corresponding number of finally rejected claims.
   NOTE: _____ (See 37 CFR 1.116 and 41.33(a)).
4. ☐ The amendments are not in compliance with 37 CFR 1.121. See attached Notice of Non-Compliant Amendment (PTOL-324).
5. ☑ Applicant's reply has overcome the following rejection(s): See Continuation Sheet
6. ☐ Newly proposed or amended claim(s) _____ would be allowable if submitted in a separate, timely filed amendment canceling the non-allowable claim(s).
7. ☐ For purposes of appeal, the proposed amendment(s):(a)☐ will not be entered, or (b)☐ will be entered, and an explanation of how the new or amended claims would be rejected is provided below or appended.

AFFIDAVIT OR OTHER EVIDENCE

8. ☐ A declaration(s)/affidavit(s) under **37 CFR 1.130(b)** was/were filed on _____
9. ☐ The affidavit or other evidence filed after final action, but before or on the date of filing a Notice of Appeal will not be entered because applicant failed to provide a showing of good and sufficient reasons why the affidavit or other evidence is necessary and was not earlier presented. See 37 CFR 1.116(e).
10. ☐ The affidavit or other evidence filed after the date of filing the Notice of Appeal, but prior to the date of filing a brief, will not be entered because the affidavit or other evidence failed to overcome all rejections under appeal and/or appellant fails to provide a showing of good and sufficient reasons why it is necessary and was not earlier presented. See 37 CFR 41.33(d)(1).
11. ☐ The affidavit or other evidence is entered. An explanation of the status of the claims after entry is below or attached.

REQUEST FOR RECONSIDERATION/OTHER

12. ☑ The request for reconsideration has been considered but does NOT place the application in condition for allowance because: See Continuation Sheet.
13. ☐ Note the attached Information *Disclosure Statement*(s). (PTO/SB/08) Paper No(s). _____
14. ☐ Other: _____.

STATUS OF CLAIMS

15. The status of the claim(s) is (or will be) as follows:
    Claim(s) allowed:_____.
    Claim(s) objected to:_____.
    Claim(s) rejected:1-7 and 11-13.
    Claim(s) withdrawn from consideration:_____.

/SETH DUMBRIS/ Primary Examiner, Art Unit 1784	

Continuation of AMENDMENTS 5. Applicant's reply has overcome the following rejection(s): The 35 USC 112(b) rejection of claims 11-13. Applicant has amended the claims as suggested and the prior rejection is withdrawn.

Continuation of REQUEST FOR RECONSIDERATION/OTHER 12. The request for reconsideration has been considered but does NOT place the application in condition for allowance because:

The terminal disclaimer filed on 05 July 2022 disclaiming the terminal portion of any patent granted on this application which would extend beyond the expiration date of US 10,547,081 has been reviewed and is NOT accepted.

The terminal disclaimer does not comply with 37 CFR 1.321 because:
This application was filed on or after September 16, 2012. The party identified in the terminal disclaimer is not the applicant of record. A request to change the applicant under 37 CFR 1.46(c) must be filed and must include an application data sheet specifying the applicant in the applicant information section and comply with 37 CFR 3.71 and 3.73. To be reconsidered, the terminal disclaimer must be filed with the request under 37 CFR 1.46(c).

To remedy this:
A request under 37 CFR 1.36(c) to change the applicant needs to be filed, which is (1) a request, signed by a CFR 1.33(b) party, (2) a corrected Application Data Sheet (37 CFR 1.76(c)) that identifies the "new" applicant in the application information, and is underlined since it is new, and (3) a CFR 3.73(c) statement showing a chain of title to the new applicant. Along with the § 1.46(c) request, a power of attorney that gives power to the attorney who is signing the terminal disclaimer, along with another copy of the terminal disclaimer, is needed unless a terminal disclaimer is filed which is signed by the applicant.

As the Double Patenting Rejection of claims 1-7 and 11-13 has not been overcome by a filing of a proper terminal disclaimer, the prior rejection is maintained.

For the reasons set forth above and of record, the Final Rejection dated 05 April 2022 is maintained.

ENTER IN PART: /S.D./

07/11/2022

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Applicant:	Seung Min KIM
Appl. No.:	16/959,352
Conf. No.:	1067
Filed:	June 30, 2020
Title:	ELECTROLYTIC COPPER FOIL HAVING EXCELLENT HANDLING CHARACTERISTICS IN POSTPROCESSING, AND MANUFACTURING METHOD THEREFOR
Art Unit:	1784
Examiner:	DUMBRIS, SETH M
Docket No.:	0313221.00022

AMENDMENT AND RESPONSE TO FINAL OFFICE ACTION

VIA ELECTRONIC FILING

Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

Dear Commissioner:

This Response is submitted in reply to the Final Office Action dated April 5, 2022.

Amendments to the Claims begins on page 2 of this paper.

Remarks begin on page 5 of this paper.

EAST Search History (Prior Art)

Ref #	Hits	Search Query	DBs	Default Operator	Plurals	Time Stamp
S1	12	((("JIN") near3 ("Shan") near3 ("Hua"))).INV.	US-PGPUB; USPAT; USOCR	OR	ON	2021/11/15 10:01
S2	22	((("LEE") near3 ("An") near3 ("Na"))).INV.	US-PGPUB; USPAT; USOCR	OR	ON	2021/11/15 10:01
S3	114	((("KIM") near3 ("Seung") near3 ("Min"))).INV.	US-PGPUB; USPAT; USOCR	OR	ON	2021/11/15 10:01
S4	383	((("JIN") near3 ("Shan" or Hua or "shanhua" or "shan-hua"))).INV.	US-PGPUB; USPAT; USOCR	OR	ON	2021/11/15 10:02
S5	942	((("LEE") near3 ("An" or Na or "An-Na"))).INV.	US-PGPUB; USPAT; USOCR	OR	ON	2021/11/15 10:02
S6	18,027	((("KIM") near3 ("Seung" or Min or "SeungMin" or "Seung-Min"))).INV.	US-PGPUB; USPAT; USOCR	OR	ON	2021/11/15 10:03
S7	49	((("JIN") near3 ("Shan" or Hua or "shanhua" or "shan-hua"))).aanm.	US-PGPUB; USPAT; USOCR	OR	ON	2021/11/15 10:03
S8	110	((("LEE") near3 ("An" or Na or "An-Na"))).aanm.	US-PGPUB; USPAT; USOCR	OR	ON	2021/11/15 10:03
S9	2,032	((("KIM") near3 ("Seung" or Min or "SeungMin" or "Seung-Min"))).aanm.	US-PGPUB; USPAT; USOCR	OR	ON	2021/11/15 10:03
S10	19,281	S1 or S2 or S3 or S4 or S5 or S6 or S7 or S8 or S9	US-PGPUB; USPAT; USOCR	OR	ON	2021/11/15 10:03

EAST Search History (Prior Art)

S12	1,930	S10 and ((Cu or copper or "cu-alloy" or "cu-base" or "Cu-based" or "copper-base" or "copper-based" or "copper-alloy") with (foil or foiled or foiling or tape or ribbon or layer or layered or layering or film or filmed or filming or clad or claded or cladded or clading or cladding or coat or coated or coating or electroplate or electroplated or electroplating or electroless or electrolessly or electroform or electroformed or electroforming or electrodeposit or electrodeposited or electrodepositing or electrodeposition or "electro-plate" or "electro-plated" or "electro-plating" or "electro-less" or "electro-lessly" or "electro-form" or "electro-formed" or "electro-forming" or "electro-deposit" or "electro-deposited" or "electro-depositing" or "electro-deposition"))	US-PGPUB; USPAT; USOCR	OR	ON	2021/11/15 10:04
S13	11	S12 and (("220" or "[220]" or "{220}" or "(220)" or "<220>") near5 (texture or coefficient or index or Miller or hkl or "h, k,l"))	US-PGPUB; USPAT; USOCR	OR	ON	2021/11/15 10:06
S14	58	((KCF) near3 (tech or technol or technology)).as,aanm.	US-PGPUB; USPAT; USOCR	OR	ON	2021/11/15 10:24
S15	50	S14 not S13	US-PGPUB; USPAT; USOCR	OR	ON	2021/11/15 10:24

EAST Search History (Prior Art)

S16	150,158	B32B15/01;C25D1/04;C25D 3/38;C25D5/34, 48;C25D21/06;H01M4/0404, 13,66,661,667;H01M10/052, 0525;H01M2004/027;Y02E6 0/10;Y10T428/12431,12438. cpc.	US-PGPU B; USPAT; USOCR	OR	ON	2021/11/15 10:53
S17	41,417	S16 and ((Cu or copper or "cu-alloy" or "cu-base" or "Cu-based" or "copper-base" or "copper-based" or "copper-alloy") near5 (foil or foiled or foiling or tape or ribbon or layer or layered or layering or film or filmed or filming or clad or claded or cladded or clading or cladding or coat or coated or coating or electroplate or electroplated or electroplating or electroless or electrolessly or electroform or electroformed or electroforming or electrodeposit or electrodeposited or electrodepositing or electrodeposition or "electro-plate" or "electro-plated" or "electro-plating" or "electro-less" or "electro-lessly" or "electro-form" or "electro-formed" or "electro-forming" or "electro-deposit" or "electro-deposited" or "electro-depositing" or "electro-deposition"))	US-PGPU B; USPAT; USOCR	OR	ON	2021/11/15 11:03
S18	81	S17 and (("220" or "[220]" or "{220}" or "(220)" or "<220>") near5 (texture or coefficient or index or Miller or hkl or "h, k,l"))	US-PGPU B; USPAT; USOCR	OR	ON	2021/11/15 11:04
S19	71	S18 not (S13 or S15)	US-PGPU B; USPAT; USOCR	OR	ON	2021/11/15 11:04

EAST Search History (Prior Art)

S20	90	S17 and (("220" or "[220]" or "{220}" or "(220)" or "<220>") near8 (texture or coefficient or index or Miller or hkl or "h, k,l"))	US-PGPUB; USPAT; USOCR	OR	ON	2021/11/15 11:20
S21	9	S20 not (S13 or S15 or S19)	US-PGPUB; USPAT; USOCR	OR	ON	2021/11/15 11:20
S22	34	S16 and (((Cu or copper or "cu-alloy" or "cu-base" or "Cu-based" or "copper-base" or "copper-based" or "copper-alloy") with (foil or foiled or foiling or tape or ribbon or layer or layered or layering or film or filmed or filming or clad or claded or cladded or clading or cladding or coat or coated or coating or electroplate or electroplated or electroplating or electroless or electrolessly or electroform or electroformed or electroforming or electrodeposit or electrodeposited or electrodepositing or electrodeposition or "electro-plate" or "electro-plated" or "electro-plating" or "electro-less" or "electro-lessly" or "electro-form" or "electro-formed" or "electro-forming" or "electro-deposit" or "electro-deposited" or "electro-depositing" or "electro-deposition")) with (("220" or "[220]" or "{220}" or "(220)" or "<220>") with (texture or coefficient or index or Miller or hkl or "h,k, l")))	US-PGPUB; USPAT; USOCR	OR	ON	2021/11/15 11:21
S23	1	S22 not (S13 or S15 or S19 or S21)	US-PGPUB; USPAT; USOCR	OR	ON	2021/11/15 11:22

EAST Search History (Prior Art)

S24	907,698	B32B15/01;C25D1/04;C25D 3/38;C25D5/34, 48;C25D21/06;H01M4/0404, 13,66,661,667;H01M10/052, 0525;H01M2004/027;Y02E6 0/10;Y10T428/12431,12438. cpc.	FPRS; EPO; JPO; DERWEN T; IBM_TDB	OR	ON	2021/11/15 11:22
S25	64	S24 and (((Cu or copper or "cu-alloy" or "cu-base" or "Cu-based" or "copper-base" or "copper-based" or "copper-alloy") with (foil or foiled or foiling or tape or ribbon or layer or layered or layering or film or filmed or filming or clad or claded or cladded or clading or cladding or coat or coated or coating or electroplate or electroplated or electroplating or electroless or electrolessly or electroform or electroformed or electroforming or electrodeposit or electrodeposited or electrodepositing or electrodeposition or "electro-plate" or "electro-plated" or "electro-plating" or "electro-less" or "electro-lessly" or "electro-form" or "electro-formed" or "electro-forming" or "electro-deposit" or "electro-deposited" or "electro-depositing" or "electro-deposition")) with (("220" or "[220]" or "{220}" or "(220)" or "<220>") with (texture or coefficient or index or Miller or hkl or "h,k, l")))	FPRS; EPO; JPO; DERWEN T; IBM_TDB	OR	ON	2021/11/15 11:22

S26	17,447	S24 and ((Cu or copper or "cu-alloy" or "cu-base" or "Cu-based" or "copper-base" or "copper-based" or "copper-alloy") near5 (foil or foiled or foiling or tape or ribbon or layer or layered or layering or film or filmed or filming or clad or claded or cladded or clading or cladding or coat or coated or coating or electroplate or electroplated or electroplating or electroless or electrolessly or electroform or electroformed or electroforming or electrodeposit or electrodeposited or electrodepositing or electrodeposition or "electro-plate" or "electro-plated" or "electro-plating" or "electro-less" or "electro-lessly" or "electro-form" or "electro-formed" or "electro-forming" or "electro-deposit" or "electro-deposited" or "electro-depositing" or "electro-deposition"))	FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2021/11/15 11:29
S27	60	S26 and (("220" or "[220]" or "{220}" or "(220)" or "<220>") near5 (texture or coefficient or index or Miller or hkl or "h, k,l"))	FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2021/11/15 11:29
S28	9	S27 not S25	FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2021/11/15 11:29
S29	73	S26 and (("220" or "[220]" or "{220}" or "(220)" or "<220>") with (texture or coefficient or index or Miller or hkl or "h,k, l"))	FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2021/11/15 11:30

EAST Search History (Prior Art)

S30	0	S29 not (S25 or S28)	FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2021/11/15 11:30
S31	21,626	S24 and ((Cu or copper or "cu-alloy" or "cu-base" or "Cu-based" or "copper-base" or "copper-based" or "copper-alloy") with (foil or foiled or foiling or tape or ribbon or layer or layered or layering or film or filmed or filming or clad or claded or cladded or clading or cladding or coat or coated or coating or electroplate or electroplated or electroplating or electroless or electrolessly or electroform or electroformed or electroforming or electrodeposit or electrodeposited or electrodepositing or electrodeposition or "electro-plate" or "electro-plated" or "electro-plating" or "electro-less" or "electro-lessly" or "electro-form" or "electro-formed" or "electro-forming" or "electro-deposit" or "electro-deposited" or "electro-depositing" or "electro-deposition"))	FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2021/11/15 11:30
S32	74	S31 and (("220" or "[220]" or "{220}" or "(220)" or "<220>") with (texture or coefficient or index or Miller or hkl or "h,k, l"))	FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2021/11/15 11:30
S33	1	S32 not (S25 or S28)	FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2021/11/15 11:31

EAST Search History (Prior Art)

S34	30	(((Cu or copper or "cu-alloy" or "cu-base" or "Cu-based" or "copper-base" or "copper-based" or "copper-alloy") near5 (foil or foiled or foiling or tape or ribbon or layer or layered or layering or film or filmed or filming or clad or claded or cladded or clading or cladding or coat or coated or coating or electroplate or electroplated or electroplating or electroless or electrolessly or electroform or electroformed or electroforming or electrodeposit or electrodeposited or electrodepositing or electrodeposition or "electro-plate" or "electro-plated" or "electro-plating" or "electro-less" or "electro-lessly" or "electro-form" or "electro-formed" or "electro-forming" or "electro-deposit" or "electro-deposited" or "electro-depositing" or "electro-deposition")) near5 (("220" or "[220]" or "{220}" or "(220)" or "<220>") near5 (texture or coefficient or index or Miller or hkl or "h,k, l")))	FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2021/11/15 11:31
S35	6	S34 not (S25 or S28 or S33)	FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2021/11/15 11:31

EAST Search History (Prior Art)

S36	123	(((Cu or copper or "cu-alloy" or "cu-base" or "Cu-based" or "copper-base" or "copper-based" or "copper-alloy") with (foil or foiled or foiling or tape or ribbon or layer or layered or layering or film or filmed or filming or clad or claded or cladded or clading or cladding or coat or coated or coating or electroplate or electroplated or electroplating or electroless or electrolessly or electroform or electroformed or electroforming or electrodeposit or electrodeposited or electrodepositing or electrodeposition or "electro-plate" or "electro-plated" or "electro-plating" or "electro-less" or "electro-lessly" or "electro-form" or "electro-formed" or "electro-forming" or "electro-deposit" or "electro-deposited" or "electro-depositing" or "electro-deposition")) with (("220" or "[220]" or "{220}" or "(220)" or "<220>") with (texture or coefficient or index or Miller or hkl or "h,k, l")))	FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2021/11/15 11:32
S37	53	S36 not (S25 or S28 or S33 or S35)	FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2021/11/15 11:32

EAST Search History (Prior Art)

S38	46	(((Cu or copper or "cu-alloy" or "cu-base" or "Cu-based" or "copper-base" or "copper-based" or "copper-alloy") near5 (foil or foiled or foiling or tape or ribbon or layer or layered or layering or film or filmed or filming or clad or claded or cladded or clading or cladding or coat or coated or coating or electroplate or electroplated or electroplating or electroless or electrolessly or electroform or electroformed or electroforming or electrodeposit or electrodeposited or electrodepositing or electrodeposition or "electro-plate" or "electro-plated" or "electro-plating" or "electro-less" or "electro-lessly" or "electro-form" or "electro-formed" or "electro-forming" or "electro-deposit" or "electro-deposited" or "electro-depositing" or "electro-deposition")) near5 (("220" or "[220]" or "{220}" or "(220)" or "<220>") near5 (texture or coefficient or index or Miller or hkl or "h,k,l")))	US-PGPUB; USPAT; USOCR	OR	ON	2021/11/15 12:17
S39	22	S38 not (S13 or S15 or S19 or S21 or S23)	US-PGPUB; USPAT; USOCR	OR	ON	2021/11/15 12:18

EAST Search History (Prior Art)

S40	112	(((Cu or copper or "cu-alloy" or "cu-base" or "Cu-based" or "copper-base" or "copper-based" or "copper-alloy") with (foil or foiled or foiling or tape or ribbon or layer or layered or layering or film or filmed or filming or clad or claded or cladded or clading or cladding or coat or coated or coating or electroplate or electroplated or electroplating or electroless or electrolessly or electroform or electroformed or electroforming or electrodeposit or electrodeposited or electrodepositing or electrodeposition or "electro-plate" or "electro-plated" or "electro-plating" or "electro-less" or "electro-lessly" or "electro-form" or "electro-formed" or "electro-forming" or "electro-deposit" or "electro-deposited" or "electro-depositing" or "electro-deposition")) with (("220" or "[220]" or "{220}" or "(220)" or "<220>") with (texture or coefficient or index or Miller or hkl or "h,k, l")))	US-PGPUB; USPAT; USOCR	OR	ON	2021/11/15 12:22
S41	56	S40 not (S13 or S15 or S19 or S21 or S23 or S39)	US-PGPUB; USPAT; USOCR	OR	ON	2021/11/15 12:22
S42	44	S17 and (("220" or "[220]" or "{220}" or "(220)" or "<220>") near5 (stress))	US-PGPUB; USPAT; USOCR	OR	ON	2021/11/15 13:19
S43	2	S24 and (("220" or "[220]" or "{220}" or "(220)" or "<220>") near5 (stress))	FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2021/11/15 13:21

EAST Search History (Prior Art)

S44	3	S24 and (("111" or "[111]" or "{111}" or "(111)" or "<111>") near5 (stress))	FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2021/11/15 13:22
S45	48	S24 and (("200" or "[200]" or "{200}" or "(200)" or "<200>") near5 (stress))	FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2021/11/15 13:23
S46	0	S24 and (("311" or "[311]" or "{311}" or "(311)" or "<311>") near5 (stress))	FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2021/11/15 13:24

EAST Search History (Prior Art)

S47	89	((Cu or copper or "cu-alloy" or "cu-base" or "Cu-based" or "copper-base" or "copper-based" or "copper-alloy") near5 (foil or foiled or foiling or tape or ribbon or layer or layered or layering or film or filmed or filming or clad or claded or cladded or clading or cladding or coat or coated or coating or electroplate or electroplated or electroplating or electroless or electrolessly or electroform or electroformed or electroforming or electrodeposit or electrodeposited or electrodepositing or electrodeposition or "electro-plate" or "electro-plated" or "electro-plating" or "electro-less" or "electro-lessly" or "electro-form" or "electro-formed" or "electro-forming" or "electro-deposit" or "electro-deposited" or "electro-depositing" or "electro-deposition")) and (("111" or "[111]" or "{111}" or "(111)" or "<111>" or "200" or "[200]" or "{200}" or "(200)" or "<200>" or "220" or "[220]" or "{220}" or "(220)" or "<220>" or "311" or "[311]" or "{311}" or "(311)" or "<311>") near5 (residual near2 stress))	US-PGPUB; USPAT; USOCR	OR	ON	2021/11/15 13:27

S48	127	((Cu or copper or "cu-alloy" or "cu-base" or "Cu-based" or "copper-base" or "copper-based" or "copper-alloy") near8 (foil or foiled or foiling or tape or ribbon or layer or layered or layering or film or filmed or filming or clad or claded or cladded or clading or cladding or coat or coated or coating or electroplate or electroplated or electroplating or electroless or electrolessly or electroform or electroformed or electroforming or electrodeposit or electrodeposited or electrodepositing or electrodeposition or "electro-plate" or "electro-plated" or "electro-plating" or "electro-less" or "electro-lessly" or "electro-form" or "electro-formed" or "electro-forming" or "electro-deposit" or "electro-deposited" or "electro-depositing" or "electro-deposition")) and (("111" or "[111]" or "{111}" or "(111)" or "<111>" or "200" or "[200]" or "{200}" or "(200)" or "<200>" or "220" or "[220]" or "{220}" or "(220)" or "<220>" or "311" or "[311]" or "{311}" or "(311)" or "<311>") near8 (residual near2 stress))	US-PGPUB; USPAT; USOCR	OR	ON	2021/11/15 13:30
S49	38	S48 not S47	US-PGPUB; USPAT; USOCR	OR	ON	2021/11/15 13:30

EAST Search History (Prior Art)

S50	257	((Cu or copper or "cu-alloy" or "cu-base" or "Cu-based" or "copper-base" or "copper-based" or "copper-alloy") with (foil or foiled or foiling or tape or ribbon or layer or layered or layering or film or filmed or filming or clad or claded or cladded or clading or cladding or coat or coated or coating or electroplate or electroplated or electroplating or electroless or electrolessly or electroform or electroformed or electroforming or electrodeposit or electrodeposited or electrodepositing or electrodeposition or "electro-plate" or "electro-plated" or "electro-plating" or "electro-less" or "electro-lessly" or "electro-form" or "electro-formed" or "electro-forming" or "electro-deposit" or "electro-deposited" or "electro-depositing" or "electro-deposition")) and (("111" or "[111]" or "{111}" or "(111)" or "<111>" or "200" or "[200]" or "{200}" or "(200)" or "<200>" or "220" or "[220]" or "{220}" or "(220)" or "<220>" or "311" or "[311]" or "{311}" or "(311)" or "<311>") with (residual near2 stress))	US-PGPUB; USPAT; USOCR	OR	ON	2021/11/15 13:31
S51	130	S50 not (S47 or S49)	US-PGPUB; USPAT; USOCR	OR	ON	2021/11/15 13:32

EAST Search History (Prior Art)

S52	23	((Cu or copper or "cu-alloy" or "cu-base" or "Cu-based" or "copper-base" or "copper-based" or "copper-alloy") with (foil or foiled or foiling or tape or ribbon or layer or layered or layering or film or filmed or filming or clad or claded or cladded or clading or cladding or coat or coated or coating or electroplate or electroplated or electroplating or electroless or electrolessly or electroform or electroformed or electroforming or electrodeposit or electrodeposited or electrodepositing or electrodeposition or "electro-plate" or "electro-plated" or "electro-plating" or "electro-less" or "electro-lessly" or "electro-form" or "electro-formed" or "electro-forming" or "electro-deposit" or "electro-deposited" or "electro-depositing" or "electro-deposition")) and (("111" or "[111]" or "{111}" or "(111)" or "<111>" or "200" or "[200]" or "{200}" or "(200)" or "<200>" or "220" or "[220]" or "{220}" or "(220)" or "<220>" or "311" or "[311]" or "{311}" or "(311)" or "<311>") with (residual near2 stress))	FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2021/11/15 13:36
S53	4	(20090095515|20160260980|9209485|9562298).did.	US-PGPUB; USPAT; USOCR	OR	ON	2021/11/15 13:47
S54	12	((("JIN") near3 ("Shan") near3 ("Hua"))).INV.	US-PGPUB; USPAT; USOCR	OR	ON	2021/11/16 07:05

EAST Search History (Prior Art)

S55	22	((("LEE") near3 ("An") near3 ("Na"))).INV.	US-PGPUB; USPAT; USOCR	OR	ON	2021/11/16 07:05
S56	114	((("KIM") near3 ("Seung") near3 ("Min"))).INV.	US-PGPUB; USPAT; USOCR	OR	ON	2021/11/16 07:05
S57	383	((("JIN") near3 ("Shan" or Hua or "shanhua" or "shan-hua"))).INV.	US-PGPUB; USPAT; USOCR	OR	ON	2021/11/16 07:05
S58	944	((("LEE") near3 ("An" or Na or "An-Na"))).INV.	US-PGPUB; USPAT; USOCR	OR	ON	2021/11/16 07:05
S59	18,038	((("KIM") near3 ("Seung" or Min or "SeungMin" or "Seung-Min"))).INV.	US-PGPUB; USPAT; USOCR	OR	ON	2021/11/16 07:05
S60	49	((("JIN") near3 ("Shan" or Hua or "shanhua" or "shan-hua"))).aanm.	US-PGPUB; USPAT; USOCR	OR	ON	2021/11/16 07:05
S61	110	((("LEE") near3 ("An" or Na or "An-Na"))).aanm.	US-PGPUB; USPAT; USOCR	OR	ON	2021/11/16 07:05
S62	2,032	((("KIM") near3 ("Seung" or Min or "SeungMin" or "Seung-Min"))).aanm.	US-PGPUB; USPAT; USOCR	OR	ON	2021/11/16 07:05
S63	19,294	S54 or S55 or S56 or S57 or S58 or S59 or S60 or S61 or S62	US-PGPUB; USPAT; USOCR	OR	ON	2021/11/16 07:05

S64	1,930	S63 and ((Cu or copper or "cu-alloy" or "cu-base" or "Cu-based" or "copper-base" or "copper-based" or "copper-alloy") with (foil or foiled or foiling or tape or ribbon or layer or layered or layering or film or filmed or filming or clad or claded or cladded or clading or cladding or coat or coated or coating or electroplate or electroplated or electroplating or electroless or electrolessly or electroform or electroformed or electroforming or electrodeposit or electrodeposited or electrodepositing or electrodeposition or "electro-plate" or "electro-plated" or "electro-plating" or "electro-less" or "electro-lessly" or "electro-form" or "electro-formed" or "electro-forming" or "electro-deposit" or "electro-deposited" or "electro-depositing" or "electro-deposition"))	US-PGPUB; USPAT; USOCR	OR	ON	2021/11/16 07:05
S65	11	S64 and (("220" or "[220]" or "{220}" or "(220)" or "<220>") near5 (texture or coefficient or index or Miller or hkl or "h, k,l"))	US-PGPUB; USPAT; USOCR	OR	ON	2021/11/16 07:05
S66	58	((KCF) near3 (tech or technol or technology)).as,aanm.	US-PGPUB; USPAT; USOCR	OR	ON	2021/11/16 07:15
S67	50	S66 not S65	US-PGPUB; USPAT; USOCR	OR	ON	2021/11/16 07:15
S68	4	(2015030873|20070098910|20110171491|20200181790|20180062180).did.	US-PGPUB; USPAT; USOCR	OR	ON	2021/11/16 07:30

EAST Search History (Prior Art)

S69	150,861	B32B15/01;C25D1/04;C25D 3/38;C25D5/34, 48;C25D7/0614;C25D21/06; H01M4/0404,13,66,661, 667;H01M10/052, 0525;H01M2004/027;Y02E6 0/10;Y10T428/12431,12438. cpc.	US-PGPU B; USPAT; USOCR	OR	ON	2021/11/16 07:37
S70	150,231	B32B15/01;C25D1/04;C25D 3/38;C25D5/34, 48;C25D21/06;H01M4/0404, 13,66,661,667;H01M10/052, 0525;H01M2004/027;Y02E6 0/10;Y10T428/12431,12438. cpc.	US-PGPU B; USPAT; USOCR	OR	ON	2021/11/16 07:38
S71	41,443	S70 and ((Cu or copper or "cu-alloy" or "cu-base" or "Cu-based" or "copper-base" or "copper-based" or "copper-alloy") near5 (foil or foiled or foiling or tape or ribbon or layer or layered or layering or film or filmed or filming or clad or claded or cladded or clading or cladding or coat or coated or coating or electroplate or electroplated or electroplating or electroless or electrolessly or electroform or electroformed or electroforming or electrodeposit or electrodeposited or electrodepositing or electrodeposition or "electro-plate" or "electro-plated" or "electro-plating" or "electro-less" or "electro-lessly" or "electro-form" or "electro-formed" or "electro-forming" or "electro-deposit" or "electro-deposited" or "electro-depositing" or "electro-deposition"))	US-PGPU B; USPAT; USOCR	OR	ON	2021/11/16 07:38

EAST Search History (Prior Art)

S72	41,443	S71 and ((Cu or copper or "cu-alloy" or "cu-base" or "Cu-based" or "copper-base" or "copper-based" or "copper-alloy") near5 (foil or foiled or foiling or tape or ribbon or layer or layered or layering or film or filmed or filming or clad or claded or cladded or clading or cladding or coat or coated or coating or electroplate or electroplated or electroplating or electroless or electrolessly or electroform or electroformed or electroforming or electrodeposit or electrodeposited or electrodepositing or electrodeposition or "electro-plate" or "electro-plated" or "electro-plating" or "electro-less" or "electro-lessly" or "electro-form" or "electro-formed" or "electro-forming" or "electro-deposit" or "electro-deposited" or "electro-depositing" or "electro-deposition"))	US-PGPUB; USPAT; USOCR	OR	ON	2021/11/16 07:38

EAST Search History (Prior Art)

S73	41,584	S69 and ((Cu or copper or "cu-alloy" or "cu-base" or "Cu-based" or "copper-base" or "copper-based" or "copper-alloy") near5 (foil or foiled or foiling or tape or ribbon or layer or layered or layering or film or filmed or filming or clad or claded or cladded or clading or cladding or coat or coated or coating or electroplate or electroplated or electroplating or electroless or electrolessly or electroform or electroformed or electroforming or electrodeposit or electrodeposited or electrodepositing or electrodeposition or "electro-plate" or "electro-plated" or "electro-plating" or "electro-less" or "electro-lessly" or "electro-form" or "electro-formed" or "electro-forming" or "electro-deposit" or "electro-deposited" or "electro-depositing" or "electro-deposition"))	US-PGPUB; USPAT; USOCR	OR	ON	2021/11/16 07:39
S74	81	S73 and (("220" or "[220]" or "{220}" or "(220)" or "<220>") near5 (texture or coefficient or index or Miller or hkl or "h, k,l"))	US-PGPUB; USPAT; USOCR	OR	ON	2021/11/16 07:39
S75	72	S74 not (S63 or S65)	US-PGPUB; USPAT; USOCR	OR	ON	2021/11/16 07:40
S76	90	S73 and (("220" or "[220]" or "{220}" or "(220)" or "<220>") near8 (texture or coefficient or index or Miller or hkl or "h, k,l"))	US-PGPUB; USPAT; USOCR	OR	ON	2021/11/16 08:08
S77	9	S76 not (S63 or S65 or S75)	US-PGPUB; USPAT; USOCR	OR	ON	2021/11/16 08:09

EAST Search History (Prior Art)

S78	144	S73 and (("220" or "[220]" or "{220}" or "(220)" or "<220>") with (texture or coefficient or index or Miller or hkl or "h,k, l"))	US-PGPUB; USPAT; USOCR	OR	ON	2021/11/16 08:12
S79	53	S78 not (S63 or S65 or S75 or S77)	US-PGPUB; USPAT; USOCR	OR	ON	2021/11/16 08:13
S80	429	S73 and ((peak near2 density) or PD.u/c.)	US-PGPUB; USPAT; USOCR	OR	ON	2021/11/16 08:19
S81	36	S73 and (((peak near2 density) or PD.u/c.) near5 (surface))	US-PGPUB; USPAT; USOCR	OR	ON	2021/11/16 08:23
S82	9	("20020153254"|"20150030873"|"20140342178"|"20160013493"|"20140017564"|"20140170489"|"20130108887"|"20110056840"|"20190078229").PN.	US-PGPUB; USPAT; USOCR	OR	ON	2021/11/16 08:32
S83	53	S69 and (((peak near2 density) or PD.u/c.) near5 (surface or shiney or shiny or matt or matte or mat or matted))	US-PGPUB; USPAT; USOCR	OR	ON	2021/11/16 08:34
S84	17	S83 not (S63 or S65 or S75 or S77 or S81)	US-PGPUB; USPAT; USOCR	OR	ON	2021/11/16 08:34
S85	910,615	B32B15/01;C25D1/04;C25D3/38;C25D5/34,48;C25D7/0614;C25D21/06;H01M4/0404,13,66,661,667;H01M10/052,0525;H01M2004/027;Y02E60/10;Y10T428/12431,12438.cpc.	FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2021/11/16 08:39

EAST Search History (Prior Art)

S86	64	S85 and (((Cu or copper or "cu-alloy" or "cu-base" or "Cu-based" or "copper-base" or "copper-based" or "copper-alloy") with (foil or foiled or foiling or tape or ribbon or layer or layered or layering or film or filmed or filming or clad or claded or cladded or clading or cladding or coat or coated or coating or electroplate or electroplated or electroplating or electroless or electrolessly or electroform or electroformed or electroforming or electrodeposit or electrodeposited or electrodepositing or electrodeposition or "electro-plate" or "electro-plated" or "electro-plating" or "electro-less" or "electro-lessly" or "electro-form" or "electro-formed" or "electro-forming" or "electro-deposit" or "electro-deposited" or "electro-depositing" or "electro-deposition")) with (("220" or "[220]" or "{220}" or "(220)" or "<220>") with (texture or coefficient or index or Miller or hkl or "h,k, l")))	FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2021/11/16 08:39
S87	16	S85 and (((peak near2 density) or PD.u/c.) near5 (surface or shiney or shiny or matt or matte or mat or matted))	FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2021/11/16 08:47

EAST Search History (Prior Art)

S88	11	(((Cu or copper or "cu-alloy" or "cu-base" or "Cu-based" or "copper-base" or "copper-based" or "copper-alloy") with (foil or foiled or foiling or tape or ribbon or layer or layered or layering or film or filmed or filming or clad or claded or cladded or clading or cladding or coat or coated or coating or electroplate or electroplated or electroplating or electroless or electrolessly or electroform or electroformed or electroforming or electrodeposit or electrodeposited or electrodepositing or electrodeposition or "electro-plate" or "electro-plated" or "electro-plating" or "electro-less" or "electro-lessly" or "electro-form" or "electro-formed" or "electro-forming" or "electro-deposit" or "electro-deposited" or "electro-depositing" or "electro-deposition")) with (("220" or "[220]" or "{220}" or "(220)" or "<220>") with (texture or coefficient or index or Miller or hkl or "h,k, l"))) and (((peak near2 density) or PD.u/c.) near5 (surface or shiney or shiny or matt or matte or mat or matted))	FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2021/11/16 08:48
S89	0	S88 not S87	FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2021/11/16 08:48

EAST Search History (Prior Art)

S90	12	(((Cu or copper or "cu-alloy" or "cu-base" or "Cu-based" or "copper-base" or "copper-based" or "copper-alloy") with (foil or foiled or foiling or tape or ribbon or layer or layered or layering or film or filmed or filming or clad or claded or cladded or clading or cladding or coat or coated or coating or electroplate or electroplated or electroplating or electroless or electrolessly or electroform or electroformed or electroforming or electrodeposit or electrodeposited or electrodepositing or electrodeposition or "electro-plate" or "electro-plated" or "electro-plating" or "electro-less" or "electro-lessly" or "electro-form" or "electro-formed" or "electro-forming" or "electro-deposit" or "electro-deposited" or "electro-depositing" or "electro-deposition")) with (("220" or "[220]" or "{220}" or "(220)" or "<220>") with (texture or coefficient or index or Miller or hkl or "h,k, l"))) and (((peak near2 density) or PD.u/c.) with (surface or shiney or shiny or matt or matte or mat or matted))	FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2021/11/16 08:49
S91	1	S90 not S87	FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2021/11/16 08:49

EAST Search History (Prior Art)

S92	18	((Cu or copper or "cu-alloy" or "cu-base" or "Cu-based" or "copper-base" or "copper-based" or "copper-alloy") near5 (foil or foiled or foiling or tape or ribbon or layer or layered or layering or film or filmed or filming or clad or claded or cladded or clading or cladding or coat or coated or coating or electroplate or electroplated or electroplating or electroless or electrolessly or electroform or electroformed or electroforming or electrodeposit or electrodeposited or electrodepositing or electrodeposition or "electro-plate" or "electro-plated" or "electro-plating" or "electro-less" or "electro-lessly" or "electro-form" or "electro-formed" or "electro-forming" or "electro-deposit" or "electro-deposited" or "electro-depositing" or "electro-deposition")) near5 (((peak near2 density) or PD. u/c.) near5 (surface or shiney or shiny or matt or matte or mat or matted))	FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2021/11/16 08:51
S93	7	S92 not (S87 or S91)	FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2021/11/16 08:51

EAST Search History (Prior Art)

S94	20	((Cu or copper or "cu-alloy" or "cu-base" or "Cu-based" or "copper-base" or "copper-based" or "copper-alloy") with (foil or foiled or foiling or tape or ribbon or layer or layered or layering or film or filmed or filming or clad or claded or cladded or clading or cladding or coat or coated or coating or electroplate or electroplated or electroplating or electroless or electrolessly or electroform or electroformed or electroforming or electrodeposit or electrodeposited or electrodepositing or electrodeposition or "electro-plate" or "electro-plated" or "electro-plating" or "electro-less" or "electro-lessly" or "electro-form" or "electro-formed" or "electro-forming" or "electro-deposit" or "electro-deposited" or "electro-depositing" or "electro-deposition")) with (((peak near2 density) or PD. u/c.) near5 (surface or shiney or shiny or matt or matte or mat or matted))	FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2021/11/16 08:52
S95	1	S94 not (S87 or S91 or S93)	FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2021/11/16 08:52

EAST Search History (Prior Art)

S96	13	((Cu or copper or "cu-alloy" or "cu-base" or "Cu-based" or "copper-base" or "copper-based" or "copper-alloy") near5 (foil or foiled or foiling or tape or ribbon or layer or layered or layering or film or filmed or filming or clad or claded or cladded or clading or cladding or coat or coated or coating or electroplate or electroplated or electroplating or electroless or electrolessly or electroform or electroformed or electroforming or electrodeposit or electrodeposited or electrodepositing or electrodeposition or "electro-plate" or "electro-plated" or "electro-plating" or "electro-less" or "electro-lessly" or "electro-form" or "electro-formed" or "electro-forming" or "electro-deposit" or "electro-deposited" or "electro-depositing" or "electro-deposition")) near5 (((peak near2 density) or PD. u/c.) near5 (surface or shiney or shiny or matt or matte or mat or matted))	US-PGPUB; USPAT; USOCR	OR	ON	2021/11/16 08:52
S97	7	S96 not (S63 or S65 or S75 or S77 or S81 or S84)	US-PGPUB; USPAT; USOCR	OR	ON	2021/11/16 08:53

EAST Search History (Prior Art)

S98	16	((Cu or copper or "cu-alloy" or "cu-base" or "Cu-based" or "copper-base" or "copper-based" or "copper-alloy") near8 (foil or foiled or foiling or tape or ribbon or layer or layered or layering or film or filmed or filming or clad or claded or cladded or clading or cladding or coat or coated or coating or electroplate or electroplated or electroplating or electroless or electrolessly or electroform or electroformed or electroforming or electrodeposit or electrodeposited or electrodepositing or electrodeposition or "electro-plate" or "electro-plated" or "electro-plating" or "electro-less" or "electro-lessly" or "electro-form" or "electro-formed" or "electro-forming" or "electro-deposit" or "electro-deposited" or "electro-depositing" or "electro-deposition")) near8 (((peak near2 density) or PD. u/c.) near5 (surface or shiney or shiny or matt or matte or mat or matted))	US-PGPUB; USPAT; USOCR	OR	ON	2021/11/16 08:57
S99	3	S98 not (S63 or S65 or S75 or S77 or S81 or S84 or S97)	US-PGPUB; USPAT; USOCR	OR	ON	2021/11/16 08:57

EAST Search History (Prior Art)

S100	22	((Cu or copper or "cu-alloy" or "cu-base" or "Cu-based" or "copper-base" or "copper-based" or "copper-alloy") with (foil or foiled or foiling or tape or ribbon or layer or layered or layering or film or filmed or filming or clad or claded or cladded or clading or cladding or coat or coated or coating or electroplate or electroplated or electroplating or electroless or electrolessly or electroform or electroformed or electroforming or electrodeposit or electrodeposited or electrodepositing or electrodeposition or "electro-plate" or "electro-plated" or "electro-plating" or "electro-less" or "electro-lessly" or "electro-form" or "electro-formed" or "electro-forming" or "electro-deposit" or "electro-deposited" or "electro-depositing" or "electro-deposition")) with (((peak near2 density) or PD. u/c.) near5 (surface or shiney or shiny or matt or matte or mat or matted))	US-PGPUB; USPAT; USOCR	OR	ON	2021/11/16 08:59
S101	6	S100 not (S63 or S65 or S75 or S77 or S81 or S84 or S97 or S99)	US-PGPUB; USPAT; USOCR	OR	ON	2021/11/16 09:00

EAST Search History (Prior Art)

S102	30	(((Cu or copper or "cu-alloy" or "cu-base" or "Cu-based" or "copper-base" or "copper-based" or "copper-alloy") near5 (foil or foiled or foiling or tape or ribbon or layer or layered or layering or film or filmed or filming or clad or claded or cladded or clading or cladding or coat or coated or coating or electroplate or electroplated or electroplating or electroless or electrolessly or electroform or electroformed or electroforming or electrodeposit or electrodeposited or electrodepositing or electrodeposition or "electro-plate" or "electro-plated" or "electro-plating" or "electro-less" or "electro-lessly" or "electro-form" or "electro-formed" or "electro-forming" or "electro-deposit" or "electro-deposited" or "electro-depositing" or "electro-deposition")) near5 (("220" or "[220]" or "{220}" or "(220)" or "<220>") near5 (texture or coefficient or index or Miller or hkl or "h,k,l")))	FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2021/11/16 09:05

EAST Search History (Prior Art)

S103	41	(((Cu or copper or "cu-alloy" or "cu-base" or "Cu-based" or "copper-base" or "copper-based" or "copper-alloy") near5 (foil or foiled or foiling or tape or ribbon or layer or layered or layering or film or filmed or filming or clad or claded or cladded or clading or cladding or coat or coated or coating or electroplate or electroplated or electroplating or electroless or electrolessly or electroform or electroformed or electroforming or electrodeposit or electrodeposited or electrodepositing or electrodeposition or "electro-plate" or "electro-plated" or "electro-plating" or "electro-less" or "electro-lessly" or "electro-form" or "electro-formed" or "electro-forming" or "electro-deposit" or "electro-deposited" or "electro-depositing" or "electro-deposition")) near5 (("220" or "[220]" or "{220}" or "(220)" or "<220>") with (texture or coefficient or index or Miller or hkl or "h,k,l")))	FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2021/11/16 09:13
S104	13	S103 not S102	FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2021/11/16 09:14

EAST Search History (Prior Art)

S105	123	(((Cu or copper or "cu-alloy" or "cu-base" or "Cu-based" or "copper-base" or "copper-based" or "copper-alloy") with (foil or foiled or foiling or tape or ribbon or layer or layered or layering or film or filmed or filming or clad or claded or cladded or clading or cladding or coat or coated or coating or electroplate or electroplated or electroplating or electroless or electrolessly or electroform or electroformed or electroforming or electrodeposit or electrodeposited or electrodepositing or electrodeposition or "electro-plate" or "electro-plated" or "electro-plating" or "electro-less" or "electro-lessly" or "electro-form" or "electro-formed" or "electro-forming" or "electro-deposit" or "electro-deposited" or "electro-depositing" or "electro-deposition")) with (("220" or "[220]" or "{220}" or "(220)" or "<220>") with (texture or coefficient or index or Miller or hkl or "h,k, l")))	FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2021/11/16 09:19
S106	80	S105 not (S102 or S104)	FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2021/11/16 09:20
S107	1	("20180062199").did.	US-PGPUB; USPAT; USOCR	OR	ON	2021/11/16 09:45

EAST Search History (Prior Art)

S108	46	(((Cu or copper or "cu-alloy" or "cu-base" or "Cu-based" or "copper-base" or "copper-based" or "copper-alloy") near5 (foil or foiled or foiling or tape or ribbon or layer or layered or layering or film or filmed or filming or clad or claded or cladded or clading or cladding or coat or coated or coating or electroplate or electroplated or electroplating or electroless or electrolessly or electroform or electroformed or electroforming or electrodeposit or electrodeposited or electrodepositing or electrodeposition or "electro-plate" or "electro-plated" or "electro-plating" or "electro-less" or "electro-lessly" or "electro-form" or "electro-formed" or "electro-forming" or "electro-deposit" or "electro-deposited" or "electro-depositing" or "electro-deposition")) near5 (("220" or "[220]" or "{220}" or "(220)" or "<220>") near5 (texture or coefficient or index or Miller or hkl or "h,k,l")))	US-PGPUB; USPAT; USOCR	OR	ON	2021/11/16 09:49
S109	22	S108 not (S63 or S65 or S75 or S77 or S81 or S84 or S97 or S99 or S101)	US-PGPUB; USPAT; USOCR	OR	ON	2021/11/16 09:49

EAST Search History (Prior Art)

S110	58	(((Cu or copper or "cu-alloy" or "cu-base" or "Cu-based" or "copper-base" or "copper-based" or "copper-alloy") near8 (foil or foiled or foiling or tape or ribbon or layer or layered or layering or film or filmed or filming or clad or claded or cladded or clading or cladding or coat or coated or coating or electroplate or electroplated or electroplating or electroless or electrolessly or electroform or electroformed or electroforming or electrodeposit or electrodeposited or electrodepositing or electrodeposition or "electro-plate" or "electro-plated" or "electro-plating" or "electro-less" or "electro-lessly" or "electro-form" or "electro-formed" or "electro-forming" or "electro-deposit" or "electro-deposited" or "electro-depositing" or "electro-deposition")) near8 (("220" or "[220]" or "{220}" or "(220)" or "<220>") near8 (texture or coefficient or index or Miller or hkl or "h,k,l")))	US-PGPUB; USPAT; USOCR	OR	ON	2021/11/16 09:51
S111	10	S110 not (S63 or S65 or S75 or S77 or S81 or S84 or S97 or S99 or S101 or S109)	US-PGPUB; USPAT; USOCR	OR	ON	2021/11/16 09:52

EAST Search History (Prior Art)

S112	80	(((Cu or copper or "cu-alloy" or "cu-base" or "Cu-based" or "copper-base" or "copper-based" or "copper-alloy") near12 (foil or foiled or foiling or tape or ribbon or layer or layered or layering or film or filmed or filming or clad or claded or cladded or clading or cladding or coat or coated or coating or electroplate or electroplated or electroplating or electroless or electrolessly or electroform or electroformed or electroforming or electrodeposit or electrodeposited or electrodepositing or electrodeposition or "electro-plate" or "electro-plated" or "electro-plating" or "electro-less" or "electro-lessly" or "electro-form" or "electro-formed" or "electro-forming" or "electro-deposit" or "electro-deposited" or "electro-depositing" or "electro-deposition")) near12 (("220" or "[220]" or "{220}" or "(220)" or "<220>") near12 (texture or coefficient or index or Miller or hkl or "h,k,l")))	US-PGPUB; USPAT; USOCR	OR	ON	2021/11/16 09:53
S113	17	S112 not (S63 or S65 or S75 or S77 or S81 or S84 or S97 or S99 or S101 or S109 or S111)	US-PGPUB; USPAT; USOCR	OR	ON	2021/11/16 09:54
S114	12	((("JIN") near3 ("Shan") near3 ("Hua"))).INV.	US-PGPUB; USPAT; USOCR	OR	ON	2022/03/28 06:21
S115	22	((("LEE") near3 ("An") near3 ("Na"))).INV.	US-PGPUB; USPAT; USOCR	OR	ON	2022/03/28 06:21

EAST Search History (Prior Art)

S116	115	((("KIM") near3 ("Seung") near3 ("Min"))).INV.	US-PGPUB; USPAT; USOCR	OR	ON	2022/03/28 06:21
S117	389	((("JIN") near3 ("Shan" or Hua or "shanhua" or "shan-hua"))).INV.	US-PGPUB; USPAT; USOCR	OR	ON	2022/03/28 06:21
S118	981	((("LEE") near3 ("An" or Na or "An-Na"))).INV.	US-PGPUB; USPAT; USOCR	OR	ON	2022/03/28 06:21
S119	18,485	((("KIM") near3 ("Seung" or Min or "SeungMin" or "Seung-Min"))).INV.	US-PGPUB; USPAT; USOCR	OR	ON	2022/03/28 06:21
S120	49	((("JIN") near3 ("Shan" or Hua or "shanhua" or "shan-hua"))).aanm.	US-PGPUB; USPAT; USOCR	OR	ON	2022/03/28 06:21
S121	110	((("LEE") near3 ("An" or Na or "An-Na"))).aanm.	US-PGPUB; USPAT; USOCR	OR	ON	2022/03/28 06:21
S122	2,041	((("KIM") near3 ("Seung" or Min or "SeungMin" or "Seung-Min"))).aanm.	US-PGPUB; USPAT; USOCR	OR	ON	2022/03/28 06:21
S123	19,784	S114 or S115 or S116 or S117 or S118 or S119 or S120 or S121 or S122	US-PGPUB; USPAT; USOCR	OR	ON	2022/03/28 06:21

EAST Search History (Prior Art)

S124	2,017	S123 and ((Cu or copper or "cu-alloy" or "cu-base" or "Cu-based" or "copper-base" or "copper-based" or "copper-alloy") with (foil or foiled or foiling or tape or ribbon or layer or layered or layering or film or filmed or filming or clad or claded or cladded or clading or cladding or coat or coated or coating or electroplate or electroplated or electroplating or electroless or electrolessly or electroform or electroformed or electroforming or electrodeposit or electrodeposited or electrodepositing or electrodeposition or "electro-plate" or "electro-plated" or "electro-plating" or "electro-less" or "electro-lessly" or "electro-form" or "electro-formed" or "electro-forming" or "electro-deposit" or "electro-deposited" or "electro-depositing" or "electro-deposition"))	US-PGPUB; USPAT; USOCR	OR	ON	2022/03/28 06:21
S125	12	S124 and (("220" or "[220]" or "{220}" or "(220)" or "<220>") near5 (texture or coefficient or index or Miller or hkl or "h,k,l"))	US-PGPUB; USPAT; USOCR	OR	ON	2022/03/28 06:21
S126	58	((KCF) near3 (tech or technol or technology)).as,aanm.	US-PGPUB; USPAT; USOCR	OR	ON	2022/03/28 06:24
S127	50	S126 not S125	US-PGPUB; USPAT; USOCR	OR	ON	2022/03/28 06:24

EAST Search History (Prior Art)

S128	155,301	B32B15/01;C25D1/04;C25D3/38;C25D5/34,48;C25D21/06;H01M4/0404,13,66,661,667;H01M10/052,0525;H01M2004/027;Y02E60/10;Y10T428/12431,12438.cpc.	US-PGPUB; USPAT; USOCR	OR	ON	2022/03/28 06:27
S129	42,847	S128 and ((Cu or copper or "cu-alloy" or "cu-base" or "Cu-based" or "copper-base" or "copper-based" or "copper-alloy") near5 (foil or foiled or foiling or tape or ribbon or layer or layered or layering or film or filmed or filming or clad or claded or cladded or clading or cladding or coat or coated or coating or electroplate or electroplated or electroplating or electroless or electrolessly or electroform or electroformed or electroforming or electrodeposit or electrodeposited or electrodepositing or electrodeposition or "electro-plate" or "electro-plated" or "electro-plating" or "electro-less" or "electro-lessly" or "electro-form" or "electro-formed" or "electro-forming" or "electro-deposit" or "electro-deposited" or "electro-depositing" or "electro-deposition"))	US-PGPUB; USPAT; USOCR	OR	ON	2022/03/28 06:27
S130	82	S129 and (("220" or "[220]" or "{220}" or "(220)" or "<220>") near5 (texture or coefficient or index or Miller or hkl or "h,k,l"))	US-PGPUB; USPAT; USOCR	OR	ON	2022/03/28 06:27
S131	72	S130 not (S125 or S127)	US-PGPUB; USPAT; USOCR	OR	ON	2022/03/28 06:27

EAST Search History (Prior Art)

S132	91	S129 and (("220" or "[220]" or "{220}" or "(220)" or "<220>") near8 (texture or coefficient or index or Miller or hkl or "h,k,l"))	US-PGPUB; USPAT; USOCR	OR	ON	2022/03/28 06:30
S133	9	S132 not (S125 or S127 or S131)	US-PGPUB; USPAT; USOCR	OR	ON	2022/03/28 06:30
S134	35	S128 and (((Cu or copper or "cu-alloy" or "cu-base" or "Cu-based" or "copper-base" or "copper-based" or "copper-alloy") with (foil or foiled or foiling or tape or ribbon or layer or layered or layering or film or filmed or filming or clad or claded or cladded or clading or cladding or coat or coated or coating or electroplate or electroplated or electroplating or electroless or electrolessly or electroform or electroformed or electroforming or electrodeposit or electrodeposited or electrodepositing or electrodeposition or "electro-plate" or "electro-plated" or "electro-plating" or "electro-less" or "electro-lessly" or "electro-form" or "electro-formed" or "electro-forming" or "electro-deposit" or "electro-deposited" or "electro-depositing" or "electro-deposition")) with (("220" or "[220]" or "{220}" or "(220)" or "<220>") with (texture or coefficient or index or Miller or hkl or "h,k,l")))	US-PGPUB; USPAT; USOCR	OR	ON	2022/03/28 06:31
S135	2	S134 not (S125 or S127 or S131 or S133)	US-PGPUB; USPAT; USOCR	OR	ON	2022/03/28 06:31

EAST Search History (Prior Art)

S136	945,781	B32B15/01;C25D1/04;C25D3/38;C25D5/34,48;C25D21/06;H01M4/0404,13,66,661,667;H01M10/052,0525;H01M2004/027;Y02E60/10;Y10T428/12431,12438.cpc.	FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2022/03/28 06:37
S137	71	S136 and (((Cu or copper or "cu-alloy" or "cu-base" or "Cu-based" or "copper-base" or "copper-based" or "copper-alloy") with (foil or foiled or foiling or tape or ribbon or layer or layered or layering or film or filmed or filming or clad or claded or cladded or clading or cladding or coat or coated or coating or electroplate or electroplated or electroplating or electroless or electrolessly or electroform or electroformed or electroforming or electrodeposit or electrodeposited or electrodepositing or electrodeposition or "electro-plate" or "electro-plated" or "electro-plating" or "electro-less" or "electro-lessly" or "electro-form" or "electro-formed" or "electro-forming" or "electro-deposit" or "electro-deposited" or "electro-depositing" or "electro-deposition")) with (("220" or "[220]" or "{220}" or "(220)" or "<220>") with (texture or coefficient or index or Miller or hkl or "h,k,l")))	FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2022/03/28 06:37

S138	17,955	S136 and ((Cu or copper or "cu-alloy" or "cu-base" or "Cu-based" or "copper-base" or "copper-based" or "copper-alloy") near5 (foil or foiled or foiling or tape or ribbon or layer or layered or layering or film or filmed or filming or clad or claded or cladded or clading or cladding or coat or coated or coating or electroplate or electroplated or electroplating or electroless or electrolessly or electroform or electroformed or electroforming or electrodeposit or electrodeposited or electrodepositing or electrodeposition or "electro-plate" or "electro-plated" or "electro-plating" or "electro-less" or "electro-lessly" or "electro-form" or "electro-formed" or "electro-forming" or "electro-deposit" or "electro-deposited" or "electro-depositing" or "electro-deposition"))	FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2022/03/28 06:40
S139	65	S138 and (("220" or "[220]" or "{220}" or "(220)" or "<220>") near5 (texture or coefficient or index or Miller or hkl or "h,k,l"))	FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2022/03/28 06:40
S140	9	S139 not S137	FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2022/03/28 06:40
S141	80	S138 and (("220" or "[220]" or "{220}" or "(220)" or "<220>") with (texture or coefficient or index or Miller or hkl or "h,k,l"))	FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2022/03/28 06:43

EAST Search History (Prior Art)

S142	0	S141 not (S137 or S140)	FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2022/03/28 06:43
S143	22,247	S136 and ((Cu or copper or "cu-alloy" or "cu-base" or "Cu-based" or "copper-base" or "copper-based" or "copper-alloy") with (foil or foiled or foiling or tape or ribbon or layer or layered or layering or film or filmed or filming or clad or claded or cladded or clading or cladding or coat or coated or coating or electroplate or electroplated or electroplating or electroless or electrolessly or electroform or electroformed or electroforming or electrodeposit or electrodeposited or electrodepositing or electrodeposition or "electro-plate" or "electro-plated" or "electro-plating" or "electro-less" or "electro-lessly" or "electro-form" or "electro-formed" or "electro-forming" or "electro-deposit" or "electro-deposited" or "electro-depositing" or "electro-deposition"))	FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2022/03/28 06:43
S144	81	S143 and (("220" or "[220]" or "{220}" or "(220)" or "<220>") with (texture or coefficient or index or Miller or hkl or "h,k,l"))	FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2022/03/28 06:43
S145	1	S144 not (S137 or S140)	FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2022/03/28 06:43

EAST Search History (Prior Art)

S146	33	(((Cu or copper or "cu-alloy" or "cu-base" or "Cu-based" or "copper-base" or "copper-based" or "copper-alloy") near5 (foil or foiled or foiling or tape or ribbon or layer or layered or layering or film or filmed or filming or clad or claded or cladded or clading or cladding or coat or coated or coating or electroplate or electroplated or electroplating or electroless or electrolessly or electroform or electroformed or electroforming or electrodeposit or electrodeposited or electrodepositing or electrodeposition or "electro-plate" or "electro-plated" or "electro-plating" or "electro-less" or "electro-lessly" or "electro-form" or "electro-formed" or "electro-forming" or "electro-deposit" or "electro-deposited" or "electro-depositing" or "electro-deposition")) near5 (("220" or "[220]" or "{220}" or "(220)" or "<220>") near5 (texture or coefficient or index or Miller or hkl or "h,k,l")))	FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2022/03/28 06:44
S147	7	S146 not (S137 or S140 or S145)	FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2022/03/28 06:44

EAST Search History (Prior Art)

S148	133	(((Cu or copper or "cu-alloy" or "cu-base" or "Cu-based" or "copper-base" or "copper-based" or "copper-alloy") with (foil or foiled or foiling or tape or ribbon or layer or layered or layering or film or filmed or filming or clad or claded or cladded or clading or cladding or coat or coated or coating or electroplate or electroplated or electroplating or electroless or electrolessly or electroform or electroformed or electroforming or electrodeposit or electrodeposited or electrodepositing or electrodeposition or "electro-plate" or "electro-plated" or "electro-plating" or "electro-less" or "electro-lessly" or "electro-form" or "electro-formed" or "electro-forming" or "electro-deposit" or "electro-deposited" or "electro-depositing" or "electro-deposition")) with (("220" or "[220]" or "{220}" or "(220)" or "<220>") with (texture or coefficient or index or Miller or hkl or "h,k,l")))	FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2022/03/28 06:48
S149	55	S148 not (S137 or S140 or S145 or S147)	FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2022/03/28 06:48

EAST Search History (Prior Art)

S150	46	(((Cu or copper or "cu-alloy" or "cu-base" or "Cu-based" or "copper-base" or "copper-based" or "copper-alloy") near5 (foil or foiled or foiling or tape or ribbon or layer or layered or layering or film or filmed or filming or clad or claded or cladded or clading or cladding or coat or coated or coating or electroplate or electroplated or electroplating or electroless or electrolessly or electroform or electroformed or electroforming or electrodeposit or electrodeposited or electrodepositing or electrodeposition or "electro-plate" or "electro-plated" or "electro-plating" or "electro-less" or "electro-lessly" or "electro-form" or "electro-formed" or "electro-forming" or "electro-deposit" or "electro-deposited" or "electro-depositing" or "electro-deposition")) near5 (("220" or "[220]" or "{220}" or "(220)" or "<220>") near5 (texture or coefficient or index or Miller or hkl or "h,k,l")))	US-PGPUB; USPAT; USOCR	OR	ON	2022/03/28 06:51
S151	22	S150 not (S125 or S127 or S131 or S133 or S135)	US-PGPUB; USPAT; USOCR	OR	ON	2022/03/28 06:51

EAST Search History (Prior Art)

S152	117	(((Cu or copper or "cu-alloy" or "cu-base" or "Cu-based" or "copper-base" or "copper-based" or "copper-alloy") with (foil or foiled or foiling or tape or ribbon or layer or layered or layering or film or filmed or filming or clad or claded or cladded or clading or cladding or coat or coated or coating or electroplate or electroplated or electroplating or electroless or electrolessly or electroform or electroformed or electroforming or electrodeposit or electrodeposited or electrodepositing or electrodeposition or "electro-plate" or "electro-plated" or "electro-plating" or "electro-less" or "electro-lessly" or "electro-form" or "electro-formed" or "electro-forming" or "electro-deposit" or "electro-deposited" or "electro-depositing" or "electro-deposition")) with (("220" or "[220]" or "{220}" or "(220)" or "<220>") with (texture or coefficient or index or Miller or hkl or "h,k, l")))	US-PGPUB; USPAT; USOCR	OR	ON	2022/03/28 06:53
S153	60	S152 not (S125 or S127 or S131 or S133 or S135 or S151)	US-PGPUB; USPAT; USOCR	OR	ON	2022/03/28 06:53
S154	2	S136 and (("220" or "[220]" or "{220}" or "(220)" or "<220>") near5 (stress))	FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2022/03/28 06:59

EAST Search History (Prior Art)

S155	3	S136 and (("111" or "[111]" or "{111}" or "(111)" or "<111>") near5 (stress))	FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2022/03/28 07:01
S156	51	S136 and (("200" or "[200]" or "{200}" or "(200)" or "<200>") near5 (stress))	FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2022/03/28 07:07

EAST Search History (Prior Art)

S157	90	((Cu or copper or "cu-alloy" or "cu-base" or "Cu-based" or "copper-base" or "copper-based" or "copper-alloy") near5 (foil or foiled or foiling or tape or ribbon or layer or layered or layering or film or filmed or filming or clad or claded or cladded or clading or cladding or coat or coated or coating or electroplate or electroplated or electroplating or electroless or electrolessly or electroform or electroformed or electroforming or electrodeposit or electrodeposited or electrodepositing or electrodeposition or "electro-plate" or "electro-plated" or "electro-plating" or "electro-less" or "electro-lessly" or "electro-form" or "electro-formed" or "electro-forming" or "electro-deposit" or "electro-deposited" or "electro-depositing" or "electro-deposition")) and (("111" or "[111]" or "{111}" or "(111)" or "<111>" or "200" or "[200]" or "{200}" or "(200)" or "<200>" or "220" or "[220]" or "{220}" or "(220)" or "<220>" or "311" or "[311]" or "{311}" or "(311)" or "<311>") near5 (residual near2 stress))	US-PGPUB; USPAT; USOCR	OR	ON	2022/03/28 07:12

S158	130	((Cu or copper or "cu-alloy" or "cu-base" or "Cu-based" or "copper-base" or "copper-based" or "copper-alloy") near8 (foil or foiled or foiling or tape or ribbon or layer or layered or layering or film or filmed or filming or clad or claded or cladded or clading or cladding or coat or coated or coating or electroplate or electroplated or electroplating or electroless or electrolessly or electroform or electroformed or electroforming or electrodeposit or electrodeposited or electrodepositing or electrodeposition or "electro-plate" or "electro-plated" or "electro-plating" or "electro-less" or "electro-lessly" or "electro-form" or "electro-formed" or "electro-forming" or "electro-deposit" or "electro-deposited" or "electro-depositing" or "electro-deposition")) and (("111" or "[111]" or "{111}" or "(111)" or "<111>" or "200" or "[200]" or "{200}" or "(200)" or "<200>" or "220" or "[220]" or "{220}" or "(220)" or "<220>" or "311" or "[311]" or "{311}" or "(311)" or "<311>") near8 (residual near2 stress))	US-PGPUB; USPAT; USOCR	OR	ON	2022/03/28 07:24
S159	40	S158 not S157	US-PGPUB; USPAT; USOCR	OR	ON	2022/03/28 07:24

EAST Search History (Prior Art)

S160	261	((Cu or copper or "cu-alloy" or "cu-base" or "Cu-based" or "copper-base" or "copper-based" or "copper-alloy") with (foil or foiled or foiling or tape or ribbon or layer or layered or layering or film or filmed or filming or clad or claded or cladded or clading or cladding or coat or coated or coating or electroplate or electroplated or electroplating or electroless or electrolessly or electroform or electroformed or electroforming or electrodeposit or electrodeposited or electrodepositing or electrodeposition or "electro-plate" or "electro-plated" or "electro-plating" or "electro-less" or "electro-lessly" or "electro-form" or "electro-formed" or "electro-forming" or "electro-deposit" or "electro-deposited" or "electro-depositing" or "electro-deposition")) and (("111" or "[111]" or "{111}" or "(111)" or "<111>" or "200" or "[200]" or "{200}" or "(200)" or "<200>" or "220" or "[220]" or "{220}" or "(220)" or "<220>" or "311" or "[311]" or "{311}" or "(311)" or "<311>") with (residual near2 stress))	US-PGPUB; USPAT; USOCR	OR	ON	2022/03/28 07:25
S161	131	S160 not (S157 or S159)	US-PGPUB; USPAT; USOCR	OR	ON	2022/03/28 07:25

S162	24	((Cu or copper or "cu-alloy" or "cu-base" or "Cu-based" or "copper-base" or "copper-based" or "copper-alloy") with (foil or foiled or foiling or tape or ribbon or layer or layered or layering or film or filmed or filming or clad or claded or cladded or clading or cladding or coat or coated or coating or electroplate or electroplated or electroplating or electroless or electrolessly or electroform or electroformed or electroforming or electrodeposit or electrodeposited or electrodepositing or electrodeposition or "electro-plate" or "electro-plated" or "electro-plating" or "electro-less" or "electro-lessly" or "electro-form" or "electro-formed" or "electro-forming" or "electro-deposit" or "electro-deposited" or "electro-depositing" or "electro-deposition")) and (("111" or "[111]" or "{111}" or "(111)" or "<111>" or "200" or "[200]" or "{200}" or "(200)" or "<200>" or "220" or "[220]" or "{220}" or "(220)" or "<220>" or "311" or "[311]" or "{311}" or "(311)" or "<311>") with (residual near2 stress))	FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2022/03/28 07:32
S163	12	((("JIN") near3 ("Shan") near3 ("Hua"))).INV.	US-PGPUB; USPAT; USOCR	OR	ON	2022/03/28 07:35
S164	22	((("LEE") near3 ("An") near3 ("Na"))).INV.	US-PGPUB; USPAT; USOCR	OR	ON	2022/03/28 07:35

EAST Search History (Prior Art)

S165	115	((("KIM") near3 ("Seung") near3 ("Min"))).INV.	US-PGPUB; USPAT; USOCR	OR	ON	2022/03/28 07:35
S166	389	((("JIN") near3 ("Shan" or Hua or "shanhua" or "shan-hua"))).INV.	US-PGPUB; USPAT; USOCR	OR	ON	2022/03/28 07:35
S167	981	((("LEE") near3 ("An" or Na or "An-Na"))).INV.	US-PGPUB; USPAT; USOCR	OR	ON	2022/03/28 07:35
S168	18,485	((("KIM") near3 ("Seung" or Min or "SeungMin" or "Seung-Min"))).INV.	US-PGPUB; USPAT; USOCR	OR	ON	2022/03/28 07:35
S169	49	((("JIN") near3 ("Shan" or Hua or "shanhua" or "shan-hua"))).aanm.	US-PGPUB; USPAT; USOCR	OR	ON	2022/03/28 07:35
S170	110	((("LEE") near3 ("An" or Na or "An-Na"))).aanm.	US-PGPUB; USPAT; USOCR	OR	ON	2022/03/28 07:35
S171	2,041	((("KIM") near3 ("Seung" or Min or "SeungMin" or "Seung-Min"))).aanm.	US-PGPUB; USPAT; USOCR	OR	ON	2022/03/28 07:35
S172	19,784	S163 or S164 or S165 or S166 or S167 or S168 or S169 or S170 or S171	US-PGPUB; USPAT; USOCR	OR	ON	2022/03/28 07:35

S173	2,017	S172 and ((Cu or copper or "cu-alloy" or "cu-base" or "Cu-based" or "copper-base" or "copper-based" or "copper-alloy") with (foil or foiled or foiling or tape or ribbon or layer or layered or layering or film or filmed or filming or clad or claded or cladded or clading or cladding or coat or coated or coating or electroplate or electroplated or electroplating or electroless or electrolessly or electroform or electroformed or electroforming or electrodeposit or electrodeposited or electrodepositing or electrodeposition or "electro-plate" or "electro-plated" or "electro-plating" or "electro-less" or "electro-lessly" or "electro-form" or "electro-formed" or "electro-forming" or "electro-deposit" or "electro-deposited" or "electro-depositing" or "electro-deposition"))	US-PGPUB; USPAT; USOCR	OR	ON	2022/03/28 07:35
S174	12	S173 and (("220" or "[220]" or "{220}" or "(220)" or "<220>") near5 (texture or coefficient or index or Miller or hkl or "h,k,l"))	US-PGPUB; USPAT; USOCR	OR	ON	2022/03/28 07:35
S175	58	((KCF) near3 (tech or technol or technology)).as,aanm.	US-PGPUB; USPAT; USOCR	OR	ON	2022/03/28 07:37
S176	50	S175 not S174	US-PGPUB; USPAT; USOCR	OR	ON	2022/03/28 07:37

EAST Search History (Prior Art)

S177	155,937	B32B15/01;C25D1/04;C25D3/38;C25D5/34,48;C25D7/0614;C25D21/06;H01M4/0404,13,66,661,667;H01M10/052,0525;H01M2004/027;Y02E60/10;Y10T428/12431,12438.cpc.	US-PGPUB; USPAT; USOCR	OR	ON	2022/03/28 07:40
S178	42,990	S177 and ((Cu or copper or "cu-alloy" or "cu-base" or "Cu-based" or "copper-base" or "copper-based" or "copper-alloy") near5 (foil or foiled or foiling or tape or ribbon or layer or layered or layering or film or filmed or filming or clad or claded or cladded or clading or cladding or coat or coated or coating or electroplate or electroplated or electroplating or electroless or electrolessly or electroform or electroformed or electroforming or electrodeposit or electrodeposited or electrodepositing or electrodeposition or "electro-plate" or "electro-plated" or "electro-plating" or "electro-less" or "electro-lessly" or "electro-form" or "electro-formed" or "electro-forming" or "electro-deposit" or "electro-deposited" or "electro-depositing" or "electro-deposition"))	US-PGPUB; USPAT; USOCR	OR	ON	2022/03/28 07:40
S179	82	S178 and (("220" or "[220]" or "{220}" or "(220)" or "<220>") near5 (texture or coefficient or index or Miller or hkl or "h,k,l"))	US-PGPUB; USPAT; USOCR	OR	ON	2022/03/28 07:40
S180	73	S179 not (S172 or S174)	US-PGPUB; USPAT; USOCR	OR	ON	2022/03/28 07:40

EAST Search History (Prior Art)

S181	91	S178 and (("220" or "[220]" or "{220}" or "(220)" or "<220>") near8 (texture or coefficient or index or Miller or hkl or "h,k,l"))	US-PGPUB; USPAT; USOCR	OR	ON	2022/03/28 07:45
S182	9	S181 not (S172 or S174 or S180)	US-PGPUB; USPAT; USOCR	OR	ON	2022/03/28 07:45
S183	147	S178 and (("220" or "[220]" or "{220}" or "(220)" or "<220>") with (texture or coefficient or index or Miller or hkl or "h,k,l"))	US-PGPUB; USPAT; USOCR	OR	ON	2022/03/28 07:48
S184	55	S183 not (S172 or S174 or S180 or S182)	US-PGPUB; USPAT; USOCR	OR	ON	2022/03/28 07:48
S185	447	S178 and ((peak near2 density) or PD.u/c.)	US-PGPUB; USPAT; USOCR	OR	ON	2022/03/28 07:53
S186	37	S178 and (((peak near2 density) or PD.u/c.) near5 (surface))	US-PGPUB; USPAT; USOCR	OR	ON	2022/03/28 07:55
S187	54	S177 and (((peak near2 density) or PD.u/c.) near5 (surface or shiney or shiny or matt or matte or mat or matted))	US-PGPUB; USPAT; USOCR	OR	ON	2022/03/28 07:59
S188	17	S187 not (S172 or S174 or S180 or S182 or S186)	US-PGPUB; USPAT; USOCR	OR	ON	2022/03/28 07:59
S189	948,740	B32B15/01;C25D1/04;C25D3/38;C25D5/34,48;C25D7/0614;C25D21/06;H01M4/0404,13,66,661,667;H01M10/052,0525;H01M2004/027;Y02E60/10;Y10T428/12431,12438.cpc.	FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2022/03/28 08:01

EAST Search History (Prior Art)

S190	71	S189 and (((Cu or copper or "cu-alloy" or "cu-base" or "Cu-based" or "copper-base" or "copper-based" or "copper-alloy") with (foil or foiled or foiling or tape or ribbon or layer or layered or layering or film or filmed or filming or clad or claded or cladded or clading or cladding or coat or coated or coating or electroplate or electroplated or electroplating or electroless or electrolessly or electroform or electroformed or electroforming or electrodeposit or electrodeposited or electrodepositing or electrodeposition or "electro-plate" or "electro-plated" or "electro-plating" or "electro-less" or "electro-lessly" or "electro-form" or "electro-formed" or "electro-forming" or "electro-deposit" or "electro-deposited" or "electro-depositing" or "electro-deposition")) with (("220" or "[220]" or "{220}" or "(220)" or "<220>") with (texture or coefficient or index or Miller or hkl or "h,k,l")))	FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2022/03/28 08:01
S191	20	S189 and (((peak near2 density) or PD.u/c.) near5 (surface or shiney or shiny or matt or matte or mat or matted))	FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2022/03/28 08:05

EAST Search History (Prior Art)

S192	15	(((Cu or copper or "cu-alloy" or "cu-base" or "Cu-based" or "copper-base" or "copper-based" or "copper-alloy") with (foil or foiled or foiling or tape or ribbon or layer or layered or layering or film or filmed or filming or clad or claded or cladded or clading or cladding or coat or coated or coating or electroplate or electroplated or electroplating or electroless or electrolessly or electroform or electroformed or electroforming or electrodeposit or electrodeposited or electrodepositing or electrodeposition or "electro-plate" or "electro-plated" or "electro-plating" or "electro-less" or "electro-lessly" or "electro-form" or "electro-formed" or "electro-forming" or "electro-deposit" or "electro-deposited" or "electro-depositing" or "electro-deposition")) with (("220" or "[220]" or "{220}" or "(220)" or "<220>") with (texture or coefficient or index or Miller or hkl or "h,k, l"))) and (((peak near2 density) or PD.u/c.) near5 (surface or shiney or shiny or matt or matte or mat or matted))	FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2022/03/28 08:11
S193	0	S192 not S191	FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2022/03/28 08:11

EAST Search History (Prior Art)

S194	16	(((Cu or copper or "cu-alloy" or "cu-base" or "Cu-based" or "copper-base" or "copper-based" or "copper-alloy") with (foil or foiled or foiling or tape or ribbon or layer or layered or layering or film or filmed or filming or clad or claded or cladded or clading or cladding or coat or coated or coating or electroplate or electroplated or electroplating or electroless or electrolessly or electroform or electroformed or electroforming or electrodeposit or electrodeposited or electrodepositing or electrodeposition or "electro-plate" or "electro-plated" or "electro-plating" or "electro-less" or "electro-lessly" or "electro-form" or "electro-formed" or "electro-forming" or "electro-deposit" or "electro-deposited" or "electro-depositing" or "electro-deposition")) with (("220" or "[220]" or "{220}" or "(220)" or "<220>") with (texture or coefficient or index or Miller or hkl or "h,k, l"))) and (((peak near2 density) or PD.u/c.) with (surface or shiney or shiny or matt or matte or mat or matted))	FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2022/03/28 08:11
S195	1	S194 not S191	FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2022/03/28 08:11

EAST Search History (Prior Art)

S196	22	((Cu or copper or "cu-alloy" or "cu-base" or "Cu-based" or "copper-base" or "copper-based" or "copper-alloy") near5 (foil or foiled or foiling or tape or ribbon or layer or layered or layering or film or filmed or filming or clad or claded or cladded or clading or cladding or coat or coated or coating or electroplate or electroplated or electroplating or electroless or electrolessly or electroform or electroformed or electroforming or electrodeposit or electrodeposited or electrodepositing or electrodeposition or "electro-plate" or "electro-plated" or "electro-plating" or "electro-less" or "electro-lessly" or "electro-form" or "electro-formed" or "electro-forming" or "electro-deposit" or "electro-deposited" or "electro-depositing" or "electro-deposition")) near5 (((peak near2 density) or PD. u/c.) near5 (surface or shiney or shiny or matt or matte or mat or matted))	FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2022/03/28 08:12
S197	7	S196 not (S191 or S195)	FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2022/03/28 08:12

EAST Search History (Prior Art)

S198	24	((Cu or copper or "cu-alloy" or "cu-base" or "Cu-based" or "copper-base" or "copper-based" or "copper-alloy") with (foil or foiled or foiling or tape or ribbon or layer or layered or layering or film or filmed or filming or clad or claded or cladded or clading or cladding or coat or coated or coating or electroplate or electroplated or electroplating or electroless or electrolessly or electroform or electroformed or electroforming or electrodeposit or electrodeposited or electrodepositing or electrodeposition or "electro-plate" or "electro-plated" or "electro-plating" or "electro-less" or "electro-lessly" or "electro-form" or "electro-formed" or "electro-forming" or "electro-deposit" or "electro-deposited" or "electro-depositing" or "electro-deposition")) with (((peak near2 density) or PD. u/c.) near5 (surface or shiney or shiny or matt or matte or mat or matted))	FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2022/03/28 08:16
S199	1	S198 not (S191 or S195 or S197)	FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2022/03/28 08:16

EAST Search History (Prior Art)

S200	13	((Cu or copper or "cu-alloy" or "cu-base" or "Cu-based" or "copper-base" or "copper-based" or "copper-alloy") near5 (foil or foiled or foiling or tape or ribbon or layer or layered or layering or film or filmed or filming or clad or claded or cladded or clading or cladding or coat or coated or coating or electroplate or electroplated or electroplating or electroless or electrolessly or electroform or electroformed or electroforming or electrodeposit or electrodeposited or electrodepositing or electrodeposition or "electro-plate" or "electro-plated" or "electro-plating" or "electro-less" or "electro-lessly" or "electro-form" or "electro-formed" or "electro-forming" or "electro-deposit" or "electro-deposited" or "electro-depositing" or "electro-deposition")) near5 (((peak near2 density) or PD. u/c.) near5 (surface or shiney or shiny or matt or matte or mat or matted))	US-PGPUB; USPAT; USOCR	OR	ON	2022/03/28 08:16
S201	7	S200 not (S172 or S174 or S180 or S182 or S186 or S188)	US-PGPUB; USPAT; USOCR	OR	ON	2022/03/28 08:16

EAST Search History (Prior Art)

S202	16	((Cu or copper or "cu-alloy" or "cu-base" or "Cu-based" or "copper-base" or "copper-based" or "copper-alloy") near8 (foil or foiled or foiling or tape or ribbon or layer or layered or layering or film or filmed or filming or clad or claded or cladded or clading or cladding or coat or coated or coating or electroplate or electroplated or electroplating or electroless or electrolessly or electroform or electroformed or electroforming or electrodeposit or electrodeposited or electrodepositing or electrodeposition or "electro-plate" or "electro-plated" or "electro-plating" or "electro-less" or "electro-lessly" or "electro-form" or "electro-formed" or "electro-forming" or "electro-deposit" or "electro-deposited" or "electro-depositing" or "electro-deposition")) near8 (((peak near2 density) or PD. u/c.) near5 (surface or shiney or shiny or matt or matte or mat or matted))	US-PGPUB; USPAT; USOCR	OR	ON	2022/03/28 08:19
S203	3	S202 not (S172 or S174 or S180 or S182 or S186 or S188 or S201)	US-PGPUB; USPAT; USOCR	OR	ON	2022/03/28 08:19

EAST Search History (Prior Art)

S204	22	((Cu or copper or "cu-alloy" or "cu-base" or "Cu-based" or "copper-base" or "copper-based" or "copper-alloy") with (foil or foiled or foiling or tape or ribbon or layer or layered or layering or film or filmed or filming or clad or claded or cladded or clading or cladding or coat or coated or coating or electroplate or electroplated or electroplating or electroless or electrolessly or electroform or electroformed or electroforming or electrodeposit or electrodeposited or electrodepositing or electrodeposition or "electro-plate" or "electro-plated" or "electro-plating" or "electro-less" or "electro-lessly" or "electro-form" or "electro-formed" or "electro-forming" or "electro-deposit" or "electro-deposited" or "electro-depositing" or "electro-deposition")) with (((peak near2 density) or PD. u/c.) near5 (surface or shiney or shiny or matt or matte or mat or matted))	US-PGPUB; USPAT; USOCR	OR	ON	2022/03/28 08:23
S205	6	S204 not (S172 or S174 or S180 or S182 or S186 or S188 or S201 or S203)	US-PGPUB; USPAT; USOCR	OR	ON	2022/03/28 08:23

EAST Search History (Prior Art)

S206	33	(((Cu or copper or "cu-alloy" or "cu-base" or "Cu-based" or "copper-base" or "copper-based" or "copper-alloy") near5 (foil or foiled or foiling or tape or ribbon or layer or layered or layering or film or filmed or filming or clad or claded or cladded or clading or cladding or coat or coated or coating or electroplate or electroplated or electroplating or electroless or electrolessly or electroform or electroformed or electroforming or electrodeposit or electrodeposited or electrodepositing or electrodeposition or "electro-plate" or "electro-plated" or "electro-plating" or "electro-less" or "electro-lessly" or "electro-form" or "electro-formed" or "electro-forming" or "electro-deposit" or "electro-deposited" or "electro-depositing" or "electro-deposition")) near5 (("220" or "[220]" or "{220}" or "(220)" or "<220>") near5 (texture or coefficient or index or Miller or hkl or "h,k,l")))	FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2022/03/28 08:24

EAST Search History (Prior Art)

S207	45	(((Cu or copper or "cu-alloy" or "cu-base" or "Cu-based" or "copper-base" or "copper-based" or "copper-alloy") near5 (foil or foiled or foiling or tape or ribbon or layer or layered or layering or film or filmed or filming or clad or claded or cladded or clading or cladding or coat or coated or coating or electroplate or electroplated or electroplating or electroless or electrolessly or electroform or electroformed or electroforming or electrodeposit or electrodeposited or electrodepositing or electrodeposition or "electro-plate" or "electro-plated" or "electro-plating" or "electro-less" or "electro-lessly" or "electro-form" or "electro-formed" or "electro-forming" or "electro-deposit" or "electro-deposited" or "electro-depositing" or "electro-deposition")) near5 (("220" or "[220]" or "{220}" or "(220)" or "<220>") with (texture or coefficient or index or Miller or hkl or "h,k, l")))	FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2022/03/28 08:25
S208	14	S207 not S206	FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2022/03/28 08:25

EAST Search History (Prior Art)

S209	133	(((Cu or copper or "cu-alloy" or "cu-base" or "Cu-based" or "copper-base" or "copper-based" or "copper-alloy") with (foil or foiled or foiling or tape or ribbon or layer or layered or layering or film or filmed or filming or clad or claded or cladded or clading or cladding or coat or coated or coating or electroplate or electroplated or electroplating or electroless or electrolessly or electroform or electroformed or electroforming or electrodeposit or electrodeposited or electrodepositing or electrodeposition or "electro-plate" or "electro-plated" or "electro-plating" or "electro-less" or "electro-lessly" or "electro-form" or "electro-formed" or "electro-forming" or "electro-deposit" or "electro-deposited" or "electro-depositing" or "electro-deposition")) with (("220" or "[220]" or "{220}" or "(220)" or "<220>") with (texture or coefficient or index or Miller or hkl or "h,k,l")))	FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2022/03/28 08:26
S210	86	S209 not (S206 or S208)	FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2022/03/28 08:26

EAST Search History (Prior Art)

S211	46	(((Cu or copper or "cu-alloy" or "cu-base" or "Cu-based" or "copper-base" or "copper-based" or "copper-alloy") near5 (foil or foiled or foiling or tape or ribbon or layer or layered or layering or film or filmed or filming or clad or claded or cladded or clading or cladding or coat or coated or coating or electroplate or electroplated or electroplating or electroless or electrolessly or electroform or electroformed or electroforming or electrodeposit or electrodeposited or electrodepositing or electrodeposition or "electro-plate" or "electro-plated" or "electro-plating" or "electro-less" or "electro-lessly" or "electro-form" or "electro-formed" or "electro-forming" or "electro-deposit" or "electro-deposited" or "electro-depositing" or "electro-deposition")) near5 (("220" or "[220]" or "{220}" or "(220)" or "<220>") near5 (texture or coefficient or index or Miller or hkl or "h,k,l")))	US-PGPUB; USPAT; USOCR	OR	ON	2022/03/28 08:30
S212	22	S211 not (S172 or S174 or S180 or S182 or S186 or S188 or S201 or S203 or S205)	US-PGPUB; USPAT; USOCR	OR	ON	2022/03/28 08:30

EAST Search History (Prior Art)

S213	58	(((Cu or copper or "cu-alloy" or "cu-base" or "Cu-based" or "copper-base" or "copper-based" or "copper-alloy") near8 (foil or foiled or foiling or tape or ribbon or layer or layered or layering or film or filmed or filming or clad or claded or cladded or clading or cladding or coat or coated or coating or electroplate or electroplated or electroplating or electroless or electrolessly or electroform or electroformed or electroforming or electrodeposit or electrodeposited or electrodepositing or electrodeposition or "electro-plate" or "electro-plated" or "electro-plating" or "electro-less" or "electro-lessly" or "electro-form" or "electro-formed" or "electro-forming" or "electro-deposit" or "electro-deposited" or "electro-depositing" or "electro-deposition")) near8 (("220" or "[220]" or "{220}" or "(220)" or "<220>") near8 (texture or coefficient or index or Miller or hkl or "h,k,l")))	US-PGPUB; USPAT; USOCR	OR	ON	2022/03/28 08:33
S214	10	S213 not (S172 or S174 or S180 or S182 or S186 or S188 or S201 or S203 or S205 or S212)	US-PGPUB; USPAT; USOCR	OR	ON	2022/03/28 08:33

EAST Search History (Prior Art)

S215	80	(((Cu or copper or "cu-alloy" or "cu-base" or "Cu-based" or "copper-base" or "copper-based" or "copper-alloy") near12 (foil or foiled or foiling or tape or ribbon or layer or layered or layering or film or filmed or filming or clad or claded or cladded or clading or cladding or coat or coated or coating or electroplate or electroplated or electroplating or electroless or electrolessly or electroform or electroformed or electroforming or electrodeposit or electrodeposited or electrodepositing or electrodeposition or "electro-plate" or "electro-plated" or "electro-plating" or "electro-less" or "electro-lessly" or "electro-form" or "electro-formed" or "electro-forming" or "electro-deposit" or "electro-deposited" or "electro-depositing" or "electro-deposition")) near12 (("220" or "[220]" or "{220}" or "(220)" or "<220>") near12 (texture or coefficient or index or Miller or hkl or "h,k,l")))	US-PGPUB; USPAT; USOCR	OR	ON	2022/03/28 08:34
S216	17	S215 not (S172 or S174 or S180 or S182 or S186 or S188 or S201 or S203 or S205 or S212 or S214)	US-PGPUB; USPAT; USOCR	OR	ON	2022/03/28 08:34
S234	1	"10158119".did.	US-PGPUB; USPAT; USOCR	OR	ON	2022/03/31 06:54
S235	15	((("JIN") near3 ("Shan") near3 ("Hua"))).INV.	US-PGPUB; USPAT; USOCR	OR	ON	2022/07/06 08:29

EAST Search History (Prior Art)

S236	24	((("LEE") near3 ("An") near3 ("Na"))).INV.	US-PGPUB; USPAT; USOCR	OR	ON	2022/07/06 08:29
S237	123	((("KIM") near3 ("Seung") near3 ("Min"))).INV.	US-PGPUB; USPAT; USOCR	OR	ON	2022/07/06 08:29
S238	395	((("JIN") near3 ("Shan" or Hua or "shanhua" or "shan-hua"))).INV.	US-PGPUB; USPAT; USOCR	OR	ON	2022/07/06 08:29
S239	1,005	((("LEE") near3 ("An" or Na or "An-Na"))).INV.	US-PGPUB; USPAT; USOCR	OR	ON	2022/07/06 08:29
S240	18,961	((("KIM") near3 ("Seung" or Min or "SeungMin" or "Seung-Min"))).INV.	US-PGPUB; USPAT; USOCR	OR	ON	2022/07/06 08:29
S241	49	((("JIN") near3 ("Shan" or Hua or "shanhua" or "shan-hua"))).aanm.	US-PGPUB; USPAT; USOCR	OR	ON	2022/07/06 08:29
S242	110	((("LEE") near3 ("An" or Na or "An-Na"))).aanm.	US-PGPUB; USPAT; USOCR	OR	ON	2022/07/06 08:29
S243	2,048	((("KIM") near3 ("Seung" or Min or "SeungMin" or "Seung-Min"))).aanm.	US-PGPUB; USPAT; USOCR	OR	ON	2022/07/06 08:29
S244	20,286	S235 or S236 or S237 or S238 or S239 or S240 or S241 or S242 or S243	US-PGPUB; USPAT; USOCR	OR	ON	2022/07/06 08:29

EAST Search History (Prior Art)

S245	2,103	S244 and ((Cu or copper or "cu-alloy" or "cu-base" or "Cu-based" or "copper-base" or "copper-based" or "copper-alloy") with (foil or foiled or foiling or tape or ribbon or layer or layered or layering or film or filmed or filming or clad or claded or cladded or clading or cladding or coat or coated or coating or electroplate or electroplated or electroplating or electroless or electrolessly or electroform or electroformed or electroforming or electrodeposit or electrodeposited or electrodepositing or electrodeposition or "electro-plate" or "electro-plated" or "electro-plating" or "electro-less" or "electro-lessly" or "electro-form" or "electro-formed" or "electro-forming" or "electro-deposit" or "electro-deposited" or "electro-depositing" or "electro-deposition"))	US-PGPUB; USPAT; USOCR	OR	ON	2022/07/06 08:29
S246	17	S245 and (("220" or "[220]" or "{220}" or "(220)" or "<220>") near5 (texture or coefficient or index or Miller or hkl or "h,k,l"))	US-PGPUB; USPAT; USOCR	OR	ON	2022/07/06 08:29
S247	63	((KCF) near3 (tech or technol or technology)).as,aanm.	US-PGPUB; USPAT; USOCR	OR	ON	2022/07/06 08:37
S248	53	S247 not S246	US-PGPUB; USPAT; USOCR	OR	ON	2022/07/06 08:37

EAST Search History (Interference)

EAST Search History (Interference)

Ref #	Hits	Search Query	DBs	Default Operator	Plurals	Time Stamp
S217	146,924	B32B15/01;C25D1/04;C25D3/38;C25D5/34,48;C25D21/06;H01M4/0404,13,66,661,667;H01M10/052,0525;H01M2004/027;Y02E60/10;Y10T428/12431,12438.cpc.	US-PGPUB; USPAT	OR	ON	2022/03/28 08:42
S218	14	S217 and ((((Cu or copper or "cu-alloy" or "cu-base" or "Cu-based" or "copper-base" or "copper-based" or "copper-alloy") near5 (foil or foiled or foiling or tape or ribbon or layer or layered or layering or film or filmed or filming or clad or claded or cladded or clading or cladding or coat or coated or coating or electroplate or electroplated or electroplating or electroless or electrolessly or electroform or electroformed or electroforming or electrodeposit or electrodeposited or electrodepositing or electrodeposition or "electro-plate" or "electro-plated" or "electro-plating" or "electro-less" or "electro-lessly" or "electro-form" or "electro-formed" or "electro-forming" or "electro-deposit" or "electro-deposited" or "electro-depositing" or "electro-deposition")) near5 (("220" or "[220]" or "{220}" or "(220)" or "<220>") near5 (texture or coefficient or index or Miller or hkl or "h,k,l"))))).clm.	US-PGPUB; USPAT	OR	ON	2022/03/28 08:42

EAST Search History (Interference)

S219	17	S217 and ((((Cu or copper or "cu-alloy" or "cu-base" or "Cu-based" or "copper-base" or "copper-based" or "copper-alloy") near8 (foil or foiled or foiling or tape or ribbon or layer or layered or layering or film or filmed or filming or clad or claded or cladded or clading or cladding or coat or coated or coating or electroplate or electroplated or electroplating or electroless or electrolessly or electroform or electroformed or electroforming or electrodeposit or electrodeposited or electrodepositing or electrodeposition or "electro-plate" or "electro-plated" or "electro-plating" or "electro-less" or "electro-lessly" or "electro-form" or "electro-formed" or "electro-forming" or "electro-deposit" or "electro-deposited" or "electro-depositing" or "electro-deposition")) near8 (("220" or "[220]" or "{220}" or "(220)" or "<220>") near5 (texture or coefficient or index or Miller or hkl or "h,k, l")))).clm.	US-PGPUB; USPAT	OR	ON	2022/03/28 08:45
S220	3	S219 not S218	US-PGPUB; USPAT	OR	ON	2022/03/28 08:45

EAST Search History (Interference)

S221	3	S217 and (((Cu or copper or "cu-alloy" or "cu-base" or "Cu-based" or "copper-base" or "copper-based" or "copper-alloy") with (foil or foiled or foiling or tape or ribbon or layer or layered or layering or film or filmed or filming or clad or claded or cladded or clading or cladding or coat or coated or coating or electroplate or electroplated or electroplating or electroless or electrolessly or electroform or electroformed or electroforming or electrodeposit or electrodeposited or electrodepositing or electrodeposition or "electro-plate" or "electro-plated" or "electro-plating" or "electro-less" or "electro-lessly" or "electro-form" or "electro-formed" or "electro-forming" or "electro-deposit" or "electro-deposited" or "electro-depositing" or "electro-deposition")) with (((peak near2 density) or PD. u/c.) near5 (surface or shiney or shiny or matt or matte or mat or matted))).clm.	US-PGPUB; USPAT	OR	ON	2022/03/28 08:46
S222	0	S221 not (S218 or S220)	US-PGPUB; USPAT	OR	ON	2022/03/28 08:46

EAST Search History (Interference)

S223	7	S217 and (((Cu or copper or "cu-alloy" or "cu-base" or "Cu-based" or "copper-base" or "copper-based" or "copper-alloy") with (foil or foiled or foiling or tape or ribbon or layer or layered or layering or film or filmed or filming or clad or claded or cladded or clading or cladding or coat or coated or coating or electroplate or electroplated or electroplating or electroless or electrolessly or electroform or electroformed or electroforming or electrodeposit or electrodeposited or electrodepositing or electrodeposition or "electro-plate" or "electro-plated" or "electro-plating" or "electro-less" or "electro-lessly" or "electro-form" or "electro-formed" or "electro-forming" or "electro-deposit" or "electro-deposited" or "electro-depositing" or "electro-deposition")) with (((peak near2 density) or PD. u/c.) with (surface or shiney or shiny or matt or matte or mat or matted))).clm.	US-PGPUB; USPAT	OR	ON	2022/03/28 08:46
S224	3	S223 not (S218 or S220)	US-PGPUB; USPAT	OR	ON	2022/03/28 08:47

EAST Search History (Interference)

S225	14	((((Cu or copper or "cu-alloy" or "cu-base" or "Cu-based" or "copper-base" or "copper-based" or "copper-alloy") near5 (foil or foiled or foiling or tape or ribbon or layer or layered or layering or film or filmed or filming or clad or claded or cladded or clading or cladding or coat or coated or coating or electroplate or electroplated or electroplating or electroless or electrolessly or electroform or electroformed or electroforming or electrodeposit or electrodeposited or electrodepositing or electrodeposition or "electro-plate" or "electro-plated" or "electro-plating" or "electro-less" or "electro-lessly" or "electro-form" or "electro-formed" or "electro-forming" or "electro-deposit" or "electro-deposited" or "electro-depositing" or "electro-deposition")) near5 (("220" or "[220]" or "{220}" or "(220)" or "<220>") near5 (texture or coefficient or index or Miller or hkl or "h,k, l")))).clm.	US-PGPUB; USPAT	OR	ON	2022/03/28 08:48
S226	0	S225 not (S218 or S220 or S224)	US-PGPUB; USPAT	OR	ON	2022/03/28 08:49

EAST Search History (Interference)

S227	14	((((Cu or copper or "cu-alloy" or "cu-base" or "Cu-based" or "copper-base" or "copper-based" or "copper-alloy") near8 (foil or foiled or foiling or tape or ribbon or layer or layered or layering or film or filmed or filming or clad or claded or cladded or clading or cladding or coat or coated or coating or electroplate or electroplated or electroplating or electroless or electrolessly or electroform or electroformed or electroforming or electrodeposit or electrodeposited or electrodepositing or electrodeposition or "electro-plate" or "electro-plated" or "electro-plating" or "electro-less" or "electro-lessly" or "electro-form" or "electro-formed" or "electro-forming" or "electro-deposit" or "electro-deposited" or "electro-depositing" or "electro-deposition")) near5 (("220" or "[220]" or "{220}" or "(220)" or "<220>") near8 (texture or coefficient or index or Miller or hkl or "h,k,l")))).clm.	US-PGPUB; USPAT	OR	ON	2022/03/28 08:49

EAST Search History (Interference)

S228	17	((((Cu or copper or "cu-alloy" or "cu-base" or "Cu-based" or "copper-base" or "copper-based" or "copper-alloy") near8 (foil or foiled or foiling or tape or ribbon or layer or layered or layering or film or filmed or filming or clad or claded or cladded or clading or cladding or coat or coated or coating or electroplate or electroplated or electroplating or electroless or electrolessly or electroform or electroformed or electroforming or electrodeposit or electrodeposited or electrodepositing or electrodeposition or "electro-plate" or "electro-plated" or "electro-plating" or "electro-less" or "electro-lessly" or "electro-form" or "electro-formed" or "electro-forming" or "electro-deposit" or "electro-deposited" or "electro-depositing" or "electro-deposition")) near8 (("220" or "[220]" or "{220}" or "(220)" or "<220>") near8 (texture or coefficient or index or Miller or hkl or "h,k, l")))).clm.	US-PGPUB; USPAT	OR	ON	2022/03/28 08:49
S229	0	S228 not (S218 or S220 or S224)	US-PGPUB; USPAT	OR	ON	2022/03/28 08:50

EAST Search History (Interference)

S230	27	((((Cu or copper or "cu-alloy" or "cu-base" or "Cu-based" or "copper-base" or "copper-based" or "copper-alloy") with (foil or foiled or foiling or tape or ribbon or layer or layered or layering or film or filmed or filming or clad or claded or cladded or clading or cladding or coat or coated or coating or electroplate or electroplated or electroplating or electroless or electrolessly or electroform or electroformed or electroforming or electrodeposit or electrodeposited or electrodepositing or electrodeposition or "electro-plate" or "electro-plated" or "electro-plating" or "electro-less" or "electro-lessly" or "electro-form" or "electro-formed" or "electro-forming" or "electro-deposit" or "electro-deposited" or "electro-depositing" or "electro-deposition")) with (("220" or "[220]" or "{220}" or "(220)" or "<220>") with (texture or coefficient or index or Miller or hkl or "h,k, l")))).clm.	US-PGPUB; USPAT	OR	ON	2022/03/28 08:50
S231	10	S230 not (S218 or S220 or S224)	US-PGPUB; USPAT	OR	ON	2022/03/28 08:50

EAST Search History (Interference)

S232	7	(((Cu or copper or "cu-alloy" or "cu-base" or "Cu-based" or "copper-base" or "copper-based" or "copper-alloy") with (foil or foiled or foiling or tape or ribbon or layer or layered or layering or film or filmed or filming or clad or claded or cladded or clading or cladding or coat or coated or coating or electroplate or electroplated or electroplating or electroless or electrolessly or electroform or electroformed or electroforming or electrodeposit or electrodeposited or electrodepositing or electrodeposition or "electro-plate" or "electro-plated" or "electro-plating" or "electro-less" or "electro-lessly" or "electro-form" or "electro-formed" or "electro-forming" or "electro-deposit" or "electro-deposited" or "electro-depositing" or "electro-deposition")) with (((peak near2 density) or PD. u/c.) with (surface or shiney or shiny or matt or matte or mat or matted))).clm.	US-PGPUB; USPAT	OR	ON	2022/03/28 08:52
S233	0	S232 not (S218 or S220 or S224 or S231)	US-PGPUB; USPAT	OR	ON	2022/03/28 08:52
S249	150,515	B32B15/01;C25D1/04;C25D3/38;C25D5/34,48;C25D21/06;H01M4/0404,13,66,661,667;H01M10/052,0525;H01M2004/027;Y02E60/10;Y10T428/12431,12438.cpc.	US-PGPUB; USPAT	OR	ON	2022/07/06 08:39

EAST Search History (Interference)

S250	16	S249 and ((((Cu or copper or "cu-alloy" or "cu-base" or "Cu-based" or "copper-base" or "copper-based" or "copper-alloy") near5 (foil or foiled or foiling or tape or ribbon or layer or layered or layering or film or filmed or filming or clad or claded or cladded or clading or cladding or coat or coated or coating or electroplate or electroplated or electroplating or electroless or electrolessly or electroform or electroformed or electroforming or electrodeposit or electrodeposited or electrodepositing or electrodeposition or "electro-plate" or "electro-plated" or "electro-plating" or "electro-less" or "electro-lessly" or "electro-form" or "electro-formed" or "electro-forming" or "electro-deposit" or "electro-deposited" or "electro-depositing" or "electro-deposition")) near5 (("220" or "[220]" or "{220}" or "(220)" or "<220>") near5 (texture or coefficient or index or Miller or hkl or "h,k,l")))).clm.	US-PGPUB; USPAT	OR	ON	2022/07/06 08:39

EAST Search History (Interference)

S251	21	S249 and ((((Cu or copper or "cu-alloy" or "cu-base" or "Cu-based" or "copper-base" or "copper-based" or "copper-alloy") near8 (foil or foiled or foiling or tape or ribbon or layer or layered or layering or film or filmed or filming or clad or claded or cladded or clading or cladding or coat or coated or coating or electroplate or electroplated or electroplating or electroless or electrolessly or electroform or electroformed or electroforming or electrodeposit or electrodeposited or electrodepositing or electrodeposition or "electro-plate" or "electro-plated" or "electro-plating" or "electro-less" or "electro-lessly" or "electro-form" or "electro-formed" or "electro-forming" or "electro-deposit" or "electro-deposited" or "electro-depositing" or "electro-deposition")) near8 (("220" or "[220]" or "{220}" or "(220)" or "<220>") near5 (texture or coefficient or index or Miller or hkl or "h,k, l")))).clm.	US-PGPUB; USPAT	OR	ON	2022/07/06 08:40
S252	5	S251 not S250	US-PGPUB; USPAT	OR	ON	2022/07/06 08:40

EAST Search History (Interference)

S253	3	S249 and (((Cu or copper or "cu-alloy" or "cu-base" or "Cu-based" or "copper-base" or "copper-based" or "copper-alloy") with (foil or foiled or foiling or tape or ribbon or layer or layered or layering or film or filmed or filming or clad or claded or cladded or clading or cladding or coat or coated or coating or electroplate or electroplated or electroplating or electroless or electrolessly or electroform or electroformed or electroforming or electrodeposit or electrodeposited or electrodepositing or electrodeposition or "electro-plate" or "electro-plated" or "electro-plating" or "electro-less" or "electro-lessly" or "electro-form" or "electro-formed" or "electro-forming" or "electro-deposit" or "electro-deposited" or "electro-depositing" or "electro-deposition")) with (((peak near2 density) or PD. u/c.) near5 (surface or shiney or shiny or matt or matte or mat or matted))).clm.	US-PGPUB; USPAT	OR	ON	2022/07/06 08:41
S254	0	S253 not (S250 or S252)	US-PGPUB; USPAT	OR	ON	2022/07/06 08:41

S255	8	S249 and (((Cu or copper or "cu-alloy" or "cu-base" or "Cu-based" or "copper-base" or "copper-based" or "copper-alloy") with (foil or foiled or foiling or tape or ribbon or layer or layered or layering or film or filmed or filming or clad or claded or cladded or clading or cladding or coat or coated or coating or electroplate or electroplated or electroplating or electroless or electrolessly or electroform or electroformed or electroforming or electrodeposit or electrodeposited or electrodepositing or electrodeposition or "electro-plate" or "electro-plated" or "electro-plating" or "electro-less" or "electro-lessly" or "electro-form" or "electro-formed" or "electro-forming" or "electro-deposit" or "electro-deposited" or "electro-depositing" or "electro-deposition")) with (((peak near2 density) or PD. u/c.) with (surface or shiney or shiny or matt or matte or mat or matted))).clm.	US-PGPUB; USPAT	OR	ON	2022/07/06 08:42
S256	3	S255 not (S250 or S252)	US-PGPUB; USPAT	OR	ON	2022/07/06 08:42

EAST Search History (Interference)

S257	16	((((Cu or copper or "cu-alloy" or "cu-base" or "Cu-based" or "copper-base" or "copper-based" or "copper-alloy") near5 (foil or foiled or foiling or tape or ribbon or layer or layered or layering or film or filmed or filming or clad or claded or cladded or clading or cladding or coat or coated or coating or electroplate or electroplated or electroplating or electroless or electrolessly or electroform or electroformed or electroforming or electrodeposit or electrodeposited or electrodepositing or electrodeposition or "electro-plate" or "electro-plated" or "electro-plating" or "electro-less" or "electro-lessly" or "electro-form" or "electro-formed" or "electro-forming" or "electro-deposit" or "electro-deposited" or "electro-depositing" or "electro-deposition")) near5 (("220" or "[220]" or "{220}" or "(220)" or "<220>") near5 (texture or coefficient or index or Miller or hkl or "h,k, l")))).clm.	US-PGPUB; USPAT	OR	ON	2022/07/06 08:43
S258	0	S257 not (S250 or S252 or S256)	US-PGPUB; USPAT	OR	ON	2022/07/06 08:43

EAST Search History (Interference)

S259	21	((((Cu or copper or "cu-alloy" or "cu-base" or "Cu-based" or "copper-base" or "copper-based" or "copper-alloy") near8 (foil or foiled or foiling or tape or ribbon or layer or layered or layering or film or filmed or filming or clad or claded or cladded or clading or cladding or coat or coated or coating or electroplate or electroplated or electroplating or electroless or electrolessly or electroform or electroformed or electroforming or electrodeposit or electrodeposited or electrodepositing or electrodeposition or "electro-plate" or "electro-plated" or "electro-plating" or "electro-less" or "electro-lessly" or "electro-form" or "electro-formed" or "electro-forming" or "electro-deposit" or "electro-deposited" or "electro-depositing" or "electro-deposition")) near8 (("220" or "[220]" or "{220}" or "(220)" or "<220>") near8 (texture or coefficient or index or Miller or hkl or "h,k, l")))).clm.	US-PGPUB; USPAT	OR	ON	2022/07/06 08:44
S260	0	S259 not (S250 or S252 or S256)	US-PGPUB; USPAT	OR	ON	2022/07/06 08:44

EAST Search History (Interference)

S261	31	((((Cu or copper or "cu-alloy" or "cu-base" or "Cu-based" or "copper-base" or "copper-based" or "copper-alloy") with (foil or foiled or foiling or tape or ribbon or layer or layered or layering or film or filmed or filming or clad or claded or cladded or clading or cladding or coat or coated or coating or electroplate or electroplated or electroplating or electroless or electrolessly or electroform or electroformed or electroforming or electrodeposit or electrodeposited or electrodepositing or electrodeposition or "electro-plate" or "electro-plated" or "electro-plating" or "electro-less" or "electro-lessly" or "electro-form" or "electro-formed" or "electro-forming" or "electro-deposit" or "electro-deposited" or "electro-depositing" or "electro-deposition")) with (("220" or "[220]" or "{220}" or "(220)" or "<220>") with (texture or coefficient or index or Miller or hkl or "h,k, l")))).clm.	US-PGPUB; USPAT	OR	ON	2022/07/06 08:44
S262	10	S261 not (S250 or S252 or S256)	US-PGPUB; USPAT	OR	ON	2022/07/06 08:44

Application Number * 16/959,352 *	Application/Control No. 16/959,352	Applicant(s)/Patent under Reexamination KIM et al.	
	Examiner DUMBRIS, SETH M	Art Unit 1784	

Document Code - DISQ	Internal Document - DO NOT MAIL

TERMINAL DISCLAIMER	☐ APPROVED	☑ DISAPPROVED
Date Filed: 05 July 2022	This patent is subject to a Terminal Disclaimer	

Approved/Disapproved by:
/TRINA STEPTOE/ **Technology Center: OPLC** **Telephone: (571)272-2577** See Continuation Sheet

Continuation of Approved/Disapproved Comments: 1. • The terminal disclaimer identifies a party who is not the applicant (only for applications filed on or after September 16, 2012; See FP 14.26.10):

For cases filed on/after 9/16/12, 37 CFR 1.321 specifies that only the applicant can disclaim, and the terminal disclaimer must specify the extent of the applicant's ownership.

To remedy this:

• A request under 37 CFR 1.46(c) to change the applicant needs to be filed, which is (1) a request, signed by a 1.33(b) party, (2) a corrected ADS (37 CFR 1.76(c)) that identifies the "new" applicant in the applicant information, and is underlined since it is new, and (3) a 3.73(c) statement showing chain of title to the new applicant. Along with the § 1.46(c) request we need a POA that gives power to the attorney who is signing the TD, along with another copy of the TD, unless they file a TD that is signed by the applicant.

2. Please check either box 1 or 2.

Please resubmit td. No fee require.

PTO/SB/06 (09-11)
Approved for use through 1/31/2014. OMB 0651-0032
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE
Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it displays a valid OMB control number.

PATENT APPLICATION FEE DETERMINATION RECORD Substitute for Form PTO-875	Application or Docket Number 16/959,352	Filing Date 06/30/2020	☐ To be Mailed

ENTITY: ☑ LARGE ☐ SMALL ☐ MICRO

APPLICATION AS FILED - PART I

	(Column 1)	(Column 2)			
FOR	NUMBER FILED	NUMBER EXTRA		RATE ($)	FEE ($)
☐ BASIC FEE (37 CFR 1.16(a), (b), or (c))	N/A	N/A		N/A	
☐ SEARCH FEE (37 CFR 1.16(k), (i), or (m))	N/A	N/A		N/A	
☐ EXAMINATION FEE (37 CFR 1.16(o), (p), or (q))	N/A	N/A		N/A	
TOTAL CLAIMS (37 CFR 1.16(i))	minus 20 =	*		x $100 =	
INDEPENDENT CLAIMS (37 CFR 1.16(h))	minus 3 =	*		x $460 =	
☐ APPLICATION SIZE FEE (37 CFR 1.16(s))	If the specification and drawings exceed 100 sheets of paper, the application size fee due is $310 ($155 for small entity) for each additional 50 sheets or fraction thereof. See 35 U.S.C. 41(a)(1)(G) and 37 CFR 1.16(s).				
☐ MULTIPLE DEPENDENT CLAIM PRESENT (37 CFR 1.16(j))					
* If the difference in column 1 is less than zero, enter "0" in column 2.				TOTAL	

APPLICATION AS AMENDED - PART II

		(Column 1)		(Column 2)	(Column 3)			
AMENDMENT	07/10/2022	CLAIMS REMAINING AFTER AMENDMENT		HIGHEST NUMBER PREVIOUSLY PAID FOR	PRESENT EXTRA		RATE ($)	ADDITIONAL FEE ($)
	Total (37 CFR 1.16(i))	* 10	Minus	** 20	= 0		x $100 =	0
	Independent (37 CFR 1.16(h))	* 1	Minus	*** 3	= 0		x $480 =	0
	☐ Application Size Fee (37 CFR 1.16(s))							
	☐ FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j))							
							TOTAL ADD'L FEE	0

		(Column 1)		(Column 2)	(Column 3)			
AMENDMENT		CLAIMS REMAINING AFTER AMENDMENT		HIGHEST NUMBER PREVIOUSLY PAID FOR	PRESENT EXTRA		RATE ($)	ADDITIONAL FEE ($)
	Total (37 CFR 1.16(i))	*	Minus	**	=		x $0 =	
	Independent (37 CFR 1.16(h))	*	Minus	***	=		x $0 =	
	☐ Application Size Fee (37 CFR 1.16(s))							
	☐ FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j))							
							TOTAL ADD'L FEE	

* If the entry in column 1 is less than the entry in column 2, write "0" in column 3.	LIE
** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 20, enter "20".	/NICOLE LOVE HENSLEY/
*** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 3, enter "3".	
The "Highest Number Previously Paid For" (Total or Independent) is the highest number found in the appropriate box in column 1.	

This collection of information is required by 37 CFR 1.16. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.14. This collection is estimated to take 12 minutes to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

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IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Applicant:	Seung Min KIM
Appl. No.:	16/959,352
Conf. No.:	1067
Filed:	June 30, 2020
Title:	ELECTROLYTIC COPPER FOIL HAVING EXCELLENT HANDLING CHARACTERISTICS IN POSTPROCESSING, AND MANUFACTURING METHOD THEREFOR
Art Unit:	1784
Examiner:	DUMBRIS, SETH M
Docket No.:	0313221.00022

AMENDMENT AND RESPONSE TO FINAL OFFICE ACTION

VIA ELECTRONIC FILING

Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

Dear Commissioner:

This Response is submitted in reply to the Final Office Action dated April 5, 2022.

Amendments to the Claims begins on page 2 of this paper.

Remarks begin on page 5 of this paper.

Amendments to the Claims:

Please amend the claims as follows:

1. (Previously Presented) An electrolytic copper foil having a first surface and a second surface, wherein

a texture coefficient of (220) plane of the electrolytic copper foil defined by Equation 1 below is 0.4 to 1.32,

(Equation 1)

$$TC(220) = \frac{\frac{I(220)}{I_0(220)}}{\frac{1}{n}\sum\frac{I(hkl)}{I_0(hkl)}}$$

a difference (|Δ(Rz/Ra)|) between Rz/Ra at the first surface of the electrolytic copper foil and Rz/Ra at the second surface of the electrolytic copper foil is less than 2.42, and

a difference (|ΔPD|) between a peak density (PD) at the first surface of the electrolytic copper foil and a peak density (PD) at the second surface of the electrolytic copper foil is 96 ea or less.

2. (Original) The electrolytic copper foil according to claim 1, wherein

the second surface is an M surface, and

Rz/Ra at the second surface is 4.2 to 9.0.

3. (Original) The electrolytic copper foil according to claim 2, wherein

the first surface is an S surface, and

Rz/Ra at the S surface of the electrolytic copper foil is 5.1 to 6.8.

4. (Previously Presented) The electrolytic copper foil according to claim 1, wherein the electrolytic copper foil has a tensile strength, measured at room temperature, of 30 to 65 kgf/mm^2.

5. (Original) The electrolytic copper foil according to claim 1, wherein the electrolytic copper foil has an elongation, measured at room temperature, of 3 % or more.

6. (Original) The electrolytic copper foil according to claim 1, wherein the electrolytic copper foil has a lateral weight deviation of 5 % or less.

7. (Original) The electrolytic copper foil according to claim 1, wherein an arithmetic mean of measured heights of corners of four protruding incision portions of the electrolytic copper foil, formed by incising electrolytic copper foil in a form of a cross having a size of 8 cm x 8 cm so as to be vertically divided into two parts, is less than 10 mm.

8-10. (Withdrawn).

11. (Currently Amended) The electrolytic copper foil of claim 1, wherein the electrolytic copper foil is manufactured by:

~~applying electric current between a positive electrode plate and a rotary negative electrode drum, wherein the positive electrode plate and the rotary negative electrode drum are disposed in an electrolytic solution in an electrolytic bath so as to be spaced apart from each other;~~

buffing a surface of [[the]] a rotary negative electrode drum using a brush having a grit

of 500# to 3000#;

electrodepositing ~~a copper film~~ the copper foil on the buffed rotary negative electrode drum by applying electric current between a positive electrode plate and the buffed rotary negative electrode drum, wherein the positive electrode plate and the buffed rotary negative electrode drum are disposed in an electrolytic solution and spaced apart from each other; and

winding the electrodeposited copper foil, ~~film,~~

wherein the electrolytic solution comprises 70 to 90 g/L of copper ions, 80 to 120 g/L of sulfuric acid, 10 to 20 ppm of chlorine ions, 3 to 12 ppm of a sulfide-based compound, 25 to 50 ppm of molybdenum (Mo), and 5 to 25 ppm of polyethylene glycol (PEG).

12. (Previously Presented) The electrolytic copper foil of claim 11, wherein the sulfide-based compound is selected from a group consisting of bis-(sodium sulfopropyl) disulfide (SPS), 3-mercapto 1-propane sulfonate (MPS), and 3-(benzothiazolyl-2-mercapto)-propyl-sulfonate (ZPS).

13. (Previously Presented) The electrolytic copper foil of claim 11, wherein the sulfide-based compound is SPS.

REMARKS

This Response is submitted in reply to the Final Office Action dated April 5, 2022. Claims 1-13 are pending in the application, of which claims 8-10 are withdrawn. Claim 11 is amended. No new matter has been added by the amendments. Favorable reconsideration of this application is respectfully requested in view of the following remarks.

Double Patenting Rejection

Claims 1-7 and 11-13 stand rejected on the ground of nonstatutory double patenting as allegedly being unpatentable over claims 12, 14 and 17 of U.S. Patent No. 10,547,081 in view of Song et al. (US 2017/0141404). Without acquiescing to the reasons for this rejection, Applicant concurrently files a terminal disclaimer to overcome the non-statutory double patenting rejections. Applicant therefore requests that this rejection be withdrawn and that the application proceed to allowance.

Claim Rejections - 35 USC § 112

In the Office Action, claims 11-13 stand rejected under 35 U.S.C. 112(b) as allegedly being indefinite for failing to particularly point out and distinctly claim the subject matter which the inventor or a joint inventor (or for applications subject to pre-AIA 35 U.S.C. 112, the applicant), regards as the invention.

The Office Action indicated on page 6 that the rejection is based on a lack of clarity between the foil and film "i.e. are they the same material or not" and that the rejection "may be overcome by amending claim 11 to recite 'electrodepositing the copper foil' or similar language to indicate the materials are the same." Claims 12-13 were included in this rejection as they depend upon a rejected claim.

Applicant has amended claim 11 in accordance with the above suggestion, and respectfully requests that the rejection be withdrawn and the claims be allowed.

Therefore, for at least the reasons provided above, Applicant respectfully submits that all of the pending claims are patentably distinguished over the prior art of record and that this application is currently in condition for allowance. An earnest endeavor has been made to place

this application in condition for formal allowance, and such allowance is courteously solicited. If the Examiner has any questions regarding this Response, Applicant respectfully requests that the Examiner contact the undersigned.

Applicant does not believe any fee is due in connection with this response. However, the Commissioner is authorized to charge any fee that may be required or to credit any overpayment to Deposit Account No. 02-1818. If such a transaction is made, please indicate the Attorney Docket No. 0313221.00022 on the account statement.

Respectfully submitted,

K&L Gates LLP

BY /Matthew S. Dicke/
Matthew S. Dicke
Reg. No. 58,819
Customer No. 29178
312-578-5415

Dated: July 5, 2022

PTO/SB/26 (08-08)
Approved for use through 09/30/2008. OMB 0651-0031
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE
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TERMINAL DISCLAIMER TO OBVIATE A DOUBLE PATENTING REJECTION OVER A "PRIOR" PATENT	Docket Number (Optional) 0313221.00022

In re Application of: Seung Min KIM

Application No.: 16/959,352

Filed: June 30, 2020

For: ELECTROLYTIC COPPER FOIL HAVING EXCELLENT HANDLING CHARACTERISTICS IN POSTPROCESSING, AND MANUFACTURING METHOD THEREFOR

The owner*, SK NEXILIS CO., LTD., of 100 percent interest in the instant application hereby disclaims, except as provided below, the terminal part of the statutory term of any patent granted on the instant application which would extend beyond the expiration date of the full statutory term **prior patent** No. 10,547,081 as the term of said prior patent is defined in 35 U.S.C. 154 and 173, and as the term of said **prior patent** is presently shortened by any terminal disclaimer. The owner hereby agrees that any patent so granted on the instant application shall be enforceable only for and during such period that it and the **prior patent** are commonly owned. This agreement runs with any patent granted on the instant application and is binding upon the grantee, its successors or assigns.

In making the above disclaimer, the owner does not disclaim the terminal part of the term of any patent granted on the instant application that would extend to the expiration date of the full statutory term as defined in 35 U.S.C. 154 and 173 of the **prior patent**, "as the term of said **prior patent** is presently shortened by any terminal disclaimer," in the event that said **prior patent** later:

expires for failure to pay a maintenance fee;
is held unenforceable;
is found invalid by a court of competent jurisdiction;
is statutorily disclaimed in whole or terminally disclaimed under 37 CFR 1.321;
has all claims canceled by a reexamination certificate;
is reissued; or
is in any manner terminated prior to the expiration of its full statutory term as presently shortened by any terminal disclaimer.

Check either box 1 or 2 below, if appropriate.

1. ☑ For submissions on behalf of a business/organization (e.g., corporation, partnership, university, government agency, etc.), the undersigned is empowered to act on behalf of the business/organization.

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

2. ☑ The undersigned is an attorney or agent of record. Reg. No. 58819

/Matthew S. Dicke/ — Signature
July 5, 2022 — Date

Matthew S. Dicke — Typed or printed name

312-578-5415 — Telephone Number

☑ Terminal disclaimer fee under 37 CFR 1.20(d) included.

WARNING: Information on this form may become public. Credit card information should not be included on this form. Provide credit card information and authorization on PTO-2038.

*Statement under 37 CFR 3.73(b) is required if terminal disclaimer is signed by the assignee (owner).
Form PTO/SB/96 may be used for making this certification. See MPEP § 324.

This collection of information is required by 37 CFR 1.321. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.11 and 1.14. This collection is estimated to take 12 minutes to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

If you need assistance in completing the form, call 1-800-PTO-9199 and select option 2.

Privacy Act Statement

The **Privacy Act of 1974 (P.L. 93-579)** requires that you be given certain information in connection with your submission of the attached form related to a patent application or patent. Accordingly, pursuant to the requirements of the Act, please be advised that: (1) the general authority for the collection of this information is 35 U.S.C. 2(b)(2); (2) furnishing of the information solicited is voluntary; and (3) the principal purpose for which the information is used by the U.S. Patent and Trademark Office is to process and/or examine your submission related to a patent application or patent. If you do not furnish the requested information, the U.S. Patent and Trademark Office may not be able to process and/or examine your submission, which may result in termination of proceedings or abandonment of the application or expiration of the patent.

The information provided by you in this form will be subject to the following routine uses:

1. The information on this form will be treated confidentially to the extent allowed under the Freedom of Information Act (5 U.S.C. 552) and the Privacy Act (5 U.S.C 552a). Records from this system of records may be disclosed to the Department of Justice to determine whether disclosure of these records is required by the Freedom of Information Act.
2. A record from this system of records may be disclosed, as a routine use, in the course of presenting evidence to a court, magistrate, or administrative tribunal, including disclosures to opposing counsel in the course of settlement negotiations.
3. A record in this system of records may be disclosed, as a routine use, to a Member of Congress submitting a request involving an individual, to whom the record pertains, when the individual has requested assistance from the Member with respect to the subject matter of the record.
4. A record in this system of records may be disclosed, as a routine use, to a contractor of the Agency having need for the information in order to perform a contract. Recipients of information shall be required to comply with the requirements of the Privacy Act of 1974, as amended, pursuant to 5 U.S.C. 552a(m).
5. A record related to an International Application filed under the Patent Cooperation Treaty in this system of records may be disclosed, as a routine use, to the International Bureau of the World Intellectual Property Organization, pursuant to the Patent Cooperation Treaty.
6. A record in this system of records may be disclosed, as a routine use, to another federal agency for purposes of National Security review (35 U.S.C. 181) and for review pursuant to the Atomic Energy Act (42 U.S.C. 218(c)).
7. A record from this system of records may be disclosed, as a routine use, to the Administrator, General Services, or his/her designee, during an inspection of records conducted by GSA as part of that agency's responsibility to recommend improvements in records management practices and programs, under authority of 44 U.S.C. 2904 and 2906. Such disclosure shall be made in accordance with the GSA regulations governing inspection of records for this purpose, and any other relevant (*i.e.*, GSA or Commerce) directive. Such disclosure shall not be used to make determinations about individuals.
8. A record from this system of records may be disclosed, as a routine use, to the public after either publication of the application pursuant to 35 U.S.C. 122(b) or issuance of a patent pursuant to 35 U.S.C. 151. Further, a record may be disclosed, subject to the limitations of 37 CFR 1.14, as a routine use, to the public if the record was filed in an application which became abandoned or in which the proceedings were terminated and which application is referenced by either a published application, an application open to public inspection or an issued patent.
9. A record from this system of records may be disclosed, as a routine use, to a Federal, State, or local law enforcement agency, if the USPTO becomes aware of a violation or potential violation of law or regulation.

Electronic Patent Application Fee Transmittal

Application Number:	16959352
Filing Date:	30-Jun-2020
Title of Invention:	ELECTROLYTIC COPPER FOIL HAVING EXCELLENT HANDLING CHARACTERISTICS IN POSTPROCESSING, AND MANUFACTURING METHOD THEREFOR
First Named Inventor/Applicant Name:	Seung Min KIM
Filer:	Matthew S. Dicke/Meg Boinski
Attorney Docket Number:	0313221.00022

Filed as Large Entity

Filing Fees for U.S. National Stage under 35 USC 371

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Basic Filing:				
Pages:				
Claims:				
Miscellaneous-Filing:				
Petition:				
Patent-Appeals-and-Interference:				
Post-Allowance-and-Post-Issuance:				
Extension-of-Time:				

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Miscellaneous:				
STATUTORY OR TERMINAL DISCLAIMER	1814	1	170	170
		Total in USD ($)		**170**

Electronic Acknowledgement Receipt	
EFS ID:	46110533
Application Number:	16959352
International Application Number:	
Confirmation Number:	1067
Title of Invention:	ELECTROLYTIC COPPER FOIL HAVING EXCELLENT HANDLING CHARACTERISTICS IN POSTPROCESSING, AND MANUFACTURING METHOD THEREFOR
First Named Inventor/Applicant Name:	Seung Min KIM
Customer Number:	24573
Filer:	Matthew S. Dicke/US Patent Mail
Filer Authorized By:	Matthew S. Dicke
Attorney Docket Number:	0313221.00022
Receipt Date:	05-JUL-2022
Filing Date:	30-JUN-2020
Time Stamp:	12:47:32
Application Type:	U.S. National Stage under 35 USC 371

Payment information:

Submitted with Payment	yes
Payment Type	DA
Payment was successfully received in RAM	$170
RAM confirmation Number	E202275C48004077
Deposit Account	021818
Authorized User	US Patent Mail
The Director of the USPTO is hereby authorized to charge indicated fees and credit any overpayment as follows: 37 CFR 1.492 (National application filing, search, and examination fees) 37 CFR 1.17 (Patent application and reexamination processing fees)	

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1		00022_RespFinal.pdf	139523 6f72ab568c9fdf2f94db91552debf101af9d2de8	yes	6
	Multipart Description/PDF files in .zip description				
	Document Description		**Start**	**End**	
	Response After Final Action		1	1	
	Claims		2	4	
	Applicant Arguments/Remarks Made in an Amendment		5	6	
Warnings:					
Information:					
2	Terminal Disclaimer Filed	00022_TD.pdf	156034 d111324c5842e5e869d4c81cff4c044238bfb96f	no	2
Warnings:					
Information:					
3	Fee Worksheet (SB06)	fee-info.pdf	38372 55126c3cac467bc784d14e5a0f63cbeae288ced1	no	2
Warnings:					
Information:					
		Total Files Size (in bytes):	333929		

This Acknowledgement Receipt evidences receipt on the noted date by the USPTO of the indicated documents, characterized by the applicant, and including page counts, where applicable. It serves as evidence of receipt similar to a Post Card, as described in MPEP 503.

New Applications Under 35 U.S.C. 111

If a new application is being filed and the application includes the necessary components for a filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application.

National Stage of an International Application under 35 U.S.C. 371

If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course.

New International Application Filed with the USPTO as a Receiving Office

If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.

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United States Patent and Trademark Office
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www.uspto.gov

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
16/959,352	06/30/2020	Seung Min KIM	0313221.00022	1067

24573 7590 04/05/2022

K&L Gates LLP-Chicago
P.O. Box 1135
Chicago, IL 60690

EXAMINER
DUMBRIS, SETH M

ART UNIT	PAPER NUMBER
1784	

NOTIFICATION DATE	DELIVERY MODE
04/05/2022	ELECTRONIC

Please find below and/or attached an Office communication concerning this application or proceeding.

The time period for reply, if any, is set in the attached communication.

Notice of the Office communication was sent electronically on above-indicated "Notification Date" to the following e-mail address(es):

USpatentmail@klgates.com

Office Action Summary	Application No. 16/959,352	Applicant(s) KIM et al.	
	Examiner SETH DUMBRIS	Art Unit 1784	AIA (FITF) Status Yes

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTHS FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1)☐ Responsive to communication(s) filed on _____.

☐ A declaration(s)/affidavit(s) under **37 CFR 1.130(b)** was/were filed on _____.

2a)☑ This action is **FINAL.** 2b) ☐ This action is non-final.

3)☐ An election was made by the applicant in response to a restriction requirement set forth during the interview on _____; the restriction requirement and election have been incorporated into this action.

4)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims*

5) ☑ Claim(s) 1-7 and 11-13 is/are pending in the application.

5a) Of the above claim(s) _____ is/are withdrawn from consideration.

6) ☐ Claim(s) _____ is/are allowed.

7) ☑ Claim(s) 1-7 and 11-13 is/are rejected.

8) ☐ Claim(s) _____ is/are objected to.

9) ☐ Claim(s) _____ are subject to restriction and/or election requirement

* If any claims have been determined allowable, you may be eligible to benefit from the **Patent Prosecution Highway** program at a participating intellectual property office for the corresponding application. For more information, please see http://www.uspto.gov/patents/init_events/pph/index.jsp or send an inquiry to **PPHfeedback@uspto.gov.**

Application Papers

10)☐ The specification is objected to by the Examiner.

11)☑ The drawing(s) filed on 30 June 2020 is/are: a)☑ accepted or b)☐ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).

Priority under 35 U.S.C. § 119

12)☑ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

Certified copies:

a)☑ All b)☐ Some** c)☐ None of the:

1.☐ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. _____.

3.☑ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

** See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

1) ☐ Notice of References Cited (PTO-892)

2) ☑ Information Disclosure Statement(s) (PTO/SB/08a and/or PTO/SB/08b) Paper No(s)/Mail Date 19 January 2022.

3) ☐ Interview Summary (PTO-413) Paper No(s)/Mail Date _____.

4) ☐ Other: _____.

DETAILED ACTION

Notice of Pre-AIA or AIA Status

1. The present application, filed on or after March 16, 2013, is being examined under the first inventor to file provisions of the AIA.

Double Patenting

2. The nonstatutory double patenting rejection is based on a judicially created doctrine grounded in public policy (a policy reflected in the statute) so as to prevent the unjustified or improper timewise extension of the "right to exclude" granted by a patent and to prevent possible harassment by multiple assignees. A nonstatutory double patenting rejection is appropriate where the conflicting claims are not identical, but at least one examined application claim is not patentably distinct from the reference claim(s) because the examined application claim is either anticipated by, or would have been obvious over, the reference claim(s). See, e.g., *In re Berg*, 140 F.3d 1428, 46 USPQ2d 1226 (Fed. Cir. 1998); *In re Goodman*, 11 F.3d 1046, 29 USPQ2d 2010 (Fed. Cir. 1993); *In re Longi*, 759 F.2d 887, 225 USPQ 645 (Fed. Cir. 1985); *In re Van Ornum*, 686 F.2d 937, 214 USPQ 761 (CCPA 1982); *In re Vogel*, 422 F.2d 438, 164 USPQ 619 (CCPA 1970); *In re Thorington*, 418 F.2d 528, 163 USPQ 644 (CCPA 1969).

3. A timely filed terminal disclaimer in compliance with 37 CFR 1.321(c) or 1.321(d) may be used to overcome an actual or provisional rejection based on nonstatutory double patenting provided the reference application or patent either is shown to be commonly owned with the examined application, or claims an invention made as a

result of activities undertaken within the scope of a joint research agreement. See MPEP § 717.02 for applications subject to examination under the first inventor to file provisions of the AIA as explained in MPEP § 2159. See MPEP § 2146 *et seq.* for applications not subject to examination under the first inventor to file provisions of the AIA. A terminal disclaimer must be signed in compliance with 37 CFR 1.321(b).

4. The USPTO Internet website contains terminal disclaimer forms which may be used. Please visit www.uspto.gov/patent/patents-forms. The filing date of the application in which the form is filed determines what form (e.g., PTO/SB/25, PTO/SB/26, PTO/AIA/25, or PTO/AIA/26) should be used. A web-based eTerminal Disclaimer may be filled out completely online using web-screens. An eTerminal Disclaimer that meets all requirements is auto-processed and approved immediately upon submission. For more information about eTerminal Disclaimers, refer to www.uspto.gov/patents/process/file/efs/guidance/eTD-info-I.jsp.

5. **Claims 1-7 and 11-13** are rejected on the ground of nonstatutory double patenting as being unpatentable over claims 12, 14 and 17 of U.S. Patent No. 10,547,081 in view of Song et al. (US 2017/0141404). Instant claim 1 recites an electrolytic copper foil with first and second surfaces and a texture coefficient (220) defined by Equation 1 ranging from 0.4-1.32 a difference (|Δ(Rz/Ra)|) of the first and second surfaces being less than 2.42 and a difference (|ΔPD|) of the first and second surfaces being 96 ea or less. This is patentably indistinct of claims 12 and 17 of the ‘081 patent which recites an electrolytic copper foil made by a method and having first and second surfaces with a first protective layer over the first surface and the first

surface having a peak density (PD) of 3-110, a texture coefficient [TC(220)] of a (220) plane being 1.32 or less, a surface roughness (Rz) of 0.5-2.7 μm, the second surface having a PD or 3-110, a [TC(220)] of a (220) plane of 1.32 or less and a surface roughness of 0.5-2.7 microns, where the difference in PD's of the first and second surfaces is 85 or less, a difference is TC's is 0.53 or less, and a difference between Rz surface roughnesses is 0.8 μm or less. The difference between the instant claims and those of the '081 patent are the claimed Rz/Ra difference.

6. In a related field of endeavor, Song teaches electrolytic copper foils (abstract). The foil has a surfaced roughness Rz of the matte side from 1.2-1.7 μm (Paragraph 24), a Ra of the matte side being 0.18-0.3 μm (Paragraph 27), where the shiny side of the foil has a similar roughness to the matte side (Paragraph 30), and a ratio of the (220) peak to the (111) is 0.7-1.4 (Paragraph 35). Song teaches where the difference in roughness Rz between the matte and shiny sides is 0.5 μm or less and where uniformity in roughness prevents degradation when the foil is incorporated into a battery (Paragraphs 30-31).

7. As the instant claims, the '081 patent, and Song are directed to copper foils they are considered analogous. As such, the instant claims would have been obvious to one of ordinary skill in the art in view of the '081 patent and the teachings of Song as Song teaches where minimization of a difference in roughness between first and second surfaces of a copper foil is known to prevent degradation and one would have had a reasonable expectation of success. While Song does not specifically teach the difference in terms of ($|\Delta(Rz/Ra)|$), Song teaches where the roughness of the first and second surfaces are similar (Paragraph 30) and where this difference is desired to be

minimized (Paragraphs 30-31) (i.e. ~zero) which overlaps the claimed range. See MPEP 2144.05.

8. Claim 2 recites a Rz/Ra of a matte surface of 4.2-9.0 and Song teaches where Rz ranges from 1.2-1.7 μm (Paragraph 24) and Ra ranges from 0.18-0.3 (Paragraph 27). This corresponds to Rz/Ra of about 4-9.4 and is obvious in view of claims 12 and 17 of the '081 patent and Song. See MPEP 2144.05. Claim 3 recites a Rz/Ra of a shiny surface of 5.1-6.8 and Song teaches where Rz ranges from 1.2-1.7 μm (Paragraph 24) and Ra ranges from 0.18-0.3 (Paragraph 27) and where the shiny surface is similar to the matte in terms of roughness (Paragraph 30). This corresponds to Rz/Ra of about 4-9.4 and is obvious in view of claims 12 and 17 of the '081 patent and Song. See MPEP 2144.05. Claim 3 recites a tensile strength of 30-65 kgf/mm^2 and Song teaches where the tensile strength is 20 kgf/mm^2 or more at room temperature (Paragraph 23) and is obvious in view of claims 12 and 17 of the '081 patent and Song. See MPEP 2144.05. Instant claim 5 recites an elongation of 3% or more which overlaps claims 12 and 14 of the '081 patent. Instant claims 6-7 recite a lateral weight deviation and arithmetic mean measured height and these are considered to overlap the substantially identical copper foil of claims 12 and 17 of the '081 patent and Song, absent an objective showing, as substantially identical materials are expected to display substantially identical physical properties. See MPEP 2112.01. Claims 11-13 recite product-by-process limitations and said limitations are not considered to render a patentable distinction over claims 12 and 17 of the '081 patent absent a showing as to how the claimed process affects the final structure of the claimed copper foil. See MPEP 2113.

Claim Rejections - 35 USC § 112

9. The following is a quotation of 35 U.S.C. 112(b):

> (b) CONCLUSION.—The specification shall conclude with one or more claims particularly pointing out and distinctly claiming the subject matter which the inventor or a joint inventor regards as the invention.

10. **Claims 11-13** are rejected under 35 U.S.C. 112(b) as being indefinite for failing to particularly point out and distinctly claim the subject matter which the inventor or a joint inventor (or for applications subject to pre-AIA 35 U.S.C. 112, the applicant), regards as the invention.

11. **Claim 11** recites "The electrolytic foil of claim 1, wherein the electrolytic copper foil is manufactured by…electrodepositing a copper film…" and is considered indefinite as it is unclear as to how the *foil* and *film* correspond to one another (i.e. are they the same material or not). This may be overcome by amending claim 11 to recite "electrodepositing the copper foil" or similar language to indicate the materials are the same. Claims 12-13 are included in this rejection as they depend upon a rejected claim.

Terminal Disclaimer

12. The terminal disclaimer filed on 25 March 2022 disclaiming the terminal portion of any patent granted on this application which would extend beyond the expiration date of 15127651 has been reviewed and is NOT accepted.

13. The terminal disclaimer does not comply with 37 CFR 1.321 because:

> The application/patent being disclaimed has been improperly identified since the number used to identify the US Patent being disclaimed is incorrect. The correct number is US Patent No. 10,547,081.

Response to Arguments

14. Applicant's arguments, see remarks, filed 25 March 2022, with respect to claim objections have been fully considered and are persuasive. The objection of claims 1 and 4 have been withdrawn. Applicant has corrected the informalities

15. Applicant's arguments filed 25 March 2022 regarding Double Patenting Rejections have been fully considered but they are not persuasive. Applicant asserts that the terminal disclaimer filed 25 March 2022 obviates the rejection. This is not persuasive as the terminal disclaimer filed lists 15127651 as the document that is being disclaimed. However, this document appears to be a miss-typing of US 10,547,081 as 15127651 does not appear to have a common inventor or assignee to the instant application or US 10,547,081. The double patenting rejection above may be overcome by filing a terminal disclaimer to US 10,547,081.

Conclusion

16. Applicant's amendment necessitated the new ground(s) of rejection presented in this Office action. Accordingly, **THIS ACTION IS MADE FINAL**. See MPEP § 706.07(a). Applicant is reminded of the extension of time policy as set forth in 37 CFR 1.136(a).

17. A shortened statutory period for reply to this final action is set to expire THREE MONTHS from the mailing date of this action. In the event a first reply is filed within TWO MONTHS of the mailing date of this final action and the advisory action is not mailed until after the end of the THREE-MONTH shortened statutory period, then the shortened statutory period will expire on the date the advisory action is mailed, and any

extension fee pursuant to 37 CFR 1.136(a) will be calculated from the mailing date of the advisory action. In no event, however, will the statutory period for reply expire later than SIX MONTHS from the date of this final action.

18. Any inquiry concerning this communication or earlier communications from the examiner should be directed to SETH DUMBRIS whose telephone number is (571)272-5105. The examiner can normally be reached M-F 6:00 AM - 3:30 PM.

Examiner interviews are available via telephone, in-person, and video conferencing using a USPTO supplied web-based collaboration tool. To schedule an interview, applicant is encouraged to use the USPTO Automated Interview Request (AIR) at http://www.uspto.gov/interviewpractice.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Humera Sheikh can be reached on 571-272-0604. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

Information regarding the status of published or unpublished applications may be obtained from Patent Center. Unpublished application information in Patent Center is available to registered users. To file and manage patent submissions in Patent Center, visit: https://patentcenter.uspto.gov. Visit https://www.uspto.gov/patents/apply/patent-center for more information about Patent Center and https://www.uspto.gov/patents/docx for information about filing in DOCX format. For additional questions, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free). If you would like assistance from a USPTO Customer Service Representative, call 800-786-9199 (IN USA OR CANADA) or 571-272-1000.

SETH DUMBRIS
Primary Examiner
Art Unit 1784

/SETH DUMBRIS/
Primary Examiner, Art Unit 1784

Search Notes	Application/Control No.	Applicant(s)/Patent Under Reexamination
	16/959,352	KIM et al.
	Examiner	Art Unit
	SETH DUMBRIS	1784

CPC - Searched*		
Symbol	Date	Examiner

CPC Combination Sets - Searched*		
Symbol	Date	Examiner

US Classification - Searched*			
Class	Subclass	Date	Examiner

* See search history printout included with this form or the SEARCH NOTES box below to determine the scope of the search.

/SETH DUMBRIS/ Primary Examiner, Art Unit 1784	

Search Notes	Application/Control No.	Applicant(s)/Patent Under Reexamination
	16/959,352	KIM et al.
	Examiner	Art Unit
	SETH DUMBRIS	1784

Search Notes		
Search Notes	**Date**	**Examiner**
Inventor, applicant, and assignee searches	12/20/2021	SD
Reviewed IDS's and ISR	12/20/2021	SD
Global Dossier review	12/20/2021	SD
Searched B32B15/01 (text limited)	12/20/2021	SD
Searched C25D1/04; 3/38; 5/34, 48; 7/0614; 21/06 (text limited)	12/20/2021	SD
Searched H01M4/0404, 13, 66, 661, 667; 10/052, 0525; 2004/027 (text limited)	12/20/2021	SD
Searched Y02E60/10 (text limited)	12/20/2021	SD
Searched Y10T428/12431, 12438 (text limited)	12/20/2021	SD
Keyword search of USPat, USPgPub, USOCR, EPO, FPRS, JPO, and DERWENT	12/20/2021	SD
Updated EAST, applicant, inventor, and assignee searches	03/31/2022	SD
Further searched above classifications and databases	03/31/2022	SD

Interference Search			
US Class/CPC Symbol	**US Subclass/CPC Group**	**Date**	**Examiner**

/SETH DUMBRIS/ Primary Examiner, Art Unit 1784	

Doc code: IDS
Doc description: Information Disclosure Statement (IDS) Filed

PTO/SB/08a (03-15)
Approved for use through 07/31/2016. OMB 0651-0031
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE
Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it contains a valid OMB control number.

INFORMATION DISCLOSURE STATEMENT BY APPLICANT
(Not for submission under 37 CFR 1.99)

Application Number	16959352
Filing Date	2020-06-30
First Named Inventor	Seung Min KIM
Art Unit	1784
Examiner Name	DUMBRIS, SETH M
Attorney Docket Number	0313221.00022

U.S.PATENTS Remove

Examiner Initial*	Cite No	Patent Number	Kind Code[1]	Issue Date	Name of Patentee or Applicant of cited Document	Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear
	1					

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Examiner Initial*	Cite No	Publication Number	Kind Code[1]	Publication Date	Name of Patentee or Applicant of cited Document	Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear
	1					

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FOREIGN PATENT DOCUMENTS Remove

Examiner Initial*	Cite No	Foreign Document Number[3]	Country Code[2]	Kind Code[4]	Publication Date	Name of Patentee or Applicant of cited Document	Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear	T[5]
	1	106048666	CN	A	2016-10-26	CHANGCHUN PETROCHEMISTRY CO LTD		
	2	106536791	CN	A	2017-03-22	LS MTRON LTD		
	3	106887595	CN	A	2017-06-23	LS MTRON LTD		

ALL REFERENCES CONSIDERED EXCEPT WHERE LINED THROUGH. /S.D./

INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)		
	Application Number	16959352
	Filing Date	2020-06-30
	First Named Inventor	Seung Min KIM
	Art Unit	1784
	Examiner Name	DUMBRIS, SETH M
	Attorney Docket Number	0313221.00022

If you wish to add additional Foreign Patent Document citation information please click the Add button [Add]

NON-PATENT LITERATURE DOCUMENTS [Remove]

Examiner Initials*	Cite No	Include name of the author (in CAPITAL LETTERS), title of the article (when appropriate), title of the item (book, magazine, journal, serial, symposium, catalog, etc), date, pages(s), volume-issue number(s), publisher, city and/or country where published.	T[5]
	1	Chinese Office Action for related Chinese Application No. 2019800106242; action dated December 17, 2021; (15 pages)	

If you wish to add additional non-patent literature document citation information please click the Add button [Add]

EXAMINER SIGNATURE

Examiner Signature	/SETH DUMBRIS/	Date Considered	03/31/2022

*EXAMINER: Initial if reference considered, whether or not citation is in conformance with MPEP 609. Draw line through a citation if not in conformance and not considered. Include copy of this form with next communication to applicant.

[1] See Kind Codes of USPTO Patent Documents at www.USPTO.GOV or MPEP 901.04. [2] Enter office that issued the document, by the two-letter code (WIPO Standard ST.3). [3] For Japanese patent documents, the indication of the year of the reign of the Emperor must precede the serial number of the patent document. [4] Kind of document by the appropriate symbols as indicated on the document under WIPO Standard ST.16 if possible. [5] Applicant is to place a check mark here if English language translation is attached.

ALL REFERENCES CONSIDERED EXCEPT WHERE LINED THROUGH. /S.D./

INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)		
	Application Number	16959352
	Filing Date	2020-06-30
	First Named Inventor	Seung Min KIM
	Art Unit	1784
	Examiner Name	DUMBRIS, SETH M
	Attorney Docket Number	0313221.00022

CERTIFICATION STATEMENT

Please see 37 CFR 1.97 and 1.98 to make the appropriate selection(s):

☒ That each item of information contained in the information disclosure statement was first cited in any communication from a foreign patent office in a counterpart foreign application not more than three months prior to the filing of the information disclosure statement. See 37 CFR 1.97(e)(1).

OR

☐ That no item of information contained in the information disclosure statement was cited in a communication from a foreign patent office in a counterpart foreign application, and, to the knowledge of the person signing the certification after making reasonable inquiry, no item of information contained in the information disclosure statement was known to any individual designated in 37 CFR 1.56(c) more than three months prior to the filing of the information disclosure statement. See 37 CFR 1.97(e)(2).

☒ See attached certification statement.

The fee set forth in 37 CFR 1.17 (p) has been submitted herewith.

A certification statement is not submitted herewith.

SIGNATURE

A signature of the applicant or representative is required in accordance with CFR 1.33, 10.18. Please see CFR 1.4(d) for the form of the signature.

Signature	/Matthew S. Dicke/	Date (YYYY-MM-DD)	2022-01-19
Name/Print	Matthew S. Dicke	Registration Number	58819

This collection of information is required by 37 CFR 1.97 and 1.98. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.14. This collection is estimated to take 1 hour to complete, including gathering, preparing and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

ALL REFERENCES CONSIDERED EXCEPT WHERE LINED THROUGH. /S.D./

Privacy Act Statement

The Privacy Act of 1974 (P.L. 93-579) requires that you be given certain information in connection with your submission of the attached form related to a patent application or patent. Accordingly, pursuant to the requirements of the Act, please be advised that: (1) the general authority for the collection of this information is 35 U.S.C. 2(b)(2); (2) furnishing of the information solicited is voluntary; and (3) the principal purpose for which the information is used by the U.S. Patent and Trademark Office is to process and/or examine your submission related to a patent application or patent. If you do not furnish the requested information, the U.S. Patent and Trademark Office may not be able to process and/or examine your submission, which may result in termination of proceedings or abandonment of the application or expiration of the patent.

The information provided by you in this form will be subject to the following routine uses:

1. The information on this form will be treated confidentially to the extent allowed under the Freedom of Information Act (5 U.S.C. 552) and the Privacy Act (5 U.S.C. 552a). Records from this system of records may be disclosed to the Department of Justice to determine whether the Freedom of Information Act requires disclosure of these record s.

2. A record from this system of records may be disclosed, as a routine use, in the course of presenting evidence to a court, magistrate, or administrative tribunal, including disclosures to opposing counsel in the course of settlement negotiations.

3. A record in this system of records may be disclosed, as a routine use, to a Member of Congress submitting a request involving an individual, to whom the record pertains, when the individual has requested assistance from the Member with respect to the subject matter of the record.

4. A record in this system of records may be disclosed, as a routine use, to a contractor of the Agency having need for the information in order to perform a contract. Recipients of information shall be required to comply with the requirements of the Privacy Act of 1974, as amended, pursuant to 5 U.S.C. 552a(m).

5. A record related to an International Application filed under the Patent Cooperation Treaty in this system of records may be disclosed, as a routine use, to the International Bureau of the World Intellectual Property Organization, pursuant to the Patent Cooperation Treaty.

6. A record in this system of records may be disclosed, as a routine use, to another federal agency for purposes of National Security review (35 U.S.C. 181) and for review pursuant to the Atomic Energy Act (42 U.S.C. 218(c)).

7. A record from this system of records may be disclosed, as a routine use, to the Administrator, General Services, or his/her designee, during an inspection of records conducted by GSA as part of that agency's responsibility to recommend improvements in records management practices and programs, under authority of 44 U.S.C. 2904 and 2906. Such disclosure shall be made in accordance with the GSA regulations governing inspection of records for this purpose, and any other relevant (i.e., GSA or Commerce) directive. Such disclosure shall not be used to make determinations about individuals.

8. A record from this system of records may be disclosed, as a routine use, to the public after either publication of the application pursuant to 35 U.S.C. 122(b) or issuance of a patent pursuant to 35 U.S.C. 151. Further, a record may be disclosed, subject to the limitations of 37 CFR 1.14, as a routine use, to the public if the record was filed in an application which became abandoned or in which the proceedings were terminated and which application is referenced by either a published application, an application open to public inspections or an issued patent.

9. A record from this system of records may be disclosed, as a routine use, to a Federal, State, or local law enforcement agency, if the USPTO becomes aware of a violation or potential violation of law or regulation.

ALL REFERENCES CONSIDERED EXCEPT WHERE LINED THROUGH. /S.D./

EAST Search History (Prior Art)

Ref #	Hits	Search Query	DBs	Default Operator	Plurals	Time Stamp
L1	12	((("JIN") near3 ("Shan") near3 ("Hua"))).INV.	US-PGPUB; USPAT; USOCR	OR	ON	2022/03/28 06:21
L2	22	(("LEE") near3 ("An") near3 ("Na"))).INV.	US-PGPUB; USPAT; USOCR	OR	ON	2022/03/28 06:21
L3	115	(("KIM") near3 ("Seung") near3 ("Min"))).INV.	US-PGPUB; USPAT; USOCR	OR	ON	2022/03/28 06:21
L4	389	(("JIN") near3 ("Shan" or Hua or "shanhua" or "shan-hua"))).INV.	US-PGPUB; USPAT; USOCR	OR	ON	2022/03/28 06:21
L5	981	(("LEE") near3 ("An" or Na or "An-Na"))).INV.	US-PGPUB; USPAT; USOCR	OR	ON	2022/03/28 06:21
L6	18,485	(("KIM") near3 ("Seung" or Min or "SeungMin" or "Seung-Min"))).INV.	US-PGPUB; USPAT; USOCR	OR	ON	2022/03/28 06:21
L7	49	(("JIN") near3 ("Shan" or Hua or "shanhua" or "shan-hua"))).aanm.	US-PGPUB; USPAT; USOCR	OR	ON	2022/03/28 06:21
L8	110	(("LEE") near3 ("An" or Na or "An-Na"))).aanm.	US-PGPUB; USPAT; USOCR	OR	ON	2022/03/28 06:21
L9	2,041	(("KIM") near3 ("Seung" or Min or "SeungMin" or "Seung-Min"))).aanm.	US-PGPUB; USPAT; USOCR	OR	ON	2022/03/28 06:21
L10	19,784	L1 or L2 or L3 or L4 or L5 or L6 or L7 or L8 or L9	US-PGPUB; USPAT; USOCR	OR	ON	2022/03/28 06:21

EAST Search History (Prior Art)

L11	2,017	L10 and ((Cu or copper or "cu-alloy" or "cu-base" or "Cu-based" or "copper-base" or "copper-based" or "copper-alloy") with (foil or foiled or foiling or tape or ribbon or layer or layered or layering or film or filmed or filming or clad or claded or cladded or clading or cladding or coat or coated or coating or electroplate or electroplated or electroplating or electroless or electrolessly or electroform or electroformed or electroforming or electrodeposit or electrodeposited or electrodepositing or electrodeposition or "electro-plate" or "electro-plated" or "electro-plating" or "electro-less" or "electro-lessly" or "electro-form" or "electro-formed" or "electro-forming" or "electro-deposit" or "electro-deposited" or "electro-depositing" or "electro-deposition"))	US-PGPUB; USPAT; USOCR	OR	ON	2022/03/28 06:21
L12	12	L11 and (("220" or "[220]" or "{220}" or "(220)" or "<220>") near5 (texture or coefficient or index or Miller or hkl or "h, k,l"))	US-PGPUB; USPAT; USOCR	OR	ON	2022/03/28 06:21
L13	58	((KCF) near3 (tech or technol or technology)).as,aanm.	US-PGPUB; USPAT; USOCR	OR	ON	2022/03/28 06:24
L14	50	L13 not L12	US-PGPUB; USPAT; USOCR	OR	ON	2022/03/28 06:24

EAST Search History (Prior Art)

L15	155,301	B32B15/01;C25D1/04;C25D 3/38;C25D5/34, 48;C25D21/06;H01M4/0404, 13,66,661,667;H01M10/052, 0525;H01M2004/027;Y02E6 0/10;Y10T428/12431,12438. cpc.	US-PGPU B; USPAT; USOCR	OR	ON	2022/03/28 06:27
L16	42,847	L15 and ((Cu or copper or "cu-alloy" or "cu-base" or "Cu-based" or "copper-base" or "copper-based" or "copper-alloy") near5 (foil or foiled or foiling or tape or ribbon or layer or layered or layering or film or filmed or filming or clad or claded or cladded or clading or cladding or coat or coated or coating or electroplate or electroplated or electroplating or electroless or electrolessly or electroform or electroformed or electroforming or electrodeposit or electrodeposited or electrodepositing or electrodeposition or "electro-plate" or "electro-plated" or "electro-plating" or "electro-less" or "electro-lessly" or "electro-form" or "electro-formed" or "electro-forming" or "electro-deposit" or "electro-deposited" or "electro-depositing" or "electro-deposition"))	US-PGPU B; USPAT; USOCR	OR	ON	2022/03/28 06:27
L17	82	L16 and (("220" or "[220]" or "{220}" or "(220)" or "<220>") near5 (texture or coefficient or index or Miller or hkl or "h, k,l"))	US-PGPU B; USPAT; USOCR	OR	ON	2022/03/28 06:27
L18	72	L17 not (L12 or L14)	US-PGPU B; USPAT; USOCR	OR	ON	2022/03/28 06:27

EAST Search History (Prior Art)

L19	91	L16 and (("220" or "[220]" or "{220}" or "(220)" or "<220>") near8 (texture or coefficient or index or Miller or hkl or "h, k,l"))	US-PGPUB; USPAT; USOCR	OR	ON	2022/03/28 06:30
L20	9	L19 not (L12 or L14 or L18)	US-PGPUB; USPAT; USOCR	OR	ON	2022/03/28 06:30
L21	35	L15 and (((Cu or copper or "cu-alloy" or "cu-base" or "Cu-based" or "copper-base" or "copper-based" or "copper-alloy") with (foil or foiled or foiling or tape or ribbon or layer or layered or layering or film or filmed or filming or clad or claded or cladded or clading or cladding or coat or coated or coating or electroplate or electroplated or electroplating or electroless or electrolessly or electroform or electroformed or electroforming or electrodeposit or electrodeposited or electrodepositing or electrodeposition or "electro-plate" or "electro-plated" or "electro-plating" or "electro-less" or "electro-lessly" or "electro-form" or "electro-formed" or "electro-forming" or "electro-deposit" or "electro-deposited" or "electro-depositing" or "electro-deposition")) with (("220" or "[220]" or "{220}" or "(220)" or "<220>") with (texture or coefficient or index or Miller or hkl or "h,k, l")))	US-PGPUB; USPAT; USOCR	OR	ON	2022/03/28 06:31
L22	2	L21 not (L12 or L14 or L18 or L20)	US-PGPUB; USPAT; USOCR	OR	ON	2022/03/28 06:31

EAST Search History (Prior Art)

L23	945,781	B32B15/01;C25D1/04;C25D 3/38;C25D5/34, 48;C25D21/06;H01M4/0404, 13,66,661,667;H01M10/052, 0525;H01M2004/027;Y02E6 0/10;Y10T428/12431,12438. cpc.	FPRS; EPO; JPO; DERWEN T; IBM_TDB	OR	ON	2022/03/28 06:37
L24	71	L23 and (((Cu or copper or "cu-alloy" or "cu-base" or "Cu-based" or "copper-base" or "copper-based" or "copper-alloy") with (foil or foiled or foiling or tape or ribbon or layer or layered or layering or film or filmed or filming or clad or claded or cladded or clading or cladding or coat or coated or coating or electroplate or electroplated or electroplating or electroless or electrolessly or electroform or electroformed or electroforming or electrodeposit or electrodeposited or electrodepositing or electrodeposition or "electro-plate" or "electro-plated" or "electro-plating" or "electro-less" or "electro-lessly" or "electro-form" or "electro-formed" or "electro-forming" or "electro-deposit" or "electro-deposited" or "electro-depositing" or "electro-deposition")) with (("220" or "[220]" or "{220}" or "(220)" or "<220>") with (texture or coefficient or index or Miller or hkl or "h,k, l")))	FPRS; EPO; JPO; DERWEN T; IBM_TDB	OR	ON	2022/03/28 06:37

L25	17,955	L23 and ((Cu or copper or "cu-alloy" or "cu-base" or "Cu-based" or "copper-base" or "copper-based" or "copper-alloy") near5 (foil or foiled or foiling or tape or ribbon or layer or layered or layering or film or filmed or filming or clad or claded or cladded or clading or cladding or coat or coated or coating or electroplate or electroplated or electroplating or electroless or electrolessly or electroform or electroformed or electroforming or electrodeposit or electrodeposited or electrodepositing or electrodeposition or "electro-plate" or "electro-plated" or "electro-plating" or "electro-less" or "electro-lessly" or "electro-form" or "electro-formed" or "electro-forming" or "electro-deposit" or "electro-deposited" or "electro-depositing" or "electro-deposition"))	FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2022/03/28 06:40
L26	65	L25 and (("220" or "[220]" or "{220}" or "(220)" or "<220>") near5 (texture or coefficient or index or Miller or hkl or "h, k,l"))	FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2022/03/28 06:40
L27	9	L26 not L24	FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2022/03/28 06:40
L28	80	L25 and (("220" or "[220]" or "{220}" or "(220)" or "<220>") with (texture or coefficient or index or Miller or hkl or "h,k, l"))	FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2022/03/28 06:43

L29	0	L28 not (L24 or L27)	FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2022/03/28 06:43
L30	22,247	L23 and ((Cu or copper or "cu-alloy" or "cu-base" or "Cu-based" or "copper-base" or "copper-based" or "copper-alloy") with (foil or foiled or foiling or tape or ribbon or layer or layered or layering or film or filmed or filming or clad or claded or cladded or clading or cladding or coat or coated or coating or electroplate or electroplated or electroplating or electroless or electrolessly or electroform or electroformed or electroforming or electrodeposit or electrodeposited or electrodepositing or electrodeposition or "electro-plate" or "electro-plated" or "electro-plating" or "electro-less" or "electro-lessly" or "electro-form" or "electro-formed" or "electro-forming" or "electro-deposit" or "electro-deposited" or "electro-depositing" or "electro-deposition"))	FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2022/03/28 06:43
L31	81	L30 and (("220" or "[220]" or "{220}" or "(220)" or "<220>") with (texture or coefficient or index or Miller or hkl or "h,k, l"))	FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2022/03/28 06:43
L32	1	L31 not (L24 or L27)	FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2022/03/28 06:43

L33	33	(((Cu or copper or "cu-alloy" or "cu-base" or "Cu-based" or "copper-base" or "copper-based" or "copper-alloy") near5 (foil or foiled or foiling or tape or ribbon or layer or layered or layering or film or filmed or filming or clad or claded or cladded or clading or cladding or coat or coated or coating or electroplate or electroplated or electroplating or electroless or electrolessly or electroform or electroformed or electroforming or electrodeposit or electrodeposited or electrodepositing or electrodeposition or "electro-plate" or "electro-plated" or "electro-plating" or "electro-less" or "electro-lessly" or "electro-form" or "electro-formed" or "electro-forming" or "electro-deposit" or "electro-deposited" or "electro-depositing" or "electro-deposition")) near5 (("220" or "[220]" or "{220}" or "(220)" or "<220>") near5 (texture or coefficient or index or Miller or hkl or "h,k, l")))	FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2022/03/28 06:44
L34	7	L33 not (L24 or L27 or L32)	FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2022/03/28 06:44

EAST Search History (Prior Art)

L35	133	(((Cu or copper or "cu-alloy" or "cu-base" or "Cu-based" or "copper-base" or "copper-based" or "copper-alloy") with (foil or foiled or foiling or tape or ribbon or layer or layered or layering or film or filmed or filming or clad or claded or cladded or clading or cladding or coat or coated or coating or electroplate or electroplated or electroplating or electroless or electrolessly or electroform or electroformed or electroforming or electrodeposit or electrodeposited or electrodepositing or electrodeposition or "electro-plate" or "electro-plated" or "electro-plating" or "electro-less" or "electro-lessly" or "electro-form" or "electro-formed" or "electro-forming" or "electro-deposit" or "electro-deposited" or "electro-depositing" or "electro-deposition")) with (("220" or "[220]" or "{220}" or "(220)" or "<220>") with (texture or coefficient or index or Miller or hkl or "h,k, l")))	FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2022/03/28 06:48
L36	55	L35 not (L24 or L27 or L32 or L34)	FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2022/03/28 06:48

EAST Search History (Prior Art)

L37	46	(((Cu or copper or "cu-alloy" or "cu-base" or "Cu-based" or "copper-base" or "copper-based" or "copper-alloy") near5 (foil or foiled or foiling or tape or ribbon or layer or layered or layering or film or filmed or filming or clad or claded or cladded or clading or cladding or coat or coated or coating or electroplate or electroplated or electroplating or electroless or electrolessly or electroform or electroformed or electroforming or electrodeposit or electrodeposited or electrodepositing or electrodeposition or "electro-plate" or "electro-plated" or "electro-plating" or "electro-less" or "electro-lessly" or "electro-form" or "electro-formed" or "electro-forming" or "electro-deposit" or "electro-deposited" or "electro-depositing" or "electro-deposition")) near5 (("220" or "[220]" or "{220}" or "(220)" or "<220>") near5 (texture or coefficient or index or Miller or hkl or "h,k, l")))	US-PGPUB; USPAT; USOCR	OR	ON	2022/03/28 06:51
L38	22	L37 not (L12 or L14 or L18 or L20 or L22)	US-PGPUB; USPAT; USOCR	OR	ON	2022/03/28 06:51

EAST Search History (Prior Art)

L39	117	(((Cu or copper or "cu-alloy" or "cu-base" or "Cu-based" or "copper-base" or "copper-based" or "copper-alloy") with (foil or foiled or foiling or tape or ribbon or layer or layered or layering or film or filmed or filming or clad or claded or cladded or clading or cladding or coat or coated or coating or electroplate or electroplated or electroplating or electroless or electrolessly or electroform or electroformed or electroforming or electrodeposit or electrodeposited or electrodepositing or electrodeposition or "electro-plate" or "electro-plated" or "electro-plating" or "electro-less" or "electro-lessly" or "electro-form" or "electro-formed" or "electro-forming" or "electro-deposit" or "electro-deposited" or "electro-depositing" or "electro-deposition")) with (("220" or "[220]" or "{220}" or "(220)" or "<220>") with (texture or coefficient or index or Miller or hkl or "h,k, l")))	US-PGPUB; USPAT; USOCR	OR	ON	2022/03/28 06:53
L40	60	L39 not (L12 or L14 or L18 or L20 or L22 or L38)	US-PGPUB; USPAT; USOCR	OR	ON	2022/03/28 06:53
L41	2	L23 and (("220" or "[220]" or "{220}" or "(220)" or "<220>") near5 (stress))	FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2022/03/28 06:59

EAST Search History (Prior Art)

L42	3	L23 and (("111" or "[111]" or "{111}" or "(111)" or "<111>") near5 (stress))	FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2022/03/28 07:01
L43	51	L23 and (("200" or "[200]" or "{200}" or "(200)" or "<200>") near5 (stress))	FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2022/03/28 07:07

EAST Search History (Prior Art)

L44	90	((Cu or copper or "cu-alloy" or "cu-base" or "Cu-based" or "copper-base" or "copper-based" or "copper-alloy") near5 (foil or foiled or foiling or tape or ribbon or layer or layered or layering or film or filmed or filming or clad or claded or cladded or clading or cladding or coat or coated or coating or electroplate or electroplated or electroplating or electroless or electrolessly or electroform or electroformed or electroforming or electrodeposit or electrodeposited or electrodepositing or electrodeposition or "electro-plate" or "electro-plated" or "electro-plating" or "electro-less" or "electro-lessly" or "electro-form" or "electro-formed" or "electro-forming" or "electro-deposit" or "electro-deposited" or "electro-depositing" or "electro-deposition")) and (("111" or "[111]" or "{111}" or "(111)" or "<111>" or "200" or "[200]" or "{200}" or "(200)" or "<200>" or "220" or "[220]" or "{220}" or "(220)" or "<220>" or "311" or "[311]" or "{311}" or "(311)" or "<311>") near5 (residual near2 stress))	US-PGPUB; USPAT; USOCR	OR	ON	2022/03/28 07:12

L45	130	((Cu or copper or "cu-alloy" or "cu-base" or "Cu-based" or "copper-base" or "copper-based" or "copper-alloy") near8 (foil or foiled or foiling or tape or ribbon or layer or layered or layering or film or filmed or filming or clad or claded or cladded or clading or cladding or coat or coated or coating or electroplate or electroplated or electroplating or electroless or electrolessly or electroform or electroformed or electroforming or electrodeposit or electrodeposited or electrodepositing or electrodeposition or "electro-plate" or "electro-plated" or "electro-plating" or "electro-less" or "electro-lessly" or "electro-form" or "electro-formed" or "electro-forming" or "electro-deposit" or "electro-deposited" or "electro-depositing" or "electro-deposition")) and (("111" or "[111]" or "{111}" or "(111)" or "<111>" or "200" or "[200]" or "{200}" or "(200)" or "<200>" or "220" or "[220]" or "{220}" or "(220)" or "<220>" or "311" or "[311]" or "{311}" or "(311)" or "<311>") near8 (residual near2 stress))	US-PGPUB; USPAT; USOCR	OR	ON	2022/03/28 07:24
L46	40	L45 not L44	US-PGPUB; USPAT; USOCR	OR	ON	2022/03/28 07:24

EAST Search History (Prior Art)

L47	261	((Cu or copper or "cu-alloy" or "cu-base" or "Cu-based" or "copper-base" or "copper-based" or "copper-alloy") with (foil or foiled or foiling or tape or ribbon or layer or layered or layering or film or filmed or filming or clad or claded or cladded or clading or cladding or coat or coated or coating or electroplate or electroplated or electroplating or electroless or electrolessly or electroform or electroformed or electroforming or electrodeposit or electrodeposited or electrodepositing or electrodeposition or "electro-plate" or "electro-plated" or "electro-plating" or "electro-less" or "electro-lessly" or "electro-form" or "electro-formed" or "electro-forming" or "electro-deposit" or "electro-deposited" or "electro-depositing" or "electro-deposition")) and (("111" or "[111]" or "{111}" or "(111)" or "<111>" or "200" or "[200]" or "{200}" or "(200)" or "<200>" or "220" or "[220]" or "{220}" or "(220)" or "<220>" or "311" or "[311]" or "{311}" or "(311)" or "<311>") with (residual near2 stress))	US-PGPUB; USPAT; USOCR	OR	ON	2022/03/28 07:25
L48	131	L47 not (L44 or L46)	US-PGPUB; USPAT; USOCR	OR	ON	2022/03/28 07:25

L49	24	((Cu or copper or "cu-alloy" or "cu-base" or "Cu-based" or "copper-base" or "copper-based" or "copper-alloy") with (foil or foiled or foiling or tape or ribbon or layer or layered or layering or film or filmed or filming or clad or claded or cladded or clading or cladding or coat or coated or coating or electroplate or electroplated or electroplating or electroless or electrolessly or electroform or electroformed or electroforming or electrodeposit or electrodeposited or electrodepositing or electrodeposition or "electro-plate" or "electro-plated" or "electro-plating" or "electro-less" or "electro-lessly" or "electro-form" or "electro-formed" or "electro-forming" or "electro-deposit" or "electro-deposited" or "electro-depositing" or "electro-deposition")) and (("111" or "[111]" or "{111}" or "(111)" or "<111>" or "200" or "[200]" or "{200}" or "(200)" or "<200>" or "220" or "[220]" or "{220}" or "(220)" or "<220>" or "311" or "[311]" or "{311}" or "(311)" or "<311>") with (residual near2 stress))	FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2022/03/28 07:32
L50	12	((("JIN") near3 ("Shan") near3 ("Hua"))).INV.	US-PGPUB; USPAT; USOCR	OR	ON	2022/03/28 07:35
L51	22	((("LEE") near3 ("An") near3 ("Na"))).INV.	US-PGPUB; USPAT; USOCR	OR	ON	2022/03/28 07:35

EAST Search History (Prior Art)

L52	115	((("KIM") near3 ("Seung") near3 ("Min"))).INV.	US-PGPUB; USPAT; USOCR	OR	ON	2022/03/28 07:35
L53	389	((("JIN") near3 ("Shan" or Hua or "shanhua" or "shan-hua"))).INV.	US-PGPUB; USPAT; USOCR	OR	ON	2022/03/28 07:35
L54	981	((("LEE") near3 ("An" or Na or "An-Na"))).INV.	US-PGPUB; USPAT; USOCR	OR	ON	2022/03/28 07:35
L55	18,485	((("KIM") near3 ("Seung" or Min or "SeungMin" or "Seung-Min"))).INV.	US-PGPUB; USPAT; USOCR	OR	ON	2022/03/28 07:35
L56	49	((("JIN") near3 ("Shan" or Hua or "shanhua" or "shan-hua"))).aanm.	US-PGPUB; USPAT; USOCR	OR	ON	2022/03/28 07:35
L57	110	((("LEE") near3 ("An" or Na or "An-Na"))).aanm.	US-PGPUB; USPAT; USOCR	OR	ON	2022/03/28 07:35
L58	2,041	((("KIM") near3 ("Seung" or Min or "SeungMin" or "Seung-Min"))).aanm.	US-PGPUB; USPAT; USOCR	OR	ON	2022/03/28 07:35
L59	19,784	L50 or L51 or L52 or L53 or L54 or L55 or L56 or L57 or L58	US-PGPUB; USPAT; USOCR	OR	ON	2022/03/28 07:35

L60	2,017	L59 and ((Cu or copper or "cu-alloy" or "cu-base" or "Cu-based" or "copper-base" or "copper-based" or "copper-alloy") with (foil or foiled or foiling or tape or ribbon or layer or layered or layering or film or filmed or filming or clad or claded or cladded or clading or cladding or coat or coated or coating or electroplate or electroplated or electroplating or electroless or electrolessly or electroform or electroformed or electroforming or electrodeposit or electrodeposited or electrodepositing or electrodeposition or "electro-plate" or "electro-plated" or "electro-plating" or "electro-less" or "electro-lessly" or "electro-form" or "electro-formed" or "electro-forming" or "electro-deposit" or "electro-deposited" or "electro-depositing" or "electro-deposition"))	US-PGPUB; USPAT; USOCR	OR	ON	2022/03/28 07:35
L61	12	L60 and (("220" or "[220]" or "{220}" or "(220)" or "<220>") near5 (texture or coefficient or index or Miller or hkl or "h, k,l"))	US-PGPUB; USPAT; USOCR	OR	ON	2022/03/28 07:35
L62	58	((KCF) near3 (tech or technol or technology)).as,aanm.	US-PGPUB; USPAT; USOCR	OR	ON	2022/03/28 07:37
L63	50	L62 not L61	US-PGPUB; USPAT; USOCR	OR	ON	2022/03/28 07:37

L64	155,937	B32B15/01;C25D1/04;C25D 3/38;C25D5/34, 48;C25D7/0614;C25D21/06; H01M4/0404,13,66,661, 667;H01M10/052, 0525;H01M2004/027;Y02E6 0/10;Y10T428/12431,12438. cpc.	US-PGPU B; USPAT; USOCR	OR	ON	2022/03/28 07:40
L65	42,990	L64 and ((Cu or copper or "cu-alloy" or "cu-base" or "Cu-based" or "copper-base" or "copper-based" or "copper-alloy") near5 (foil or foiled or foiling or tape or ribbon or layer or layered or layering or film or filmed or filming or clad or claded or cladded or clading or cladding or coat or coated or coating or electroplate or electroplated or electroplating or electroless or electrolessly or electroform or electroformed or electroforming or electrodeposit or electrodeposited or electrodepositing or electrodeposition or "electro-plate" or "electro-plated" or "electro-plating" or "electro-less" or "electro-lessly" or "electro-form" or "electro-formed" or "electro-forming" or "electro-deposit" or "electro-deposited" or "electro-depositing" or "electro-deposition"))	US-PGPU B; USPAT; USOCR	OR	ON	2022/03/28 07:40
L66	82	L65 and (("220" or "[220]" or "{220}" or "(220)" or "<220>") near5 (texture or coefficient or index or Miller or hkl or "h, k,l"))	US-PGPU B; USPAT; USOCR	OR	ON	2022/03/28 07:40
L67	73	L66 not (L59 or L61)	US-PGPU B; USPAT; USOCR	OR	ON	2022/03/28 07:40

EAST Search History (Prior Art)

L68	91	L65 and (("220" or "[220]" or "{220}" or "(220)" or "<220>") near8 (texture or coefficient or index or Miller or hkl or "h, k,l"))	US-PGPUB; USPAT; USOCR	OR	ON	2022/03/28 07:45
L69	9	L68 not (L59 or L61 or L67)	US-PGPUB; USPAT; USOCR	OR	ON	2022/03/28 07:45
L70	147	L65 and (("220" or "[220]" or "{220}" or "(220)" or "<220>") with (texture or coefficient or index or Miller or hkl or "h,k, l"))	US-PGPUB; USPAT; USOCR	OR	ON	2022/03/28 07:48
L71	55	L70 not (L59 or L61 or L67 or L69)	US-PGPUB; USPAT; USOCR	OR	ON	2022/03/28 07:48
L72	447	L65 and ((peak near2 density) or PD.u/c.)	US-PGPUB; USPAT; USOCR	OR	ON	2022/03/28 07:53
L73	37	L65 and (((peak near2 density) or PD.u/c.) near5 (surface))	US-PGPUB; USPAT; USOCR	OR	ON	2022/03/28 07:55
L74	54	L64 and (((peak near2 density) or PD.u/c.) near5 (surface or shiney or shiny or matt or matte or mat or matted))	US-PGPUB; USPAT; USOCR	OR	ON	2022/03/28 07:59
L75	17	L74 not (L59 or L61 or L67 or L69 or L73)	US-PGPUB; USPAT; USOCR	OR	ON	2022/03/28 07:59
L76	948,740	B32B15/01;C25D1/04;C25D3/38;C25D5/34,48;C25D7/0614;C25D21/06;H01M4/0404,13,66,661,667;H01M10/052,0525;H01M2004/027;Y02E60/10;Y10T428/12431,12438.cpc.	FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2022/03/28 08:01

EAST Search History (Prior Art)

L77	71	L76 and (((Cu or copper or "cu-alloy" or "cu-base" or "Cu-based" or "copper-base" or "copper-based" or "copper-alloy") with (foil or foiled or foiling or tape or ribbon or layer or layered or layering or film or filmed or filming or clad or claded or cladded or clading or cladding or coat or coated or coating or electroplate or electroplated or electroplating or electroless or electrolessly or electroform or electroformed or electroforming or electrodeposit or electrodeposited or electrodepositing or electrodeposition or "electro-plate" or "electro-plated" or "electro-plating" or "electro-less" or "electro-lessly" or "electro-form" or "electro-formed" or "electro-forming" or "electro-deposit" or "electro-deposited" or "electro-depositing" or "electro-deposition")) with (("220" or "[220]" or "{220}" or "(220)" or "<220>") with (texture or coefficient or index or Miller or hkl or "h,k, l")))	FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2022/03/28 08:01
L78	20	L76 and (((peak near2 density) or PD.u/c.) near5 (surface or shiney or shiny or matt or matte or mat or matted))	FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2022/03/28 08:05

EAST Search History (Prior Art)

L79	15	(((Cu or copper or "cu-alloy" or "cu-base" or "Cu-based" or "copper-base" or "copper-based" or "copper-alloy") with (foil or foiled or foiling or tape or ribbon or layer or layered or layering or film or filmed or filming or clad or claded or cladded or clading or cladding or coat or coated or coating or electroplate or electroplated or electroplating or electroless or electrolessly or electroform or electroformed or electroforming or electrodeposit or electrodeposited or electrodepositing or electrodeposition or "electro-plate" or "electro-plated" or "electro-plating" or "electro-less" or "electro-lessly" or "electro-form" or "electro-formed" or "electro-forming" or "electro-deposit" or "electro-deposited" or "electro-depositing" or "electro-deposition")) with (("220" or "[220]" or "{220}" or "(220)" or "<220>") with (texture or coefficient or index or Miller or hkl or "h,k, l"))) and (((peak near2 density) or PD.u/c.) near5 (surface or shiney or shiny or matt or matte or mat or matted))	FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2022/03/28 08:11
L80	0	L79 not L78	FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2022/03/28 08:11

EAST Search History (Prior Art)

L81	16	(((Cu or copper or "cu-alloy" or "cu-base" or "Cu-based" or "copper-base" or "copper-based" or "copper-alloy") with (foil or foiled or foiling or tape or ribbon or layer or layered or layering or film or filmed or filming or clad or claded or cladded or clading or cladding or coat or coated or coating or electroplate or electroplated or electroplating or electroless or electrolessly or electroform or electroformed or electroforming or electrodeposit or electrodeposited or electrodepositing or electrodeposition or "electro-plate" or "electro-plated" or "electro-plating" or "electro-less" or "electro-lessly" or "electro-form" or "electro-formed" or "electro-forming" or "electro-deposit" or "electro-deposited" or "electro-depositing" or "electro-deposition")) with (("220" or "[220]" or "{220}" or "(220)" or "<220>") with (texture or coefficient or index or Miller or hkl or "h,k, l"))) and (((peak near2 density) or PD.u/c.) with (surface or shiney or shiny or matt or matte or mat or matted))	FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2022/03/28 08:11
L82	1	L81 not L78	FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2022/03/28 08:11

EAST Search History (Prior Art)

L83	22	((Cu or copper or "cu-alloy" or "cu-base" or "Cu-based" or "copper-base" or "copper-based" or "copper-alloy") near5 (foil or foiled or foiling or tape or ribbon or layer or layered or layering or film or filmed or filming or clad or claded or cladded or clading or cladding or coat or coated or coating or electroplate or electroplated or electroplating or electroless or electrolessly or electroform or electroformed or electroforming or electrodeposit or electrodeposited or electrodepositing or electrodeposition or "electro-plate" or "electro-plated" or "electro-plating" or "electro-less" or "electro-lessly" or "electro-form" or "electro-formed" or "electro-forming" or "electro-deposit" or "electro-deposited" or "electro-depositing" or "electro-deposition")) near5 (((peak near2 density) or PD. u/c.) near5 (surface or shiney or shiny or matt or matte or mat or matted))	FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2022/03/28 08:12
L84	7	L83 not (L78 or L82)	FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2022/03/28 08:12

L85	24	((Cu or copper or "cu-alloy" or "cu-base" or "Cu-based" or "copper-base" or "copper-based" or "copper-alloy") with (foil or foiled or foiling or tape or ribbon or layer or layered or layering or film or filmed or filming or clad or claded or cladded or clading or cladding or coat or coated or coating or electroplate or electroplated or electroplating or electroless or electrolessly or electroform or electroformed or electroforming or electrodeposit or electrodeposited or electrodepositing or electrodeposition or "electro-plate" or "electro-plated" or "electro-plating" or "electro-less" or "electro-lessly" or "electro-form" or "electro-formed" or "electro-forming" or "electro-deposit" or "electro-deposited" or "electro-depositing" or "electro-deposition")) with (((peak near2 density) or PD. u/c.) near5 (surface or shiney or shiny or matt or matte or mat or matted))	FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2022/03/28 08:16
L86	1	L85 not (L78 or L82 or L84)	FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2022/03/28 08:16

L87	13	((Cu or copper or "cu-alloy" or "cu-base" or "Cu-based" or "copper-base" or "copper-based" or "copper-alloy") near5 (foil or foiled or foiling or tape or ribbon or layer or layered or layering or film or filmed or filming or clad or claded or cladded or clading or cladding or coat or coated or coating or electroplate or electroplated or electroplating or electroless or electrolessly or electroform or electroformed or electroforming or electrodeposit or electrodeposited or electrodepositing or electrodeposition or "electro-plate" or "electro-plated" or "electro-plating" or "electro-less" or "electro-lessly" or "electro-form" or "electro-formed" or "electro-forming" or "electro-deposit" or "electro-deposited" or "electro-depositing" or "electro-deposition")) near5 (((peak near2 density) or PD. u/c.) near5 (surface or shiney or shiny or matt or matte or mat or matted))	US-PGPUB; USPAT; USOCR	OR	ON	2022/03/28 08:16
L88	7	L87 not (L59 or L61 or L67 or L69 or L73 or L75)	US-PGPUB; USPAT; USOCR	OR	ON	2022/03/28 08:16

L89	16	((Cu or copper or "cu-alloy" or "cu-base" or "Cu-based" or "copper-base" or "copper-based" or "copper-alloy") near8 (foil or foiled or foiling or tape or ribbon or layer or layered or layering or film or filmed or filming or clad or claded or cladded or clading or cladding or coat or coated or coating or electroplate or electroplated or electroplating or electroless or electrolessly or electroform or electroformed or electroforming or electrodeposit or electrodeposited or electrodepositing or electrodeposition or "electro-plate" or "electro-plated" or "electro-plating" or "electro-less" or "electro-lessly" or "electro-form" or "electro-formed" or "electro-forming" or "electro-deposit" or "electro-deposited" or "electro-depositing" or "electro-deposition")) near8 (((peak near2 density) or PD. u/c.) near5 (surface or shiney or shiny or matt or matte or mat or matted))	US-PGPUB; USPAT; USOCR	OR	ON	2022/03/28 08:19
L90	3	L89 not (L59 or L61 or L67 or L69 or L73 or L75 or L88)	US-PGPUB; USPAT; USOCR	OR	ON	2022/03/28 08:19

EAST Search History (Prior Art)

L91	22	((Cu or copper or "cu-alloy" or "cu-base" or "Cu-based" or "copper-base" or "copper-based" or "copper-alloy") with (foil or foiled or foiling or tape or ribbon or layer or layered or layering or film or filmed or filming or clad or claded or cladded or clading or cladding or coat or coated or coating or electroplate or electroplated or electroplating or electroless or electrolessly or electroform or electroformed or electroforming or electrodeposit or electrodeposited or electrodepositing or electrodeposition or "electro-plate" or "electro-plated" or "electro-plating" or "electro-less" or "electro-lessly" or "electro-form" or "electro-formed" or "electro-forming" or "electro-deposit" or "electro-deposited" or "electro-depositing" or "electro-deposition")) with (((peak near2 density) or PD. u/c.) near5 (surface or shiney or shiny or matt or matte or mat or matted))	US-PGPUB; USPAT; USOCR	OR	ON	2022/03/28 08:23
L92	6	L91 not (L59 or L61 or L67 or L69 or L73 or L75 or L88 or L90)	US-PGPUB; USPAT; USOCR	OR	ON	2022/03/28 08:23

EAST Search History (Prior Art)

L93	33	(((Cu or copper or "cu-alloy" or "cu-base" or "Cu-based" or "copper-base" or "copper-based" or "copper-alloy") near5 (foil or foiled or foiling or tape or ribbon or layer or layered or layering or film or filmed or filming or clad or claded or cladded or clading or cladding or coat or coated or coating or electroplate or electroplated or electroplating or electroless or electrolessly or electroform or electroformed or electroforming or electrodeposit or electrodeposited or electrodepositing or electrodeposition or "electro-plate" or "electro-plated" or "electro-plating" or "electro-less" or "electro-lessly" or "electro-form" or "electro-formed" or "electro-forming" or "electro-deposit" or "electro-deposited" or "electro-depositing" or "electro-deposition")) near5 (("220" or "[220]" or "{220}" or "(220)" or "<220>") near5 (texture or coefficient or index or Miller or hkl or "h,k,l")))	FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2022/03/28 08:24

EAST Search History (Prior Art)

L94	45	(((Cu or copper or "cu-alloy" or "cu-base" or "Cu-based" or "copper-base" or "copper-based" or "copper-alloy") near5 (foil or foiled or foiling or tape or ribbon or layer or layered or layering or film or filmed or filming or clad or claded or cladded or clading or cladding or coat or coated or coating or electroplate or electroplated or electroplating or electroless or electrolessly or electroform or electroformed or electroforming or electrodeposit or electrodeposited or electrodepositing or electrodeposition or "electro-plate" or "electro-plated" or "electro-plating" or "electro-less" or "electro-lessly" or "electro-form" or "electro-formed" or "electro-forming" or "electro-deposit" or "electro-deposited" or "electro-depositing" or "electro-deposition")) near5 (("220" or "[220]" or "{220}" or "(220)" or "<220>") with (texture or coefficient or index or Miller or hkl or "h,k, l")))	FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2022/03/28 08:25
L95	14	L94 not L93	FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2022/03/28 08:25

L96	133	(((Cu or copper or "cu-alloy" or "cu-base" or "Cu-based" or "copper-base" or "copper-based" or "copper-alloy") with (foil or foiled or foiling or tape or ribbon or layer or layered or layering or film or filmed or filming or clad or claded or cladded or clading or cladding or coat or coated or coating or electroplate or electroplated or electroplating or electroless or electrolessly or electroform or electroformed or electroforming or electrodeposit or electrodeposited or electrodepositing or electrodeposition or "electro-plate" or "electro-plated" or "electro-plating" or "electro-less" or "electro-lessly" or "electro-form" or "electro-formed" or "electro-forming" or "electro-deposit" or "electro-deposited" or "electro-depositing" or "electro-deposition")) with (("220" or "[220]" or "{220}" or "(220)" or "<220>") with (texture or coefficient or index or Miller or hkl or "h,k, l")))	FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2022/03/28 08:26
L97	86	L96 not (L93 or L95)	FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2022/03/28 08:26

L98	46	(((Cu or copper or "cu-alloy" or "cu-base" or "Cu-based" or "copper-base" or "copper-based" or "copper-alloy") near5 (foil or foiled or foiling or tape or ribbon or layer or layered or layering or film or filmed or filming or clad or claded or cladded or clading or cladding or coat or coated or coating or electroplate or electroplated or electroplating or electroless or electrolessly or electroform or electroformed or electroforming or electrodeposit or electrodeposited or electrodepositing or electrodeposition or "electro-plate" or "electro-plated" or "electro-plating" or "electro-less" or "electro-lessly" or "electro-form" or "electro-formed" or "electro-forming" or "electro-deposit" or "electro-deposited" or "electro-depositing" or "electro-deposition")) near5 (("220" or "[220]" or "{220}" or "(220)" or "<220>") near5 (texture or coefficient or index or Miller or hkl or "h,k, l")))	US-PGPUB; USPAT; USOCR	OR	ON	2022/03/28 08:30
L99	22	L98 not (L59 or L61 or L67 or L69 or L73 or L75 or L88 or L90 or L92)	US-PGPUB; USPAT; USOCR	OR	ON	2022/03/28 08:30

EAST Search History (Prior Art)

L100	58	(((Cu or copper or "cu-alloy" or "cu-base" or "Cu-based" or "copper-base" or "copper-based" or "copper-alloy") near8 (foil or foiled or foiling or tape or ribbon or layer or layered or layering or film or filmed or filming or clad or claded or cladded or clading or cladding or coat or coated or coating or electroplate or electroplated or electroplating or electroless or electrolessly or electroform or electroformed or electroforming or electrodeposit or electrodeposited or electrodepositing or electrodeposition or "electro-plate" or "electro-plated" or "electro-plating" or "electro-less" or "electro-lessly" or "electro-form" or "electro-formed" or "electro-forming" or "electro-deposit" or "electro-deposited" or "electro-depositing" or "electro-deposition")) near8 (("220" or "[220]" or "{220}" or "(220)" or "<220>") near8 (texture or coefficient or index or Miller or hkl or "h,k,l")))	US-PGPUB; USPAT; USOCR	OR	ON	2022/03/28 08:33
L101	10	L100 not (L59 or L61 or L67 or L69 or L73 or L75 or L88 or L90 or L92 or L99)	US-PGPUB; USPAT; USOCR	OR	ON	2022/03/28 08:33

EAST Search History (Prior Art)

L102	80	(((Cu or copper or "cu-alloy" or "cu-base" or "Cu-based" or "copper-base" or "copper-based" or "copper-alloy") near12 (foil or foiled or foiling or tape or ribbon or layer or layered or layering or film or filmed or filming or clad or claded or cladded or clading or cladding or coat or coated or coating or electroplate or electroplated or electroplating or electroless or electrolessly or electroform or electroformed or electroforming or electrodeposit or electrodeposited or electrodepositing or electrodeposition or "electro-plate" or "electro-plated" or "electro-plating" or "electro-less" or "electro-lessly" or "electro-form" or "electro-formed" or "electro-forming" or "electro-deposit" or "electro-deposited" or "electro-depositing" or "electro-deposition")) near12 (("220" or "[220]" or "{220}" or "(220)" or "<220>") near12 (texture or coefficient or index or Miller or hkl or "h,k,l")))	US-PGPUB; USPAT; USOCR	OR	ON	2022/03/28 08:34
L103	17	L102 not (L59 or L61 or L67 or L69 or L73 or L75 or L88 or L90 or L92 or L99 or L101)	US-PGPUB; USPAT; USOCR	OR	ON	2022/03/28 08:34
S1	12	((("JIN") near3 ("Shan") near3 ("Hua"))).INV.	US-PGPUB; USPAT; USOCR	OR	ON	2021/11/15 10:01
S2	22	((("LEE") near3 ("An") near3 ("Na"))).INV.	US-PGPUB; USPAT; USOCR	OR	ON	2021/11/15 10:01

EAST Search History (Prior Art)

S3	114	((("KIM") near3 ("Seung") near3 ("Min"))).INV.	US-PGPUB; USPAT; USOCR	OR	ON	2021/11/15 10:01
S4	383	((("JIN") near3 ("Shan" or Hua or "shanhua" or "shan-hua"))).INV.	US-PGPUB; USPAT; USOCR	OR	ON	2021/11/15 10:02
S5	942	((("LEE") near3 ("An" or Na or "An-Na"))).INV.	US-PGPUB; USPAT; USOCR	OR	ON	2021/11/15 10:02
S6	18,027	((("KIM") near3 ("Seung" or Min or "SeungMin" or "Seung-Min"))).INV.	US-PGPUB; USPAT; USOCR	OR	ON	2021/11/15 10:03
S7	49	((("JIN") near3 ("Shan" or Hua or "shanhua" or "shan-hua"))).aanm.	US-PGPUB; USPAT; USOCR	OR	ON	2021/11/15 10:03
S8	110	((("LEE") near3 ("An" or Na or "An-Na"))).aanm.	US-PGPUB; USPAT; USOCR	OR	ON	2021/11/15 10:03
S9	2,032	((("KIM") near3 ("Seung" or Min or "SeungMin" or "Seung-Min"))).aanm.	US-PGPUB; USPAT; USOCR	OR	ON	2021/11/15 10:03
S10	19,281	S1 or S2 or S3 or S4 or S5 or S6 or S7 or S8 or S9	US-PGPUB; USPAT; USOCR	OR	ON	2021/11/15 10:03

S12	1,930	S10 and ((Cu or copper or "cu-alloy" or "cu-base" or "Cu-based" or "copper-base" or "copper-based" or "copper-alloy") with (foil or foiled or foiling or tape or ribbon or layer or layered or layering or film or filmed or filming or clad or claded or cladded or clading or cladding or coat or coated or coating or electroplate or electroplated or electroplating or electroless or electrolessly or electroform or electroformed or electroforming or electrodeposit or electrodeposited or electrodepositing or electrodeposition or "electro-plate" or "electro-plated" or "electro-plating" or "electro-less" or "electro-lessly" or "electro-form" or "electro-formed" or "electro-forming" or "electro-deposit" or "electro-deposited" or "electro-depositing" or "electro-deposition"))	US-PGPUB; USPAT; USOCR	OR	ON	2021/11/15 10:04
S13	11	S12 and (("220" or "[220]" or "{220}" or "(220)" or "<220>") near5 (texture or coefficient or index or Miller or hkl or "h, k,l"))	US-PGPUB; USPAT; USOCR	OR	ON	2021/11/15 10:06
S14	58	((KCF) near3 (tech or technol or technology)).as,aanm.	US-PGPUB; USPAT; USOCR	OR	ON	2021/11/15 10:24
S15	50	S14 not S13	US-PGPUB; USPAT; USOCR	OR	ON	2021/11/15 10:24

S16	150,158	B32B15/01;C25D1/04;C25D 3/38;C25D5/34, 48;C25D21/06;H01M4/0404, 13,66,661,667;H01M10/052, 0525;H01M2004/027;Y02E6 0/10;Y10T428/12431,12438. cpc.	US-PGPU B; USPAT; USOCR	OR	ON	2021/11/15 10:53
S17	41,417	S16 and ((Cu or copper or "cu-alloy" or "cu-base" or "Cu-based" or "copper-base" or "copper-based" or "copper-alloy") near5 (foil or foiled or foiling or tape or ribbon or layer or layered or layering or film or filmed or filming or clad or claded or cladded or clading or cladding or coat or coated or coating or electroplate or electroplated or electroplating or electroless or electrolessly or electroform or electroformed or electroforming or electrodeposit or electrodeposited or electrodepositing or electrodeposition or "electro-plate" or "electro-plated" or "electro-plating" or "electro-less" or "electro-lessly" or "electro-form" or "electro-formed" or "electro-forming" or "electro-deposit" or "electro-deposited" or "electro-depositing" or "electro-deposition"))	US-PGPU B; USPAT; USOCR	OR	ON	2021/11/15 11:03
S18	81	S17 and (("220" or "[220]" or "{220}" or "(220)" or "<220>") near5 (texture or coefficient or index or Miller or hkl or "h, k,l"))	US-PGPU B; USPAT; USOCR	OR	ON	2021/11/15 11:04
S19	71	S18 not (S13 or S15)	US-PGPU B; USPAT; USOCR	OR	ON	2021/11/15 11:04

EAST Search History (Prior Art)

S20	90	S17 and (("220" or "[220]" or "{220}" or "(220)" or "<220>") near8 (texture or coefficient or index or Miller or hkl or "h, k,l"))	US-PGPUB; USPAT; USOCR	OR	ON	2021/11/15 11:20
S21	9	S20 not (S13 or S15 or S19)	US-PGPUB; USPAT; USOCR	OR	ON	2021/11/15 11:20
S22	34	S16 and (((Cu or copper or "cu-alloy" or "cu-base" or "Cu-based" or "copper-base" or "copper-based" or "copper-alloy") with (foil or foiled or foiling or tape or ribbon or layer or layered or layering or film or filmed or filming or clad or claded or cladded or clading or cladding or coat or coated or coating or electroplate or electroplated or electroplating or electroless or electrolessly or electroform or electroformed or electroforming or electrodeposit or electrodeposited or electrodepositing or electrodeposition or "electro-plate" or "electro-plated" or "electro-plating" or "electro-less" or "electro-lessly" or "electro-form" or "electro-formed" or "electro-forming" or "electro-deposit" or "electro-deposited" or "electro-depositing" or "electro-deposition")) with (("220" or "[220]" or "{220}" or "(220)" or "<220>") with (texture or coefficient or index or Miller or hkl or "h,k, l")))	US-PGPUB; USPAT; USOCR	OR	ON	2021/11/15 11:21
S23	1	S22 not (S13 or S15 or S19 or S21)	US-PGPUB; USPAT; USOCR	OR	ON	2021/11/15 11:22

EAST Search History (Prior Art)

S24	907,698	B32B15/01;C25D1/04;C25D 3/38;C25D5/34, 48;C25D21/06;H01M4/0404, 13,66,661,667;H01M10/052, 0525;H01M2004/027;Y02E6 0/10;Y10T428/12431,12438. cpc.	FPRS; EPO; JPO; DERWEN T; IBM_TDB	OR	ON	2021/11/15 11:22
S25	64	S24 and (((Cu or copper or "cu-alloy" or "cu-base" or "Cu-based" or "copper-base" or "copper-based" or "copper-alloy") with (foil or foiled or foiling or tape or ribbon or layer or layered or layering or film or filmed or filming or clad or claded or cladded or clading or cladding or coat or coated or coating or electroplate or electroplated or electroplating or electroless or electrolessly or electroform or electroformed or electroforming or electrodeposit or electrodeposited or electrodepositing or electrodeposition or "electro-plate" or "electro-plated" or "electro-plating" or "electro-less" or "electro-lessly" or "electro-form" or "electro-formed" or "electro-forming" or "electro-deposit" or "electro-deposited" or "electro-depositing" or "electro-deposition")) with (("220" or "[220]" or "{220}" or "(220)" or "<220>") with (texture or coefficient or index or Miller or hkl or "h,k, l")))	FPRS; EPO; JPO; DERWEN T; IBM_TDB	OR	ON	2021/11/15 11:22

S26	17,447	S24 and ((Cu or copper or "cu-alloy" or "cu-base" or "Cu-based" or "copper-base" or "copper-based" or "copper-alloy") near5 (foil or foiled or foiling or tape or ribbon or layer or layered or layering or film or filmed or filming or clad or claded or cladded or clading or cladding or coat or coated or coating or electroplate or electroplated or electroplating or electroless or electrolessly or electroform or electroformed or electroforming or electrodeposit or electrodeposited or electrodepositing or electrodeposition or "electro-plate" or "electro-plated" or "electro-plating" or "electro-less" or "electro-lessly" or "electro-form" or "electro-formed" or "electro-forming" or "electro-deposit" or "electro-deposited" or "electro-depositing" or "electro-deposition"))	FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2021/11/15 11:29
S27	60	S26 and (("220" or "[220]" or "{220}" or "(220)" or "<220>") near5 (texture or coefficient or index or Miller or hkl or "h, k,l"))	FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2021/11/15 11:29
S28	9	S27 not S25	FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2021/11/15 11:29
S29	73	S26 and (("220" or "[220]" or "{220}" or "(220)" or "<220>") with (texture or coefficient or index or Miller or hkl or "h,k, l"))	FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2021/11/15 11:30

EAST Search History (Prior Art)

S30	0	S29 not (S25 or S28)	FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2021/11/15 11:30
S31	21,626	S24 and ((Cu or copper or "cu-alloy" or "cu-base" or "Cu-based" or "copper-base" or "copper-based" or "copper-alloy") with (foil or foiled or foiling or tape or ribbon or layer or layered or layering or film or filmed or filming or clad or claded or cladded or clading or cladding or coat or coated or coating or electroplate or electroplated or electroplating or electroless or electrolessly or electroform or electroformed or electroforming or electrodeposit or electrodeposited or electrodepositing or electrodeposition or "electro-plate" or "electro-plated" or "electro-plating" or "electro-less" or "electro-lessly" or "electro-form" or "electro-formed" or "electro-forming" or "electro-deposit" or "electro-deposited" or "electro-depositing" or "electro-deposition"))	FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2021/11/15 11:30
S32	74	S31 and (("220" or "[220]" or "{220}" or "(220)" or "<220>") with (texture or coefficient or index or Miller or hkl or "h,k, l"))	FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2021/11/15 11:30
S33	1	S32 not (S25 or S28)	FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2021/11/15 11:31

EAST Search History (Prior Art)

S34	30	(((Cu or copper or "cu-alloy" or "cu-base" or "Cu-based" or "copper-base" or "copper-based" or "copper-alloy") near5 (foil or foiled or foiling or tape or ribbon or layer or layered or layering or film or filmed or filming or clad or claded or cladded or clading or cladding or coat or coated or coating or electroplate or electroplated or electroplating or electroless or electrolessly or electroform or electroformed or electroforming or electrodeposit or electrodeposited or electrodepositing or electrodeposition or "electro-plate" or "electro-plated" or "electro-plating" or "electro-less" or "electro-lessly" or "electro-form" or "electro-formed" or "electro-forming" or "electro-deposit" or "electro-deposited" or "electro-depositing" or "electro-deposition")) near5 (("220" or "[220]" or "{220}" or "(220)" or "<220>") near5 (texture or coefficient or index or Miller or hkl or "h,k, l")))	FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2021/11/15 11:31
S35	6	S34 not (S25 or S28 or S33)	FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2021/11/15 11:31

EAST Search History (Prior Art)

S36	123	(((Cu or copper or "cu-alloy" or "cu-base" or "Cu-based" or "copper-base" or "copper-based" or "copper-alloy") with (foil or foiled or foiling or tape or ribbon or layer or layered or layering or film or filmed or filming or clad or claded or cladded or clading or cladding or coat or coated or coating or electroplate or electroplated or electroplating or electroless or electrolessly or electroform or electroformed or electroforming or electrodeposit or electrodeposited or electrodepositing or electrodeposition or "electro-plate" or "electro-plated" or "electro-plating" or "electro-less" or "electro-lessly" or "electro-form" or "electro-formed" or "electro-forming" or "electro-deposit" or "electro-deposited" or "electro-depositing" or "electro-deposition")) with (("220" or "[220]" or "{220}" or "(220)" or "<220>") with (texture or coefficient or index or Miller or hkl or "h,k, l")))	FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2021/11/15 11:32
S37	53	S36 not (S25 or S28 or S33 or S35)	FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2021/11/15 11:32

EAST Search History (Prior Art)

S38	46	(((Cu or copper or "cu-alloy" or "cu-base" or "Cu-based" or "copper-base" or "copper-based" or "copper-alloy") near5 (foil or foiled or foiling or tape or ribbon or layer or layered or layering or film or filmed or filming or clad or claded or cladded or clading or cladding or coat or coated or coating or electroplate or electroplated or electroplating or electroless or electrolessly or electroform or electroformed or electroforming or electrodeposit or electrodeposited or electrodepositing or electrodeposition or "electro-plate" or "electro-plated" or "electro-plating" or "electro-less" or "electro-lessly" or "electro-form" or "electro-formed" or "electro-forming" or "electro-deposit" or "electro-deposited" or "electro-depositing" or "electro-deposition")) near5 (("220" or "[220]" or "{220}" or "(220)" or "<220>") near5 (texture or coefficient or index or Miller or hkl or "h,k,l")))	US-PGPUB; USPAT; USOCR	OR	ON	2021/11/15 12:17
S39	22	S38 not (S13 or S15 or S19 or S21 or S23)	US-PGPUB; USPAT; USOCR	OR	ON	2021/11/15 12:18

S40	112	(((Cu or copper or "cu-alloy" or "cu-base" or "Cu-based" or "copper-base" or "copper-based" or "copper-alloy") with (foil or foiled or foiling or tape or ribbon or layer or layered or layering or film or filmed or filming or clad or claded or cladded or clading or cladding or coat or coated or coating or electroplate or electroplated or electroplating or electroless or electrolessly or electroform or electroformed or electroforming or electrodeposit or electrodeposited or electrodepositing or electrodeposition or "electro-plate" or "electro-plated" or "electro-plating" or "electro-less" or "electro-lessly" or "electro-form" or "electro-formed" or "electro-forming" or "electro-deposit" or "electro-deposited" or "electro-depositing" or "electro-deposition")) with (("220" or "[220]" or "{220}" or "(220)" or "<220>") with (texture or coefficient or index or Miller or hkl or "h,k, l")))	US-PGPUB; USPAT; USOCR	OR	ON	2021/11/15 12:22
S41	56	S40 not (S13 or S15 or S19 or S21 or S23 or S39)	US-PGPUB; USPAT; USOCR	OR	ON	2021/11/15 12:22
S42	44	S17 and (("220" or "[220]" or "{220}" or "(220)" or "<220>") near5 (stress))	US-PGPUB; USPAT; USOCR	OR	ON	2021/11/15 13:19
S43	2	S24 and (("220" or "[220]" or "{220}" or "(220)" or "<220>") near5 (stress))	FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2021/11/15 13:21

EAST Search History (Prior Art)

S44	3	S24 and (("111" or "[111]" or "{111}" or "(111)" or "<111>") near5 (stress))	FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2021/11/15 13:22
S45	48	S24 and (("200" or "[200]" or "{200}" or "(200)" or "<200>") near5 (stress))	FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2021/11/15 13:23
S46	0	S24 and (("311" or "[311]" or "{311}" or "(311)" or "<311>") near5 (stress))	FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2021/11/15 13:24

EAST Search History (Prior Art)

S47	89	((Cu or copper or "cu-alloy" or "cu-base" or "Cu-based" or "copper-base" or "copper-based" or "copper-alloy") near5 (foil or foiled or foiling or tape or ribbon or layer or layered or layering or film or filmed or filming or clad or claded or cladded or clading or cladding or coat or coated or coating or electroplate or electroplated or electroplating or electroless or electrolessly or electroform or electroformed or electroforming or electrodeposit or electrodeposited or electrodepositing or electrodeposition or "electro-plate" or "electro-plated" or "electro-plating" or "electro-less" or "electro-lessly" or "electro-form" or "electro-formed" or "electro-forming" or "electro-deposit" or "electro-deposited" or "electro-depositing" or "electro-deposition")) and (("111" or "[111]" or "{111}" or "(111)" or "<111>" or "200" or "[200]" or "{200}" or "(200)" or "<200>" or "220" or "[220]" or "{220}" or "(220)" or "<220>" or "311" or "[311]" or "{311}" or "(311)" or "<311>") near5 (residual near2 stress))	US-PGPUB; USPAT; USOCR	OR	ON	2021/11/15 13:27

S48	127	((Cu or copper or "cu-alloy" or "cu-base" or "Cu-based" or "copper-base" or "copper-based" or "copper-alloy") near8 (foil or foiled or foiling or tape or ribbon or layer or layered or layering or film or filmed or filming or clad or claded or cladded or clading or cladding or coat or coated or coating or electroplate or electroplated or electroplating or electroless or electrolessly or electroform or electroformed or electroforming or electrodeposit or electrodeposited or electrodepositing or electrodeposition or "electro-plate" or "electro-plated" or "electro-plating" or "electro-less" or "electro-lessly" or "electro-form" or "electro-formed" or "electro-forming" or "electro-deposit" or "electro-deposited" or "electro-depositing" or "electro-deposition")) and (("111" or "[111]" or "{111}" or "(111)" or "<111>" or "200" or "[200]" or "{200}" or "(200)" or "<200>" or "220" or "[220]" or "{220}" or "(220)" or "<220>" or "311" or "[311]" or "{311}" or "(311)" or "<311>") near8 (residual near2 stress))	US-PGPUB; USPAT; USOCR	OR	ON	2021/11/15 13:30
S49	38	S48 not S47	US-PGPUB; USPAT; USOCR	OR	ON	2021/11/15 13:30

EAST Search History (Prior Art)

S50	257	((Cu or copper or "cu-alloy" or "cu-base" or "Cu-based" or "copper-base" or "copper-based" or "copper-alloy") with (foil or foiled or foiling or tape or ribbon or layer or layered or layering or film or filmed or filming or clad or claded or cladded or clading or cladding or coat or coated or coating or electroplate or electroplated or electroplating or electroless or electrolessly or electroform or electroformed or electroforming or electrodeposit or electrodeposited or electrodepositing or electrodeposition or "electro-plate" or "electro-plated" or "electro-plating" or "electro-less" or "electro-lessly" or "electro-form" or "electro-formed" or "electro-forming" or "electro-deposit" or "electro-deposited" or "electro-depositing" or "electro-deposition")) and (("111" or "[111]" or "{111}" or "(111)" or "<111>" or "200" or "[200]" or "{200}" or "(200)" or "<200>" or "220" or "[220]" or "{220}" or "(220)" or "<220>" or "311" or "[311]" or "{311}" or "(311)" or "<311>") with (residual near2 stress))	US-PGPUB; USPAT; USOCR	OR	ON	2021/11/15 13:31
S51	130	S50 not (S47 or S49)	US-PGPUB; USPAT; USOCR	OR	ON	2021/11/15 13:32

S52	23	((Cu or copper or "cu-alloy" or "cu-base" or "Cu-based" or "copper-base" or "copper-based" or "copper-alloy") with (foil or foiled or foiling or tape or ribbon or layer or layered or layering or film or filmed or filming or clad or claded or cladded or clading or cladding or coat or coated or coating or electroplate or electroplated or electroplating or electroless or electrolessly or electroform or electroformed or electroforming or electrodeposit or electrodeposited or electrodepositing or electrodeposition or "electro-plate" or "electro-plated" or "electro-plating" or "electro-less" or "electro-lessly" or "electro-form" or "electro-formed" or "electro-forming" or "electro-deposit" or "electro-deposited" or "electro-depositing" or "electro-deposition")) and (("111" or "[111]" or "{111}" or "(111)" or "<111>" or "200" or "[200]" or "{200}" or "(200)" or "<200>" or "220" or "[220]" or "{220}" or "(220)" or "<220>" or "311" or "[311]" or "{311}" or "(311)" or "<311>") with (residual near2 stress))	FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2021/11/15 13:36
S53	4	(20090095515|20160260980|9209485|9562298).did.	US-PGPUB; USPAT; USOCR	OR	ON	2021/11/15 13:47
S54	12	((("JIN") near3 ("Shan") near3 ("Hua"))).INV.	US-PGPUB; USPAT; USOCR	OR	ON	2021/11/16 07:05

EAST Search History (Prior Art)

S55	22	((("LEE") near3 ("An") near3 ("Na"))).INV.	US-PGPUB; USPAT; USOCR	OR	ON	2021/11/16 07:05
S56	114	((("KIM") near3 ("Seung") near3 ("Min"))).INV.	US-PGPUB; USPAT; USOCR	OR	ON	2021/11/16 07:05
S57	383	((("JIN") near3 ("Shan" or Hua or "shanhua" or "shan-hua"))).INV.	US-PGPUB; USPAT; USOCR	OR	ON	2021/11/16 07:05
S58	944	((("LEE") near3 ("An" or Na or "An-Na"))).INV.	US-PGPUB; USPAT; USOCR	OR	ON	2021/11/16 07:05
S59	18,038	((("KIM") near3 ("Seung" or Min or "SeungMin" or "Seung-Min"))).INV.	US-PGPUB; USPAT; USOCR	OR	ON	2021/11/16 07:05
S60	49	((("JIN") near3 ("Shan" or Hua or "shanhua" or "shan-hua"))).aanm.	US-PGPUB; USPAT; USOCR	OR	ON	2021/11/16 07:05
S61	110	((("LEE") near3 ("An" or Na or "An-Na"))).aanm.	US-PGPUB; USPAT; USOCR	OR	ON	2021/11/16 07:05
S62	2,032	((("KIM") near3 ("Seung" or Min or "SeungMin" or "Seung-Min"))).aanm.	US-PGPUB; USPAT; USOCR	OR	ON	2021/11/16 07:05
S63	19,294	S54 or S55 or S56 or S57 or S58 or S59 or S60 or S61 or S62	US-PGPUB; USPAT; USOCR	OR	ON	2021/11/16 07:05

S64	1,930	S63 and ((Cu or copper or "cu-alloy" or "cu-base" or "Cu-based" or "copper-base" or "copper-based" or "copper-alloy") with (foil or foiled or foiling or tape or ribbon or layer or layered or layering or film or filmed or filming or clad or claded or cladded or clading or cladding or coat or coated or coating or electroplate or electroplated or electroplating or electroless or electrolessly or electroform or electroformed or electroforming or electrodeposit or electrodeposited or electrodepositing or electrodeposition or "electro-plate" or "electro-plated" or "electro-plating" or "electro-less" or "electro-lessly" or "electro-form" or "electro-formed" or "electro-forming" or "electro-deposit" or "electro-deposited" or "electro-depositing" or "electro-deposition"))	US-PGPUB; USPAT; USOCR	OR	ON	2021/11/16 07:05
S65	11	S64 and (("220" or "[220]" or "{220}" or "(220)" or "<220>") near5 (texture or coefficient or index or Miller or hkl or "h, k,l"))	US-PGPUB; USPAT; USOCR	OR	ON	2021/11/16 07:05
S66	58	((KCF) near3 (tech or technol or technology)).as,aanm.	US-PGPUB; USPAT; USOCR	OR	ON	2021/11/16 07:15
S67	50	S66 not S65	US-PGPUB; USPAT; USOCR	OR	ON	2021/11/16 07:15
S68	4	(2015030873|20070098910|20110171491|20200181790|20180062180).did.	US-PGPUB; USPAT; USOCR	OR	ON	2021/11/16 07:30

EAST Search History (Prior Art)

S69	150,861	B32B15/01;C25D1/04;C25D 3/38;C25D5/34, 48;C25D7/0614;C25D21/06; H01M4/0404,13,66,661, 667;H01M10/052, 0525;H01M2004/027;Y02E6 0/10;Y10T428/12431,12438. cpc.	US-PGPU B; USPAT; USOCR	OR	ON	2021/11/16 07:37
S70	150,231	B32B15/01;C25D1/04;C25D 3/38;C25D5/34, 48;C25D21/06;H01M4/0404, 13,66,661,667;H01M10/052, 0525;H01M2004/027;Y02E6 0/10;Y10T428/12431,12438. cpc.	US-PGPU B; USPAT; USOCR	OR	ON	2021/11/16 07:38
S71	41,443	S70 and ((Cu or copper or "cu-alloy" or "cu-base" or "Cu-based" or "copper-base" or "copper-based" or "copper-alloy") near5 (foil or foiled or foiling or tape or ribbon or layer or layered or layering or film or filmed or filming or clad or claded or cladded or clading or cladding or coat or coated or coating or electroplate or electroplated or electroplating or electroless or electrolessly or electroform or electroformed or electroforming or electrodeposit or electrodeposited or electrodepositing or electrodeposition or "electro-plate" or "electro-plated" or "electro-plating" or "electro-less" or "electro-lessly" or "electro-form" or "electro-formed" or "electro-forming" or "electro-deposit" or "electro-deposited" or "electro-depositing" or "electro-deposition"))	US-PGPU B; USPAT; USOCR	OR	ON	2021/11/16 07:38

EAST Search History (Prior Art)

S72	41,443	S71 and ((Cu or copper or "cu-alloy" or "cu-base" or "Cu-based" or "copper-base" or "copper-based" or "copper-alloy") near5 (foil or foiled or foiling or tape or ribbon or layer or layered or layering or film or filmed or filming or clad or claded or cladded or clading or cladding or coat or coated or coating or electroplate or electroplated or electroplating or electroless or electrolessly or electroform or electroformed or electroforming or electrodeposit or electrodeposited or electrodepositing or electrodeposition or "electro-plate" or "electro-plated" or "electro-plating" or "electro-less" or "electro-lessly" or "electro-form" or "electro-formed" or "electro-forming" or "electro-deposit" or "electro-deposited" or "electro-depositing" or "electro-deposition"))	US-PGPUB; USPAT; USOCR	OR	ON	2021/11/16 07:38

S73	41,584	S69 and ((Cu or copper or "cu-alloy" or "cu-base" or "Cu-based" or "copper-base" or "copper-based" or "copper-alloy") near5 (foil or foiled or foiling or tape or ribbon or layer or layered or layering or film or filmed or filming or clad or claded or cladded or clading or cladding or coat or coated or coating or electroplate or electroplated or electroplating or electroless or electrolessly or electroform or electroformed or electroforming or electrodeposit or electrodeposited or electrodepositing or electrodeposition or "electro-plate" or "electro-plated" or "electro-plating" or "electro-less" or "electro-lessly" or "electro-form" or "electro-formed" or "electro-forming" or "electro-deposit" or "electro-deposited" or "electro-depositing" or "electro-deposition"))	US-PGPUB; USPAT; USOCR	OR	ON	2021/11/16 07:39
S74	81	S73 and (("220" or "[220]" or "{220}" or "(220)" or "<220>") near5 (texture or coefficient or index or Miller or hkl or "h, k,l"))	US-PGPUB; USPAT; USOCR	OR	ON	2021/11/16 07:39
S75	72	S74 not (S63 or S65)	US-PGPUB; USPAT; USOCR	OR	ON	2021/11/16 07:40
S76	90	S73 and (("220" or "[220]" or "{220}" or "(220)" or "<220>") near8 (texture or coefficient or index or Miller or hkl or "h, k,l"))	US-PGPUB; USPAT; USOCR	OR	ON	2021/11/16 08:08
S77	9	S76 not (S63 or S65 or S75)	US-PGPUB; USPAT; USOCR	OR	ON	2021/11/16 08:09

EAST Search History (Prior Art)

S78	144	S73 and (("220" or "[220]" or "{220}" or "(220)" or "<220>") with (texture or coefficient or index or Miller or hkl or "h,k, l"))	US-PGPUB; USPAT; USOCR	OR	ON	2021/11/16 08:12
S79	53	S78 not (S63 or S65 or S75 or S77)	US-PGPUB; USPAT; USOCR	OR	ON	2021/11/16 08:13
S80	429	S73 and ((peak near2 density) or PD.u/c.)	US-PGPUB; USPAT; USOCR	OR	ON	2021/11/16 08:19
S81	36	S73 and (((peak near2 density) or PD.u/c.) near5 (surface))	US-PGPUB; USPAT; USOCR	OR	ON	2021/11/16 08:23
S82	9	("20020153254"|"20150030873"|"20140342178"|"20160013493"|"20140017564"|"20140170489"|"20130108887"|"20110056840"|"20190078229").PN.	US-PGPUB; USPAT; USOCR	OR	ON	2021/11/16 08:32
S83	53	S69 and (((peak near2 density) or PD.u/c.) near5 (surface or shiney or shiny or matt or matte or mat or matted))	US-PGPUB; USPAT; USOCR	OR	ON	2021/11/16 08:34
S84	17	S83 not (S63 or S65 or S75 or S77 or S81)	US-PGPUB; USPAT; USOCR	OR	ON	2021/11/16 08:34
S85	910,615	B32B15/01;C25D1/04;C25D3/38;C25D5/34,48;C25D7/0614;C25D21/06;H01M4/0404,13,66,661,667;H01M10/052,0525;H01M2004/027;Y02E60/10;Y10T428/12431,12438.cpc.	FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2021/11/16 08:39

EAST Search History (Prior Art)

S86	64	S85 and (((Cu or copper or "cu-alloy" or "cu-base" or "Cu-based" or "copper-base" or "copper-based" or "copper-alloy") with (foil or foiled or foiling or tape or ribbon or layer or layered or layering or film or filmed or filming or clad or claded or cladded or clading or cladding or coat or coated or coating or electroplate or electroplated or electroplating or electroless or electrolessly or electroform or electroformed or electroforming or electrodeposit or electrodeposited or electrodepositing or electrodeposition or "electro-plate" or "electro-plated" or "electro-plating" or "electro-less" or "electro-lessly" or "electro-form" or "electro-formed" or "electro-forming" or "electro-deposit" or "electro-deposited" or "electro-depositing" or "electro-deposition")) with (("220" or "[220]" or "{220}" or "(220)" or "<220>") with (texture or coefficient or index or Miller or hkl or "h,k, l")))	FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2021/11/16 08:39
S87	16	S85 and (((peak near2 density) or PD.u/c.) near5 (surface or shiney or shiny or matt or matte or mat or matted))	FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2021/11/16 08:47

EAST Search History (Prior Art)

S88	11	(((Cu or copper or "cu-alloy" or "cu-base" or "Cu-based" or "copper-base" or "copper-based" or "copper-alloy") with (foil or foiled or foiling or tape or ribbon or layer or layered or layering or film or filmed or filming or clad or claded or cladded or clading or cladding or coat or coated or coating or electroplate or electroplated or electroplating or electroless or electrolessly or electroform or electroformed or electroforming or electrodeposit or electrodeposited or electrodepositing or electrodeposition or "electro-plate" or "electro-plated" or "electro-plating" or "electro-less" or "electro-lessly" or "electro-form" or "electro-formed" or "electro-forming" or "electro-deposit" or "electro-deposited" or "electro-depositing" or "electro-deposition")) with (("220" or "[220]" or "{220}" or "(220)" or "<220>") with (texture or coefficient or index or Miller or hkl or "h,k, l"))) and (((peak near2 density) or PD.u/c.) near5 (surface or shiney or shiny or matt or matte or mat or matted))	FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2021/11/16 08:48
S89	0	S88 not S87	FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2021/11/16 08:48

EAST Search History (Prior Art)

S90	12	(((Cu or copper or "cu-alloy" or "cu-base" or "Cu-based" or "copper-base" or "copper-based" or "copper-alloy") with (foil or foiled or foiling or tape or ribbon or layer or layered or layering or film or filmed or filming or clad or claded or cladded or clading or cladding or coat or coated or coating or electroplate or electroplated or electroplating or electroless or electrolessly or electroform or electroformed or electroforming or electrodeposit or electrodeposited or electrodepositing or electrodeposition or "electro-plate" or "electro-plated" or "electro-plating" or "electro-less" or "electro-lessly" or "electro-form" or "electro-formed" or "electro-forming" or "electro-deposit" or "electro-deposited" or "electro-depositing" or "electro-deposition")) with (("220" or "[220]" or "{220}" or "(220)" or "<220>") with (texture or coefficient or index or Miller or hkl or "h,k, l"))) and (((peak near2 density) or PD.u/c.) with (surface or shiney or shiny or matt or matte or mat or matted))	FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2021/11/16 08:49
S91	1	S90 not S87	FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2021/11/16 08:49

S92	18	((Cu or copper or "cu-alloy" or "cu-base" or "Cu-based" or "copper-base" or "copper-based" or "copper-alloy") near5 (foil or foiled or foiling or tape or ribbon or layer or layered or layering or film or filmed or filming or clad or claded or cladded or clading or cladding or coat or coated or coating or electroplate or electroplated or electroplating or electroless or electrolessly or electroform or electroformed or electroforming or electrodeposit or electrodeposited or electrodepositing or electrodeposition or "electro-plate" or "electro-plated" or "electro-plating" or "electro-less" or "electro-lessly" or "electro-form" or "electro-formed" or "electro-forming" or "electro-deposit" or "electro-deposited" or "electro-depositing" or "electro-deposition")) near5 (((peak near2 density) or PD. u/c.) near5 (surface or shiney or shiny or matt or matte or mat or matted))	FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2021/11/16 08:51
S93	7	S92 not (S87 or S91)	FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2021/11/16 08:51

S94	20	((Cu or copper or "cu-alloy" or "cu-base" or "Cu-based" or "copper-base" or "copper-based" or "copper-alloy") with (foil or foiled or foiling or tape or ribbon or layer or layered or layering or film or filmed or filming or clad or claded or cladded or clading or cladding or coat or coated or coating or electroplate or electroplated or electroplating or electroless or electrolessly or electroform or electroformed or electroforming or electrodeposit or electrodeposited or electrodepositing or electrodeposition or "electro-plate" or "electro-plated" or "electro-plating" or "electro-less" or "electro-lessly" or "electro-form" or "electro-formed" or "electro-forming" or "electro-deposit" or "electro-deposited" or "electro-depositing" or "electro-deposition")) with (((peak near2 density) or PD. u/c.) near5 (surface or shiney or shiny or matt or matte or mat or matted))	FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2021/11/16 08:52
S95	1	S94 not (S87 or S91 or S93)	FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2021/11/16 08:52

S96	13	((Cu or copper or "cu-alloy" or "cu-base" or "Cu-based" or "copper-base" or "copper-based" or "copper-alloy") near5 (foil or foiled or foiling or tape or ribbon or layer or layered or layering or film or filmed or filming or clad or claded or cladded or clading or cladding or coat or coated or coating or electroplate or electroplated or electroplating or electroless or electrolessly or electroform or electroformed or electroforming or electrodeposit or electrodeposited or electrodepositing or electrodeposition or "electro-plate" or "electro-plated" or "electro-plating" or "electro-less" or "electro-lessly" or "electro-form" or "electro-formed" or "electro-forming" or "electro-deposit" or "electro-deposited" or "electro-depositing" or "electro-deposition")) near5 (((peak near2 density) or PD. u/c.) near5 (surface or shiney or shiny or matt or matte or mat or matted))	US-PGPUB; USPAT; USOCR	OR	ON	2021/11/16 08:52
S97	7	S96 not (S63 or S65 or S75 or S77 or S81 or S84)	US-PGPUB; USPAT; USOCR	OR	ON	2021/11/16 08:53

S98	16	((Cu or copper or "cu-alloy" or "cu-base" or "Cu-based" or "copper-base" or "copper-based" or "copper-alloy") near8 (foil or foiled or foiling or tape or ribbon or layer or layered or layering or film or filmed or filming or clad or claded or cladded or clading or cladding or coat or coated or coating or electroplate or electroplated or electroplating or electroless or electrolessly or electroform or electroformed or electroforming or electrodeposit or electrodeposited or electrodepositing or electrodeposition or "electro-plate" or "electro-plated" or "electro-plating" or "electro-less" or "electro-lessly" or "electro-form" or "electro-formed" or "electro-forming" or "electro-deposit" or "electro-deposited" or "electro-depositing" or "electro-deposition")) near8 (((peak near2 density) or PD. u/c.) near5 (surface or shiney or shiny or matt or matte or mat or matted))	US-PGPUB; USPAT; USOCR	OR	ON	2021/11/16 08:57
S99	3	S98 not (S63 or S65 or S75 or S77 or S81 or S84 or S97)	US-PGPUB; USPAT; USOCR	OR	ON	2021/11/16 08:57

EAST Search History (Prior Art)

S100	22	((Cu or copper or "cu-alloy" or "cu-base" or "Cu-based" or "copper-base" or "copper-based" or "copper-alloy") with (foil or foiled or foiling or tape or ribbon or layer or layered or layering or film or filmed or filming or clad or claded or cladded or clading or cladding or coat or coated or coating or electroplate or electroplated or electroplating or electroless or electrolessly or electroform or electroformed or electroforming or electrodeposit or electrodeposited or electrodepositing or electrodeposition or "electro-plate" or "electro-plated" or "electro-plating" or "electro-less" or "electro-lessly" or "electro-form" or "electro-formed" or "electro-forming" or "electro-deposit" or "electro-deposited" or "electro-depositing" or "electro-deposition")) with (((peak near2 density) or PD. u/c.) near5 (surface or shiney or shiny or matt or matte or mat or matted))	US-PGPUB; USPAT; USOCR	OR	ON	2021/11/16 08:59
S101	6	S100 not (S63 or S65 or S75 or S77 or S81 or S84 or S97 or S99)	US-PGPUB; USPAT; USOCR	OR	ON	2021/11/16 09:00

EAST Search History (Prior Art)

S102	30	(((Cu or copper or "cu-alloy" or "cu-base" or "Cu-based" or "copper-base" or "copper-based" or "copper-alloy") near5 (foil or foiled or foiling or tape or ribbon or layer or layered or layering or film or filmed or filming or clad or claded or cladded or clading or cladding or coat or coated or coating or electroplate or electroplated or electroplating or electroless or electrolessly or electroform or electroformed or electroforming or electrodeposit or electrodeposited or electrodepositing or electrodeposition or "electro-plate" or "electro-plated" or "electro-plating" or "electro-less" or "electro-lessly" or "electro-form" or "electro-formed" or "electro-forming" or "electro-deposit" or "electro-deposited" or "electro-depositing" or "electro-deposition")) near5 (("220" or "[220]" or "{220}" or "(220)" or "<220>") near5 (texture or coefficient or index or Miller or hkl or "h,k,l")))	FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2021/11/16 09:05

EAST Search History (Prior Art)

S103	41	(((Cu or copper or "cu-alloy" or "cu-base" or "Cu-based" or "copper-base" or "copper-based" or "copper-alloy") near5 (foil or foiled or foiling or tape or ribbon or layer or layered or layering or film or filmed or filming or clad or claded or cladded or clading or cladding or coat or coated or coating or electroplate or electroplated or electroplating or electroless or electrolessly or electroform or electroformed or electroforming or electrodeposit or electrodeposited or electrodepositing or electrodeposition or "electro-plate" or "electro-plated" or "electro-plating" or "electro-less" or "electro-lessly" or "electro-form" or "electro-formed" or "electro-forming" or "electro-deposit" or "electro-deposited" or "electro-depositing" or "electro-deposition")) near5 (("220" or "[220]" or "{220}" or "(220)" or "<220>") with (texture or coefficient or index or Miller or hkl or "h,k, l")))	FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2021/11/16 09:13
S104	13	S103 not S102	FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2021/11/16 09:14

EAST Search History (Prior Art)

S105	123	(((Cu or copper or "cu-alloy" or "cu-base" or "Cu-based" or "copper-base" or "copper-based" or "copper-alloy") with (foil or foiled or foiling or tape or ribbon or layer or layered or layering or film or filmed or filming or clad or claded or cladded or clading or cladding or coat or coated or coating or electroplate or electroplated or electroplating or electroless or electrolessly or electroform or electroformed or electroforming or electrodeposit or electrodeposited or electrodepositing or electrodeposition or "electro-plate" or "electro-plated" or "electro-plating" or "electro-less" or "electro-lessly" or "electro-form" or "electro-formed" or "electro-forming" or "electro-deposit" or "electro-deposited" or "electro-depositing" or "electro-deposition")) with (("220" or "[220]" or "{220}" or "(220)" or "<220>") with (texture or coefficient or index or Miller or hkl or "h,k,l")))	FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2021/11/16 09:19
S106	80	S105 not (S102 or S104)	FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2021/11/16 09:20
S107	1	("20180062199").did.	US-PGPUB; USPAT; USOCR	OR	ON	2021/11/16 09:45

S108	46	(((Cu or copper or "cu-alloy" or "cu-base" or "Cu-based" or "copper-base" or "copper-based" or "copper-alloy") near5 (foil or foiled or foiling or tape or ribbon or layer or layered or layering or film or filmed or filming or clad or claded or cladded or clading or cladding or coat or coated or coating or electroplate or electroplated or electroplating or electroless or electrolessly or electroform or electroformed or electroforming or electrodeposit or electrodeposited or electrodepositing or electrodeposition or "electro-plate" or "electro-plated" or "electro-plating" or "electro-less" or "electro-lessly" or "electro-form" or "electro-formed" or "electro-forming" or "electro-deposit" or "electro-deposited" or "electro-depositing" or "electro-deposition")) near5 (("220" or "[220]" or "{220}" or "(220)" or "<220>") near5 (texture or coefficient or index or Miller or hkl or "h,k,l")))	US-PGPUB; USPAT; USOCR	OR	ON	2021/11/16 09:49
S109	22	S108 not (S63 or S65 or S75 or S77 or S81 or S84 or S97 or S99 or S101)	US-PGPUB; USPAT; USOCR	OR	ON	2021/11/16 09:49

EAST Search History (Prior Art)

S110	58	(((Cu or copper or "cu-alloy" or "cu-base" or "Cu-based" or "copper-base" or "copper-based" or "copper-alloy") near8 (foil or foiled or foiling or tape or ribbon or layer or layered or layering or film or filmed or filming or clad or claded or cladded or clading or cladding or coat or coated or coating or electroplate or electroplated or electroplating or electroless or electrolessly or electroform or electroformed or electroforming or electrodeposit or electrodeposited or electrodepositing or electrodeposition or "electro-plate" or "electro-plated" or "electro-plating" or "electro-less" or "electro-lessly" or "electro-form" or "electro-formed" or "electro-forming" or "electro-deposit" or "electro-deposited" or "electro-depositing" or "electro-deposition")) near8 (("220" or "[220]" or "{220}" or "(220)" or "<220>") near8 (texture or coefficient or index or Miller or hkl or "h,k,l")))	US-PGPUB; USPAT; USOCR	OR	ON	2021/11/16 09:51
S111	10	S110 not (S63 or S65 or S75 or S77 or S81 or S84 or S97 or S99 or S101 or S109)	US-PGPUB; USPAT; USOCR	OR	ON	2021/11/16 09:52

EAST Search History (Prior Art)

S112	80	(((Cu or copper or "cu-alloy" or "cu-base" or "Cu-based" or "copper-base" or "copper-based" or "copper-alloy") near12 (foil or foiled or foiling or tape or ribbon or layer or layered or layering or film or filmed or filming or clad or claded or cladded or clading or cladding or coat or coated or coating or electroplate or electroplated or electroplating or electroless or electrolessly or electroform or electroformed or electroforming or electrodeposit or electrodeposited or electrodepositing or electrodeposition or "electro-plate" or "electro-plated" or "electro-plating" or "electro-less" or "electro-lessly" or "electro-form" or "electro-formed" or "electro-forming" or "electro-deposit" or "electro-deposited" or "electro-depositing" or "electro-deposition")) near12 (("220" or "[220]" or "{220}" or "(220)" or "<220>") near12 (texture or coefficient or index or Miller or hkl or "h,k,l")))	US-PGPUB; USPAT; USOCR	OR	ON	2021/11/16 09:53
S113	17	S112 not (S63 or S65 or S75 or S77 or S81 or S84 or S97 or S99 or S101 or S109 or S111)	US-PGPUB; USPAT; USOCR	OR	ON	2021/11/16 09:54

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Applicant:	Seung Min KIM
Appl. No.:	16/959,352
Conf. No.:	1067
Filed:	June 30, 2020
Title:	ELECTROLYTIC COPPER FOIL HAVING EXCELLENT HANDLING CHARACTERISTICS IN POSTPROCESSING, AND MANUFACTURING METHOD THEREFOR
Art Unit:	1784
Examiner:	DUMBRIS, SETH M
Docket No.:	0313221.00022

AMENDMENT AND RESPONSE TO NON-FINAL OFFICE ACTION

VIA ELECTRONIC FILING

Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

Dear Commissioner:

This Response is submitted in reply to the non-final Office Action dated December 27, 2021.

Amendments to the Claims begins on page 2 of this paper.

Remarks begin on page 5 of this paper.

Amendments to the Claims:

Please amend the claims as follows:

1. (Currently Amended) An electrolytic copper foil having a first surface and a second surface, wherein

a texture coefficient of (220) plane of the electrolytic copper foil defined by Equation 1 below is 0.4 to 1.32,

(Equation 1)

$$TC(220) = \frac{\frac{I(220)}{I_0(220)}}{\frac{1}{n}\sum\frac{I(hkl)}{I_0(hkl)}}$$

a difference (|Δ(Rz/Ra)|) between Rz/Ra at the first surface of the electrolytic copper foil and Rz/Ra at the second surface of the electrolytic copper foil is less than 2.42, and

a difference (|ΔPD|) between a peak density (PD) at the first surface of the electrolytic copper foil and a peak density (PD) at the second surface of the electrolytic copper foil is 96 ea or less.

2. (Original) The electrolytic copper foil according to claim 1, wherein

the second surface is an M surface, and

Rz/Ra at the second surface is 4.2 to 9.0.

3. (Original) The electrolytic copper foil according to claim 2, wherein

the first surface is an S surface, and

Rz/Ra at the S surface of the electrolytic copper foil is 5.1 to 6.8.

4. (Currently Amended) The electrolytic copper foil according to claim 1, wherein the electrolytic copper foil has a tensile strength, measured at room temperature, of 30 to 65 [[kgf/mm2]] kgf/mm^2.

5. (Original) The electrolytic copper foil according to claim 1, wherein the electrolytic copper foil has an elongation, measured at room temperature, of 3 % or more.

6. (Original) The electrolytic copper foil according to claim 1, wherein the electrolytic copper foil has a lateral weight deviation of 5 % or less.

7. (Original) The electrolytic copper foil according to claim 1, wherein an arithmetic mean of measured heights of corners of four protruding incision portions of the electrolytic copper foil, formed by incising electrolytic copper foil in a form of a cross having a size of 8 cm x 8 cm so as to be vertically divided into two parts, is less than 10 mm.

8-10. (Withdrawn).

11. (New) The electrolytic copper foil of claim 1, wherein the electrolytic copper foil is manufactured by:

applying electric current between a positive electrode plate and a rotary negative electrode drum, wherein the positive electrode plate and the rotary negative electrode drum are disposed in an electrolytic solution in an electrolytic bath so as to be spaced apart from each other;

buffing a surface of the rotary negative electrode drum using a brush having a grit of

500# to 3000#;

electrodepositing a copper film on the buffed rotary negative electrode drum; and

winding the electrodeposited copper film, wherein the electrolytic solution comprises 70 to 90 g/L of copper ions, 80 to 120 g/L of sulfuric acid, 10 to 20 ppm of chlorine ions, 3 to 12 ppm of a sulfide-based compound, 25 to 50 ppm of molybdenum (Mo), and 5 to 25 ppm of polyethylene glycol (PEG).

12. (New) The electrolytic copper foil of claim 11, wherein the sulfide-based compound is selected from a group consisting of bis-(sodium sulfopropyl) disulfide (SPS), 3-mercapto 1-propane sulfonate (MPS), and 3-(benzothiazolyl-2-mercapto)-propyl-sulfonate (ZPS).

13. (New) The electrolytic copper foil of claim 11, wherein the sulfide-based compound is SPS.

REMARKS

This Response is submitted in reply to the non-final Office Action dated December 27, 2021. Claims 1-10 are pending in the application, of which claims 8-10 are withdrawn. Claims 1-7 stand rejected. Claim 1 is in independent form. Claims 1 and 4 are amended. New claims 11-13 are added. No new matter has been added by the amendments. Favorable reconsideration of this application is respectfully requested in view of the following remarks.

Double Patenting Rejection

Claims 1-7 are rejected on the ground of nonstatutory double patenting as allegedly being unpatentable over claims 12, 14 and 17 of U.S. Patent No. 10,547,081 in view of Song et al. (US 2017/0141404). Without acquiescing to the reasons for this rejection, Applicant concurrently files a terminal disclaimer to overcome the non-statutory double patenting rejections. Applicant therefore requests that this rejection be withdrawn and that the application proceed to allowance.

Claim Objections

Claims 1 and 4 are objected to because of the following informalities:

Claim 1 does not provide Equation 1 within the body of the claim. This appears to be a miss-copy in the amendment filed 28 September 2021.

Claim 4 recites "kgf/mm2" and should be "kgf/mm^2" in superscript.

Applicant amends claims 1 and 4 to correct these informalities, and therefore requests that these objections be withdrawn.

Respectfully submitted,

K&L Gates LLP

BY /Matthew S. Dicke/
Matthew S. Dicke
Reg. No. 58,819
Customer No. 29178
312-578-5415

Dated: March 25, 2022

Electronic Acknowledgement Receipt	
EFS ID:	45318938
Application Number:	16959352
International Application Number:	
Confirmation Number:	1067
Title of Invention:	ELECTROLYTIC COPPER FOIL HAVING EXCELLENT HANDLING CHARACTERISTICS IN POSTPROCESSING, AND MANUFACTURING METHOD THEREFOR
First Named Inventor/Applicant Name:	Seung Min KIM
Customer Number:	24573
Filer:	Matthew S. Dicke/US Patent Mail
Filer Authorized By:	Matthew S. Dicke
Attorney Docket Number:	0313221.00022
Receipt Date:	25-MAR-2022
Filing Date:	30-JUN-2020
Time Stamp:	16:03:24
Application Type:	U.S. National Stage under 35 USC 371

Payment information:

Submitted with Payment	no

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1		0313221-00022_RespNFOA.pdf	116913 e3e19ab2d58b4c961b9ddb41b5387b149d360ebf	yes	5

	Multipart Description/PDF files in .zip description		
	Document Description	**Start**	**End**
	Amendment/Request for Reconsideration-After Non-Final Rejection	1	1
	Claims	2	4
	Applicant Arguments/Remarks Made in an Amendment	5	5
Warnings:			
Information:			
	Total Files Size (in bytes):	116913	

This Acknowledgement Receipt evidences receipt on the noted date by the USPTO of the indicated documents, characterized by the applicant, and including page counts, where applicable. It serves as evidence of receipt similar to a Post Card, as described in MPEP 503.

<u>New Applications Under 35 U.S.C. 111</u>
If a new application is being filed and the application includes the necessary components for a filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application.
<u>National Stage of an International Application under 35 U.S.C. 371</u>
If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course.
<u>New International Application Filed with the USPTO as a Receiving Office</u>
If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.

Doc Code: DIST.E.FILE **Document Description: Electronic Terminal Disclaimer - Filed**	PTO/SB/25 U.S. Patent and Trademark Office Department of Commerce

Electronic Petition Request	**TERMINAL DISCLAIMER TO OBVIATE A PROVISIONAL DOUBLE PATENTING REJECTION OVER A PENDING "REFERENCE" APPLICATION**
Application Number	16959352
Filing Date	30-Jun-2020
First Named Inventor	Seung KIM
Attorney Docket Number	0313221.00022
Title of Invention	ELECTROLYTIC COPPER FOIL HAVING EXCELLENT HANDLING CHARACTERISTICS IN POSTPROCESSING, AND MANUFACTURING METHOD THEREFOR

☒ Filing of terminal disclaimer does not obviate requirement for response under 37 CFR 1.111 to outstanding Office Action

☒ This electronic Terminal Disclaimer is not being used for a Joint Research Agreement.

Owner	Percent Interest
ILJIM MATERIALS CO., LTD.	100%

The owner(s) of percent interest listed above in the instant application hereby disclaims, except as provided below, the terminal part of the statutory term of any patent granted on the instant application which would extend beyond the expiration date of the full statutory term of any patent granted on pending reference Application Number(s)

15127651 filed on 09/20/2016

as the term of any patent granted on said reference application may be shortened by any terminal disclaimer filed prior to the grant of any patent on the pending reference application. The owner hereby agrees that any patent so granted on the instant application shall be enforceable only for and during such period that it and any patent granted on the reference application are commonly owned. This agreement runs with any patent granted on the instant application and is binding upon the grantee, its successors or assigns.

In making the above disclaimer, the owner does not disclaim the terminal part of any patent granted on the instant application that would extend to the expiration date of the full statutory term of any patent granted on said reference application, "as the term of any patent granted on said reference application may be shortened by any terminal disclaimer filed prior to the grant of any patent on the pending reference application," in the event that any such patent granted on the pending reference application: expires for failure to pay a maintenance fee, is held unenforceable, is found invalid by a court of competent jurisdiction, is statutorily disclaimed in whole or terminally disclaimed under 37 CFR 1.321, has all claims canceled by a reexamination certificate, is reissued, or is in any manner terminated prior to the expiration of its full statutory term as shortened by any terminal disclaimer filed prior to its grant.

◉ Terminal disclaimer fee under 37 CFR 1.20(d) is included with Electronic Terminal Disclaimer request.

○ I certify, in accordance with 37 CFR 1.4(d)(4), that the terminal disclaimer fee under 37 CFR 1.20(d) required for this terminal disclaimer has already been paid in the above-identified application.	
Applicant claims the following fee status: ○ Small Entity ○ Micro Entity ◉ Regular Undiscounted I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.	
THIS PORTION MUST BE COMPLETED BY THE SIGNATORY OR SIGNATORIES I certify, in accordance with 37 CFR 1.4(d)(4) that I am: ◉ An attorney or agent registered to practice before the Patent and Trademark Office who is of record in this application Registration Number 58819 ○ A sole inventor ○ A joint inventor; I certify that I am authorized to sign this submission on behalf of all of the inventors as evidenced by the power of attorney in the application ○ A joint inventor; all of whom are signing this request	
Signature	/Matthew S. Dicke/
Name	Matthew S. Dicke

*Statement under 37 CFR 3.73(b) is required if terminal disclaimer is signed by the assignee (owner).
Form PTO/SB/96 may be used for making this certification. See MPEP § 324.

Electronic Patent Application Fee Transmittal

Application Number:	16959352
Filing Date:	30-Jun-2020
Title of Invention:	ELECTROLYTIC COPPER FOIL HAVING EXCELLENT HANDLING CHARACTERISTICS IN POSTPROCESSING, AND MANUFACTURING METHOD THEREFOR
First Named Inventor/Applicant Name:	Seung Min KIM
Filer:	Matthew S. Dicke/US Patent Mail
Attorney Docket Number:	0313221.00022

Filed as Large Entity

Filing Fees for U.S. National Stage under 35 USC 371

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Basic Filing:				
STATUTORY OR TERMINAL DISCLAIMER	1814	1	170	170
Pages:				
Claims:				
Miscellaneous-Filing:				
Petition:				
Patent-Appeals-and-Interference:				
Post-Allowance-and-Post-Issuance:				

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Extension-of-Time:				
Miscellaneous:				
			Total in USD ($)	**170**

Doc Code: DISQ.E.FILE
Document Description: Electronic Terminal Disclaimer – Approved

Application No.: 16959352

Filing Date: 30-Jun-2020

Applicant/Patent under Reexamination: KIM

Electronic Terminal Disclaimer filed on March 25, 2022

☒ APPROVED

This patent is subject to a terminal disclaimer

☐ DISAPPROVED

Approved/Disapproved by: Electronic Terminal Disclaimer automatically approved by EFS-Web

U.S. Patent and Trademark Office

Electronic Acknowledgement Receipt	
EFS ID:	45318892
Application Number:	16959352
International Application Number:	
Confirmation Number:	1067
Title of Invention:	ELECTROLYTIC COPPER FOIL HAVING EXCELLENT HANDLING CHARACTERISTICS IN POSTPROCESSING, AND MANUFACTURING METHOD THEREFOR
First Named Inventor/Applicant Name:	Seung Min KIM
Customer Number:	24573
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Attorney Docket Number:	0313221.00022
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File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1	Terminal Disclaimer-Filed (Electronic)	eTerminal-Disclaimer.pdf	43855 001b4bf0f98a50f3426fa78ba4ce762e73c57b1d	no	2
Warnings:					
Information:					
2	Fee Worksheet (SB06)	fee-info.pdf	38208 16be67495c75f4ae41d2dbda83d237f3afedddd3	no	2
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PTO/SB/06 (09-11)
Approved for use through 1/31/2014. OMB 0651-0032
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PATENT APPLICATION FEE DETERMINATION RECORD Substitute for Form PTO-875	Application or Docket Number 16/959,352	Filing Date 06/30/2020	☐ To be Mailed

ENTITY: ☑ LARGE ☐ SMALL ☐ MICRO

APPLICATION AS FILED - PART I

	(Column 1)	(Column 2)			
FOR	NUMBER FILED	NUMBER EXTRA		RATE ($)	FEE ($)
☐ BASIC FEE (37 CFR 1.16(a), (b), or (c))	N/A	N/A		N/A	
☐ SEARCH FEE (37 CFR 1.16(k), (i), or (m))	N/A	N/A		N/A	
☐ EXAMINATION FEE (37 CFR 1.16(o), (p), or (q))	N/A	N/A		N/A	
TOTAL CLAIMS (37 CFR 1.16(i))	minus 20 =	*		x $100 =	
INDEPENDENT CLAIMS (37 CFR 1.16(h))	minus 3 =	*		x $460 =	
☐ APPLICATION SIZE FEE (37 CFR 1.16(s))	If the specification and drawings exceed 100 sheets of paper, the application size fee due is $310 ($155 for small entity) for each additional 50 sheets or fraction thereof. See 35 U.S.C. 41(a)(1)(G) and 37 CFR 1.16(s).				
☐ MULTIPLE DEPENDENT CLAIM PRESENT (37 CFR 1.16(j))					
* If the difference in column 1 is less than zero, enter "0" in column 2.				TOTAL	

APPLICATION AS AMENDED - PART II

		(Column 1)		(Column 2)	(Column 3)			
AMENDMENT	03/25/2022	CLAIMS REMAINING AFTER AMENDMENT		HIGHEST NUMBER PREVIOUSLY PAID FOR	PRESENT EXTRA		RATE ($)	ADDITIONAL FEE ($)
	Total (37 CFR 1.16(i))	* 10	Minus	** 20	= 0		x $100 =	0
	Independent (37 CFR 1.16(h))	* 1	Minus	*** 3	= 0		x $480 =	0
	☐ Application Size Fee (37 CFR 1.16(s))							
	☐ FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j))							
							TOTAL ADD'L FEE	0

		(Column 1)		(Column 2)	(Column 3)			
AMENDMENT		CLAIMS REMAINING AFTER AMENDMENT		HIGHEST NUMBER PREVIOUSLY PAID FOR	PRESENT EXTRA		RATE ($)	ADDITIONAL FEE ($)
	Total (37 CFR 1.16(i))	*	Minus	**	=		x $0 =	
	Independent (37 CFR 1.16(h))	*	Minus	***	=		x $0 =	
	☐ Application Size Fee (37 CFR 1.16(s))							
	☐ FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j))							
							TOTAL ADD'L FEE	

* If the entry in column 1 is less than the entry in column 2, write "0" in column 3.	LIE
** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 20, enter "20".	/NICOLE LOVE HENSLEY/
*** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 3, enter "3".	
The "Highest Number Previously Paid For" (Total or Independent) is the highest number found in the appropriate box in column 1.	

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If you need assistance in completing the form, call 1-800-PTO-9199 and select option 2.

Doc code: IDS
Doc description: Information Disclosure Statement (IDS) Filed

PTO/SB/08a (03-15)
Approved for use through 07/31/2016. OMB 0651-0031
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INFORMATION DISCLOSURE STATEMENT BY APPLICANT

(Not for submission under 37 CFR 1.99)

Application Number	16959352
Filing Date	2020-06-30
First Named Inventor	Seung Min KIM
Art Unit	1784
Examiner Name	DUMBRIS, SETH M
Attorney Docket Number	0313221.00022

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Examiner Initial*	Cite No	Patent Number	Kind Code[1]	Issue Date	Name of Patentee or Applicant of cited Document	Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear
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Examiner Initial*	Cite No	Publication Number	Kind Code[1]	Publication Date	Name of Patentee or Applicant of cited Document	Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear
	1					

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Examiner Initial*	Cite No	Foreign Document Number[3]	Country Code[2]	Kind Code[4]	Publication Date	Name of Patentee or Applicant of cited Document	Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear	T[5]
	1	106048666	CN	A	2016-10-26	CHANGCHUN PETROCHEMISTRY CO LTD		
	2	106536791	CN	A	2017-03-22	LS MTRON LTD		
	3	106887595	CN	A	2017-06-23	LS MTRON LTD		

INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)		
	Application Number	16959352
	Filing Date	2020-06-30
	First Named Inventor	Seung Min KIM
	Art Unit	1784
	Examiner Name	DUMBRIS, SETH M
	Attorney Docket Number	0313221.00022

If you wish to add additional Foreign Patent Document citation information please click the Add button		Add	
NON-PATENT LITERATURE DOCUMENTS		Remove	
Examiner Initials*	Cite No	Include name of the author (in CAPITAL LETTERS), title of the article (when appropriate), title of the item (book, magazine, journal, serial, symposium, catalog, etc), date, pages(s), volume-issue number(s), publisher, city and/or country where published.	T[5]
	1	Chinese Office Action for related Chinese Application No. 2019800106242; action dated December 17, 2021; (15 pages)	
If you wish to add additional non-patent literature document citation information please click the Add button		Add	

EXAMINER SIGNATURE			
Examiner Signature		Date Considered	

*EXAMINER: Initial if reference considered, whether or not citation is in conformance with MPEP 609. Draw line through a citation if not in conformance and not considered. Include copy of this form with next communication to applicant.

[1] See Kind Codes of USPTO Patent Documents at www.USPTO.GOV or MPEP 901.04. [2] Enter office that issued the document, by the two-letter code (WIPO Standard ST.3). [3] For Japanese patent documents, the indication of the year of the reign of the Emperor must precede the serial number of the patent document. [4] Kind of document by the appropriate symbols as indicated on the document under WIPO Standard ST.16 if possible. [5] Applicant is to place a check mark here if English language translation is attached.

INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)		
	Application Number	16959352
	Filing Date	2020-06-30
	First Named Inventor	Seung Min KIM
	Art Unit	1784
	Examiner Name	DUMBRIS, SETH M
	Attorney Docket Number	0313221.00022

CERTIFICATION STATEMENT

Please see 37 CFR 1.97 and 1.98 to make the appropriate selection(s):

☒ That each item of information contained in the information disclosure statement was first cited in any communication from a foreign patent office in a counterpart foreign application not more than three months prior to the filing of the information disclosure statement. See 37 CFR 1.97(e)(1).

OR

☐ That no item of information contained in the information disclosure statement was cited in a communication from a foreign patent office in a counterpart foreign application, and, to the knowledge of the person signing the certification after making reasonable inquiry, no item of information contained in the information disclosure statement was known to any individual designated in 37 CFR 1.56(c) more than three months prior to the filing of the information disclosure statement. See 37 CFR 1.97(e)(2).

☒ See attached certification statement.

The fee set forth in 37 CFR 1.17 (p) has been submitted herewith.

A certification statement is not submitted herewith.

SIGNATURE

A signature of the applicant or representative is required in accordance with CFR 1.33, 10.18. Please see CFR 1.4(d) for the form of the signature.

Signature	/Matthew S. Dicke/	Date (YYYY-MM-DD)	2022-01-19
Name/Print	Matthew S. Dicke	Registration Number	58819

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The information provided by you in this form will be subject to the following routine uses:

1. The information on this form will be treated confidentially to the extent allowed under the Freedom of Information Act (5 U.S.C. 552) and the Privacy Act (5 U.S.C. 552a). Records from this system of records may be disclosed to the Department of Justice to determine whether the Freedom of Information Act requires disclosure of these record s.

2. A record from this system of records may be disclosed, as a routine use, in the course of presenting evidence to a court, magistrate, or administrative tribunal, including disclosures to opposing counsel in the course of settlement negotiations.

3. A record in this system of records may be disclosed, as a routine use, to a Member of Congress submitting a request involving an individual, to whom the record pertains, when the individual has requested assistance from the Member with respect to the subject matter of the record.

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5. A record related to an International Application filed under the Patent Cooperation Treaty in this system of records may be disclosed, as a routine use, to the International Bureau of the World Intellectual Property Organization, pursuant to the Patent Cooperation Treaty.

6. A record in this system of records may be disclosed, as a routine use, to another federal agency for purposes of National Security review (35 U.S.C. 181) and for review pursuant to the Atomic Energy Act (42 U.S.C. 218(c)).

7. A record from this system of records may be disclosed, as a routine use, to the Administrator, General Services, or his/her designee, during an inspection of records conducted by GSA as part of that agency's responsibility to recommend improvements in records management practices and programs, under authority of 44 U.S.C. 2904 and 2906. Such disclosure shall be made in accordance with the GSA regulations governing inspection of records for this purpose, and any other relevant (i.e., GSA or Commerce) directive. Such disclosure shall not be used to make determinations about individuals.

8. A record from this system of records may be disclosed, as a routine use, to the public after either publication of the application pursuant to 35 U.S.C. 122(b) or issuance of a patent pursuant to 35 U.S.C. 151. Further, a record may be disclosed, subject to the limitations of 37 CFR 1.14, as a routine use, to the public if the record was filed in an application which became abandoned or in which the proceedings were terminated and which application is referenced by either a published application, an application open to public inspections or an issued patent.

9. A record from this system of records may be disclosed, as a routine use, to a Federal, State, or local law enforcement agency, if the USPTO becomes aware of a violation or potential violation of law or regulation.

Espacenet

Bibliographic data: CN106048666 (A) — 2016-10-26

Anti-warp copper foil

Inventor(s): ZHOU RUICHANG; ZHENG GUISEN; LAI YAOSHENG; HUANG HUIFANG ± (周瑞昌, ; 郑桂森, ; 赖耀生, ; 黄慧芳)

Applicant(s): CHANGCHUN PETROCHEMISTRY CO LTD ± (长春石油化学股份有限公司)

Classification: - international: *C25D1/04; C25D3/38; H01M4/66*
- cooperative: C25D1/04 (EP, CN, KR, US); C25D3/38 (EP, CN, US); H01M4/133 (EP, KR, US); H01M4/587 (EP, KR, US); H01M4/661 (EP, CN, KR, US); H01M2220/20 (EP, KR, US); H01M2220/30 (EP, KR, US); Y02E60/10 (EP, KR)

Application number: CN201610180127 20160325 Global Dossier

Priority number(s): US201562149402P 20150417 ; US201514737033 20150611

Also published as: CN106048666 (B) JP2016204747 (A) KR101673279 (B1) KR20160124002 (A) TW201637854 (A) more

Abstract of CN106048666 (A)

The invention relates to improved coating copper foil and a method for manufacturing the same. The foil has the performances of resisting warp and wrinkles. Specifically, the copper foil is provided with a bright surface and a rough surface. The bright surface has a mechanical direction glossiness (330-620) measured at a 60-degree incident angle. The surface roughness (Rz) between the bright surface and the rough surface is within the range from 0.3 microns to 0.59 microns. The tension strength difference in an amplitude direction is 1.2 kgf/mm2 or less.

(19)中华人民共和国国家知识产权局

(12)发明专利申请

(10)申请公布号 CN 106048666 A
(43)申请公布日 2016.10.26

(21)申请号 201610180127.5

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(51)Int.Cl.
C25D 1/04(2006.01)
C25D 3/38(2006.01)
H01M 4/66(2006.01)

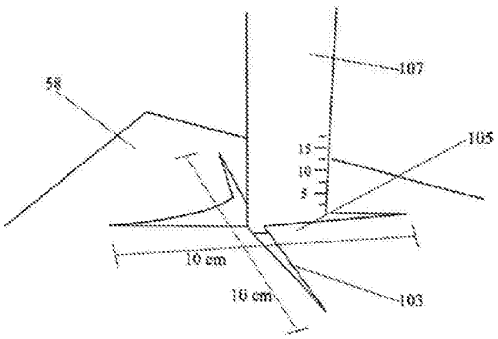
权利要求书2页 说明书8页 附图2页

(54)发明名称

抗翘曲铜箔

(57)摘要

本发明涉及一种经改良的涂覆铜箔及一种制造该铜箔的方法，其中该铜箔具有抵抗翘曲和抵抗皱纹的性质。具体而言，本发明的铜箔具有：(a)光泽面；(b)粗糙面，其中该粗糙面具有330至620的于60°入射角量测的机械方向光泽度；(c)该光泽面与粗糙面之间的表面粗糙度(Rz)差介于0.3至0.59微米；(d)该幅方向上的拉伸强度差为1.2公斤力/平方毫米(kgf/mm²)或更小。



CN 106048666 A

1.一种具耐翘曲性的铜箔，具有机械方向的尺寸、幅方向的尺寸以及厚度，且该铜箔进一步包括：

a.光泽面；

b.粗糙面，具有330至620的于60°入射角量测的机械方向光泽度；

c.该光泽面与粗糙面之间的表面粗糙度差为介于0.3至0.59微米；以及

d.自该铜箔的幅方向上取至少两个样品的拉伸强度差为1.2公斤力/平方毫米或更小。

2.如权利要求1的铜箔，其特征在于，该粗糙面于60°入射角量测的机械方向光泽度为介于400至600。

3.如权利要求1的铜箔，其特征在于，该粗糙面于60°入射角量测的机械方向光泽度为介于450至550。

4.如权利要求1的铜箔，其特征在于，该铜箔的厚度为1至50微米。

5.如权利要求1的铜箔，其特征在于，该铜箔的厚度为4至25微米。

6.如权利要求1的铜箔，其特征在于，该铜箔的厚度为6至20微米。

7.如权利要求1的铜箔，于该铜箔的该光泽面或粗糙面的至少一面上进一步包括碳质层。

8.如权利要求7的铜箔，其特征在于，该铜箔受到辗压及加热后的翘曲程度为小于5毫米。

9.如权利要求7的铜箔，其特征在于，该铜箔受到辗压及加热后的翘曲程度为小于2毫米。

10.如权利要求7的铜箔，其特征在于，该铜箔受到辗压及加热后的翘曲程度为小于1毫米。

11.如权利要求1的铜箔，于该铜箔的光泽及粗糙两面上进一步包括碳质层。

12.如权利要求1的铜箔，其特征在于，该光泽面与粗糙面之间的表面粗糙度差为介于0.3至0.51微米。

13.如权利要求1的铜箔，其特征在于，该粗糙面的表面粗糙度为介于0.5至0.8微米。

14.如权利要求1的铜箔，其特征在于，自该铜箔幅方向上取至少两个样品的拉伸强度差为0.9公斤力/平方毫米或更小。

15.如权利要求1的铜箔，其特征在于，该铜箔受到辗压后的翘曲程度为小于3毫米。

16.如权利要求1的铜箔，其特征在于，该铜箔受到辗压后的翘曲程度为小于2毫米。

17.如权利要求1的铜箔，其特征在于，该铜箔受到辗压后的翘曲程度为小于1毫米。

18.如权利要求1的铜箔，其特征在于，该铜箔受到辗压及加热后的翘曲程度为大于3但小于5毫米。

19.如权利要求1的铜箔，其特征在于，该铜箔受到辗压后的翘曲程度为小于5毫米。

20.如权利要求7的铜箔，其特征在于，该铜箔受到辗压及加热后的翘曲程度为小于3毫米。

21.如权利要求1的铜箔，其特征在于，该光泽面的表面粗糙度为介于1.08至1.12微米。

22.如权利要求1的铜箔，当该铜箔的厚度为6微米时，具有4至8％的伸长率，当该铜箔的厚度为8微米时，具有5至10％的伸长率，当该铜箔的厚度为10微米时，具有7至12％的伸长率，当该铜箔的厚度为20微米时，具有14至18％的伸长率，且于60°入射角量测的幅方向

光泽度为介于300至650。

23.一种二次电池，包括：

如权利要求1的铜箔；

电解液；

隔离膜；以及

碳质材料。

24.一种包括如权利要求23的二次电池的电子装置，该电子装置选自电源工具、电动运载工具、移动电话、平板电脑及便携式电子装置所组成的组。

抗翘曲铜箔

技术领域

[0001] 本发明有关于一种经改良的铜箔及一种制造该铜箔的方法，其中该铜箔具有抵抗翘曲和抵抗皱纹的性质。

背景技术

[0002] 电解铜箔的制备是使用硫酸及硫酸铜所组成的水溶液作为电解液、由铱或其氧化物覆盖的钛板作为尺寸稳定性阳极(DSA)、钛制辊筒作为阴极，于两极间通以直流电，使电解液中的铜离子电沉积在钛制辊筒上，之后从钛制辊筒的表面剥离该电解铜箔并连续卷绕来制造。该电解铜箔与钛制辊筒表面接触的面被称为“光泽面(S面)”，而电解铜箔的反面被称为“粗糙面(M面)”。通常，电解铜箔S面的粗糙度取决于钛制辊筒表面的粗糙度，因此电解铜箔的S面的粗糙度相当一致，而M面的粗糙度可以通过调节硫酸铜电解液的条件来控制。

[0003] 目前用于制造供锂离子二次电池使用的电解铜箔的硫酸铜电解液主要可分为两大类，其中的一为所谓的含添加剂系统，即在硫酸铜电解液中加入能够抑制铜离子电沉积的明胶(gelatin)、羟乙基纤维素(HEC)或聚乙二醇(PEG)等有机添加剂以及添加具有细晶化效果的3-巯基-1-丙烷磺酸钠(sodium3-mercaptopropane sulphonate;MPS)、聚二硫丙烷磺酸钠(bis-(3-sodiumsulfopropyl disulfide;SPS)等含硫化合物，如此，可以降低电解铜箔M面的粗糙度，并由此得到双面光泽的电解铜箔及具有含细晶体颗粒的结构。另一类为所谓的不含添加剂系统，即在硫酸铜电解液中不加入任何有机添加剂。该类型的不含添加剂系统与含添加剂系统相反。有机物在硫酸铜电解液的总含量愈低，获得在M面具有低粗糙度和表面无异常突出颗粒的有光泽的电解铜箔的可能性愈高。纵使不含添加剂的系统中没有有机添加剂添加于硫酸铜电解液，用于硫酸铜电解液的铜原料主要来自于市售回收铜导线。该铜导线表面含有油脂或其它有机物质，使得当铜线溶解在硫酸时，用于生产电解铜箔的电解液中会充满像油脂或有机杂质等的不纯物质。有机杂质的含量越高，产生在M面具有许多异常突出颗粒的电解铜箔的可能性越高，因此无法得到具有双面光泽的电解铜箔。

[0004] 此外，当电解铜箔的M面具有许多异常突出颗粒，常导致电解铜箔后续应用的制程上有问题。举例而言，在铜粗化处理时，该M面的异常突出颗粒容易导致尖端放电，造成铜粗化颗粒异常集中，随后，当通过压合电解铜箔形成铜箔基板时，因不完全蚀刻所产生的残铜容易引起短路，造成下游产品产率低落。

[0005] 近年环保意识抬头，用完即丢的一次电池渐渐为高性能二次电池所取代，并广泛的运用于消费性电子产品、储能系统及其他产业。

[0006] 随着汽车工业的发展，对锂离子二次电池的需求也随之增加。除了良好的充电-放电性能的要求，锂离子二次电池的安全性和电池寿命也应考虑在内。而未来锂离子二次电池的发展趋势为朝向能量储存系统用的电能储存电池。为了开发锂离子二次电池以满足系统规模的要求并满足能源储存技术的发展趋势，在锂离子二次电池的电池容量必须达到百万瓦/百万瓦小时(MW/MWh)的规模，在移动电话中使用的锂离子二次电池的循环寿命应超过2000次，及在能量储存系统中使用的锂离子二次电池的循环寿命应超过6000次。

[0007] 锂离子二次电池的制造是将负极极片、隔离膜及正极极片卷绕在一起，将其置入容器中，加入电解液并密封该容器，其中该负极极片由以铜箔构成的负极集电体与涂布于其表面的以碳材等作为材料的负极活性物质所构成，该铜箔是压延铜箔或电解铜箔。

发明内容

[0008] 本发明有关一种铜箔，其展现惊人的抗变形性质(如，抗翘曲及抗皱)，典型的铜箔具有变形的倾向，特别是因为温度及压力的改变而在边缘产生变形(在边缘处翘曲)。当辗压该铜箔时，不必要的翘曲会造成问题。

[0009] 举例而言，当铜箔经过导辊，翘曲边缘会被卡在机器因而导致铜箔起皱。本发明提供一种铜箔(及制造该涂覆铜箔的方法)，其具有比典型的铜箔更少的变形(例如，更少的翘曲和起皱)。本发明揭示影响铜箔变形性质的因素，举例而言，如光泽度、粗糙度及拉伸强度。在某些情况下，本发明揭示下列三个要素可用于制备具有经改良的抗变形性质的改良铜箔：(1)铜箔的粗糙面的光泽度；(2)铜箔的光泽面与粗糙面之间的表面粗糙度(Rz)差；及(3)铜箔在幅方向(TD)上的拉伸强度差。

[0010] 本发明一方面提供一种具耐翘曲性的铜箔，具有机械方向的尺寸、幅方向的尺寸以及厚度，且该铜箔进一步包括：a.光泽面；b.粗糙面，具有330至620的于60°入射角量测的机械方向光泽度；c.该光泽面与粗糙面之间的表面粗糙度差为介于0.3至0.59微米；以及d.自该铜箔的幅方向上取至少两个样品的拉伸强度差为1.2公斤力/平方毫米或更小。

[0011] 本发明另一方面提供一种二次电池，包括上述铜箔；电解液；隔离膜；以及碳质材料。

[0012] 本发明另一方面提供一种包括上述二次电池的电子装置，该电子装置选自电源工具、电动运载工具、移动电话、平板电脑及便携式电子装置所组成的组。

附图说明

[0013] 以下透过例示性的参考附图说明本发明的实施方式，其中：

[0014] 图1是显示铜箔于两轧辊之间受到辗压的示意图；

[0015] 图2是显示测量铜箔的翘曲数值的示意图；以及

[0016] 图3是显示如何计算铜箔在幅方向上的△T/S值。

[0017] 据知，本发明的各种实施形式不应限于上述图式示意的设置与手段。

[0018] 符号说明

[0019] 55 轧辊

[0020] 58 铜箔

[0021] 103 十字狭缝

[0022] 105 切角

[0023] 107 尺规。

具体实施方式

[0024] 典型地，本发明的铜箔具有：(a)光泽面；(b)粗糙面，其中该粗糙面具有330至620的机械方向(MD)光泽度；(c)该光泽面与粗糙面之间的表面粗糙度(Rz)差为介于0.3至0.59

微米；以及(d)该幅方向上的拉伸强度差为1.2公斤力/平方毫米(kgf/mm^2)或更小。该粗糙面亦可具有400至600的光泽度或450至500的光泽度，该铜箔的厚度可例如为1至50微米、4至35微米、4至25微米或6至20微米。

[0025] 本发明的铜箔独特，不像传统铜箔般翘曲。举例而言，在一些实施例中，在经过辗压和热处理后的翘曲程度小于5毫米。翘曲程度(在经过辗压和热处理后)为2毫米或更小，或1毫米或更小。翘曲度的计算是在室温下通过于该铜箔以十字形状(或“X”形状)切割两个10公分长的狭缝，然后于该箔的切角(被“X”切割所创造的切角)测量翘曲或变形量，于切割该箔后立即进行该测量。

[0026] 本发明的铜箔在光泽面与粗糙面之间具有介于0.3至0.59微米的表面粗糙度(Rz)差，该粗糙面的表面粗糙度(Rz)为介于0.5至0.8微米。除此之外，该铜箔在幅方向上具有0.9、0.7、0.5或0.4公斤力/平方毫米(kgf/mm^2)或更小的拉伸强度差。

[0027] 本发明亦有关于一种铜箔，是在该箔的一面或双面进一步包括一碳质层。若该碳质层在一面，其可位于M面或S面上。于一面或双面具有碳质层的铜箔等铜箔可被包含在锂离子电池等二次电池中。据此，本发明涉及包含本文所述的铜箔的二次电池。通过将正极极片、隔离膜及负极极片卷绕在一起，将其放置于一容器内，注入电解液，并密封以形成一电池，而得到锂离子二次电池等的二次电池，其中该负极极片由铜箔制成的负极集电体及涂覆在其表面且由碳材等制成的负极活性物质所构成。

[0028] 本发明亦有关于一种制造上述铜箔的方法，该方法可包括添加硫酸铜电解液；于该硫酸铜电解液中执行电化学反应，以产生电解铜箔，其中该电解铜箔包括：(a)光泽面；(b)粗糙面，具有330至620的MD光泽度；(c)该光泽面与粗糙面之间的表面粗糙度(Rz)差为介于0.3至0.59微米；以及(d)该幅方向上的拉伸强度差为1.2公斤力/平方毫米(kgf/mm^2)或更小。更进一步地，该方法可包括卷绕该铜箔。

[0029] 本发明还有关于一种具耐翘曲性的铜箔，包括(a)光泽面，其表面粗糙度(Rz)为介于1.0至1.5微米；(b)粗糙面，具有330至620的MD光泽度；(c)该光泽面与粗糙面之间的表面粗糙度(Rz)差为介于0.3至0.59微米；以及(d)该幅方向上的拉伸强度差为1.2公斤力/平方毫米(kgf/mm^2)或更小。在一些实施例中，该铜箔的光泽面粗糙度(Rz)为介于1.08至1.12微米。再者，当该铜箔的厚度为6微米时，具有4至8％的伸长率，当该铜箔的厚度为8微米时，具有5至10％的伸长率，当该铜箔的厚度为10微米时，具有7至12％的伸长率，当该铜箔的厚度为20微米时，具有14至18％的伸长率。更进一步地，该铜箔具有介于300至650或介于329至610的幅方向(TD)光泽度。

[0030] 在一些实施例中，该铜箔具有：(a)光泽面，其表面粗糙度(Rz)为介于1.08至1.12微米；(b)粗糙面，其具有330至620的MD光泽度；(c)该光泽面与粗糙面之间的表面粗糙度(Rz)差为介于0.3至0.59微米；以及(d)幅方向上的拉伸强度差为1.2公斤力/平方毫米(kgf/mm^2)或更小，其中该铜箔的厚度为6至20微米。

[0031] 本发明的铜箔可用于电池中、包含电池的电子装置中、及/或于电子装置自身当中(非在电池中)，举例而言，该铜箔可应用于电子装置，例如电源工具、汽车、包含电动汽车等的电动运载工具、移动电话、平板电脑及便携式电子装置等。

[0032] 最后，本发明有关于用于减少因铜箔的翘曲或起皱造成的产品拒收的方法，该铜箔包括形成如本文的铜箔，将碳质层设置于该铜箔上，选择性地辗压该经涂覆的铜箔，以及

卷绕该铜箔。

[0033] 光泽度的测量是透过以固定强度及角度投射光束于一表面并于相等但相反的角度测量反射光的量，光泽度计(光泽计)用于测量表面的镜面反射光泽度，该光泽度计施以一特定角度的光线于该测试表面并同时测量其反射量。

[0034] 粗糙度是表面纹理的一个要素，由一实际表面与其理想形式的正交向量方向上的偏差进行定量。若偏差大，则该表面为粗糙；若偏差小，则该表面为平滑。粗糙度通常以Ra或Rz值表达，Ra定义为测量长度上中心线到粗糙度曲线的所有绝对距离的算术平均值，Rz定义为测量长度上5个连续取样长度的最大峰谷高度的平均值，该值约相当于从微切片技术测定的曲线值，被认为最适合于高频电性性能测量者为Rq值，亦被认为是扫描区域中峰谷测量的均方根(RMS)。咸知，铜表面的粗糙度是用物理探针方法测量，该方法为公众所习知的试验方法，但由于探针针头触及谷深的限制，其可能呈现较为平滑的曲线。还有通常被视为更精确的激光表面轮廓仪测量方法，然而仍可考量多种不同的技术及方法。在较佳的实施例中，光泽面与粗糙面之间的表面粗糙度(Rz)差为介于0.3至0.51微米。

[0035] 拉伸强度指当材料被延展或拉伸于失去作用或断裂前，材料能够承受的最大应力。拉伸强度不同于抗压强度，其数值亦彼此迥异。伸长率、拉伸强度、和粗糙度是使用IPC-TM-650进行测量。

[0036] 传统上，于硫酸铜电解液中加入有机添加剂(例如，一种低分子量的凝胶(如明胶)、羟乙基纤维素(HEC)或聚乙二醇(PEG))或具有细晶化效果的含硫化合物(例如3-巯基-1-丙烷磺酸钠(MPS)、聚二硫丙烷磺酸钠(SPS))以改变电解铜箔的结晶相。

[0037] 实施例1电解铜箔的制备

[0038] 将铜线以50重量％的硫酸水溶液溶解，制备含320克/升的硫酸铜($CuSO_4 \cdot 5H_2O$)与100克/升的硫酸的硫酸铜电解液。于每升的硫酸铜电解液中添加5.31毫克的明胶(2CP：Koei Chemical股份有限公司)、2.89毫克的3-巯基-1-丙烷磺酸钠(MPS:HOPAX公司)、0.21毫克的硫脲(Chem-Lab)及25毫克的氯离子。接着，在45℃的液温和34安培/平方分米(A/dm^2)的电流密度制备6微米厚的电解铜箔。见下表1的本发明铜箔编号1(未经涂覆)。未经涂覆的电解铜箔的粗糙度、拉伸强度、伸长率、光泽度和翘曲的测定于实施例4中叙述。

[0039] 实施例2涂覆电解铜箔

[0040] 负极浆料的制备是使用水作为溶剂，负极材料则如下表1所示，且固-液比为73％(100克阳极材料:73克水)。

[0041] 表1

[0042]

负极材料	以负极材料总重计%
负极活性物质 (石墨化介相沥清粉末；MGPA)	95 重量%
助导剂 (导电碳粉；Super P®)	1 重量%
增黏剂 (羧甲基纤维素；CMC)	1.6 重量%
水性黏着剂 (苯乙烯-丁二烯橡胶；SBR)	2.4 重量%

[0043] 负极材料配方的成分混合之后，以每分钟5米的速度将该碳材浆液涂覆至该铜箔的表面到厚度为200微米，然后以120℃的烘箱烘干。见下表2的本发明铜箔编号1(经涂覆)。经涂覆的电解铜箔的粗糙度、拉伸强度、仲长率、光泽度和翘曲的测定于实施例4中叙述。

[0044] 实施例3辗压电解铜箔

[0045] 实施例1的未经涂覆电解铜箔(表2的未经涂覆的本发明铜箔编号1)及实施例2的经涂覆电解铜箔(表2的经涂覆的本发明铜箔编号1)皆受到辗压。辗压机的轧辊尺寸为250毫米(直径)×250毫米(幅宽)，硬度为62～65°HRC，轧辊材料是高碳铬轴承钢(SUJ2)。实施例1的铜箔(表2的未经涂覆的本发明铜箔编号1)是经由1公尺/分钟的速度及5000公斤的压力辗压，直到厚度减少了至少0.3％。实施例2的铜箔(表2的经涂覆的本发明铜箔编号1)是经由1公尺/分钟的速度及5000公斤的压力辗压，直到碳质层达到1.5克/立方公分的密度。图1显示铜箔58被输入两个轧辊55之间辗压。

[0046] 实施例4测量

[0047] 翘曲：将实施例1和实施例2的受辗压铜箔的一部分置于固体塑胶板上，且铜箔的M面朝上。将绘制有10公分×10公分十字记号的纸片放置于铜箔M面的上方，使用锋利的刀片沿着绘制在纸上的10公分×10公分的十字记号来切割该纸片及下层的铜箔。在切割过程中使用尺规来协助稳定刀，并确保切线呈直线。然后将该纸张从铜箔移起，该铜箔从切线所得的切角被允许自由地向上翘曲。用尺规来测量翘曲的最大高度。图2显示尺规107放置于铜箔58的十字狭缝103所形成的开口中，尺规107用来测量在切角105翘曲的最大高度，如果翘曲的测量值为约1至2毫米(或更小)，则该铜箔具有显著的耐翘曲性，这代表为优良的结果。如果翘曲的测量值在大于2且小于3毫米之间，则该铜箔仍对极度的翘曲维持相当大的耐性，这代表为良好的结果。在约3至5毫米之间的翘曲测量值被认定为中等的结果。翘曲测量值大于5毫米被认定为不好的结果。

[0048] 拉伸强度：拉伸强度是通过IPC-TM-650进行测量，切割电解铜箔以获得100毫米×12.7毫米(长×宽)尺寸的测试样品。测试样品在室温(约25℃)下测试，在50毫米的夹头距离及50毫米/分钟的十字头速度的条件下使用岛津股份有限公司(Shimadzu Corporation)型号为AG-I的试验机测定。

[0049] 幅方向上的△T/S的测量:从铜箔的幅方向上切下三个具有10厘米×10厘米尺寸的样品,从两个边缘取得两个样品,以及从中心取得第三个样品。该△T/S是通过从最大T/S减去最小T/S计算得到,图3显示三个从铜箔58在幅方向上切割下的正方形样品1、2及3,尺寸各为10公分×10公分。

[0050] 仲长率:仲长率是使用IPC-TM-650进行测量,切割铜箔以得到100毫米×12.7毫米(长×宽)尺寸的测试样品。测试样品在室温(约25℃)下测试,在50毫米的夹头距离及50毫米/分钟的十字头速度的条件下使用岛津股份有限公司型号为AG-I的试验机测定。

[0051] 光泽度:使用光泽度计(由BYK公司制造,型号micro-gloss 60°型)并按照JIS Z8741测量光泽度,即通过测量在M面的机器方向(MD)和幅方向(TD)上于60°光入射角的光泽度。

[0052] 使用如上述实施例所描述的步骤制备下表2的本发明铜箔编号2至14以及下表3的比较铜箔编号1至11并测量其性质。

[0053] 表2

[0054]

	性质								铜箔辗压后的翘曲(mm)	涂覆铜箔辗压后的翘曲(mm)
本发明铜箔编号	厚度(μm)	MD光泽度	TD光泽度	S面粗糙度(μm)	M面粗糙度(μm)	两面粗糙度差(μm)	幅方向的△T/S(kgf/mm²)	伸长率(%)		
1	6	335	329	1.09	0.79	0.30	0.9	7.4	1	0
2	6	358	342	1.1	0.78	0.32	0.7	6.5	1	0
3	6	384	378	1.08	0.76	0.32	0.4	6.8	2	0
4	6	429	418	1.09	0.73	0.36	0.3	5.7	3	1
5	6	452	443	1.09	0.71	0.38	0.5	4.4	4	2
6	8	541	523	1.11	0.67	0.44	0	9.2	1	0
7	8	557	552	1.08	0.67	0.41	0.2	8.5	3	1
8	8	560	551	1.08	0.66	0.42	0	7.8	2	1
9	8	563	558	1.09	0.62	0.47	0.1	6.5	5	3

[0055]

10	8	565	557	1.13	0.59	0.54	0.1	5.6	2	0
11	20	581	573	1.12	0.63	0.49	0.2	17.8	1	0
12	20	586	574	1.12	0.62	0.5	0.4	16.2	3	1
13	20	598	583	1.11	0.60	0.51	0.6	16.4	3	1
14	20	619	610	1.1	0.51	0.59	1.2	14.6	1	0

[0056] 表3

[0057]

	性质								铜箔辗压后的翘曲 (mm)	涂覆铜箔辗压后的翘曲 (mm)
比较铜箔编号	厚度 (μm)	MD光泽度	TD光泽度	S面粗糙度 (μm)	M面粗糙度 (μm)	两面粗糙度差 (μm)	幅方向的△T/S (kgf/mm²)	伸长率 (%)		
1	6	179	163	1.08	1.24	0.16	1.5	7.5	12	8
2	6	198	173	1.12	1.18	0.06	1.5	7.8	13	9
3	6	225	213	1.11	1.09	0.02	1.4	7.1	13	10
4	6	252	243	1.11	1.11	0	1.4	6.8	11	9
5	8	273	261	1.09	1.10	0.01	1.4	9.4	8	6
6	8	289	273	1.08	0.99	0.09	1.4	8.6	10	9
7	8	318	310	1.12	0.87	0.25	1.3	8.7	9	7
8	20	632	624	1.12	0.51	0.61	1.4	15.5	6	4
9	20	643	635	1.13	0.48	0.65	1.5	14.3	8	6
10	20	651	643	1.11	0.47	0.64	1.3	14.6	7	4
11	20	641	632	1.09	0.48	0.61	1.5	14.2	6	6

[0058] 上表中的数据显示该具有以下参数的铜箔表现出意想不到的耐翘曲性：

[0059] (a)粗糙面具有330至620的MD光泽度。

[0060] (b)其光泽面与粗糙面之间的表面粗糙度(Rz)差为介于0.3至0.59微米；以及

[0061] (c)幅方向上的拉伸强度差为1.2公斤力/平方毫米(kgf/mm²)或更小。

[0062] 上述实施例仅为例示性说明，而非用于限制本发明。任何该领域技术人员均可在不违背本发明的精神及范畴下，对上述实施例进行修饰与改变。因此，本发明的权利保护范围由本案权利要求书所定义，只要不影响本发明的效果及实施目的，应涵盖于此公开技术

内容中。

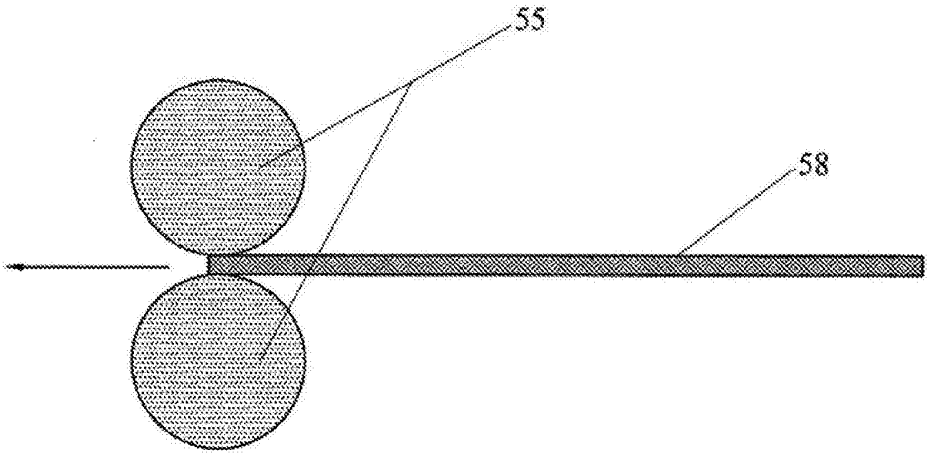


图1

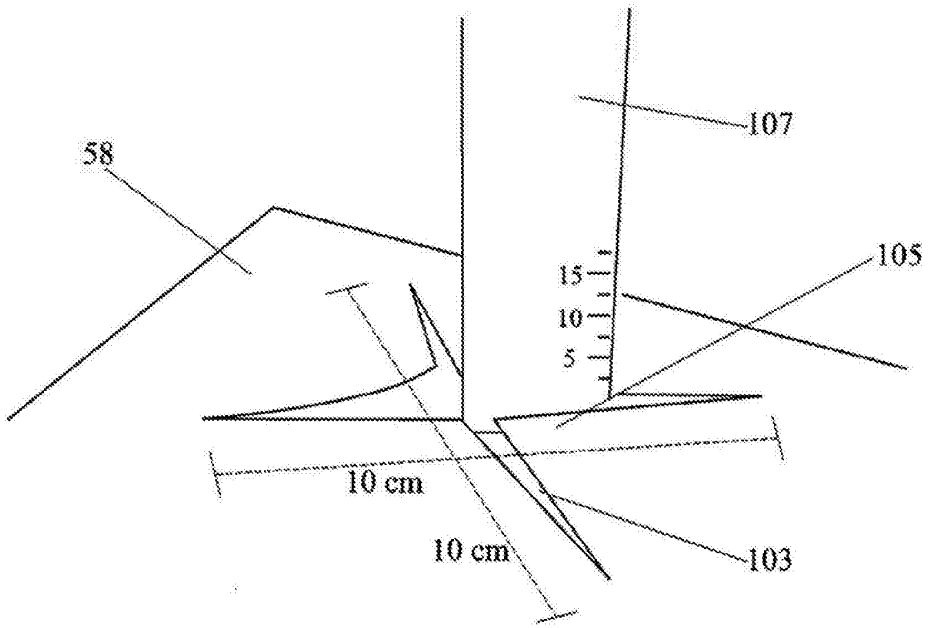


图2

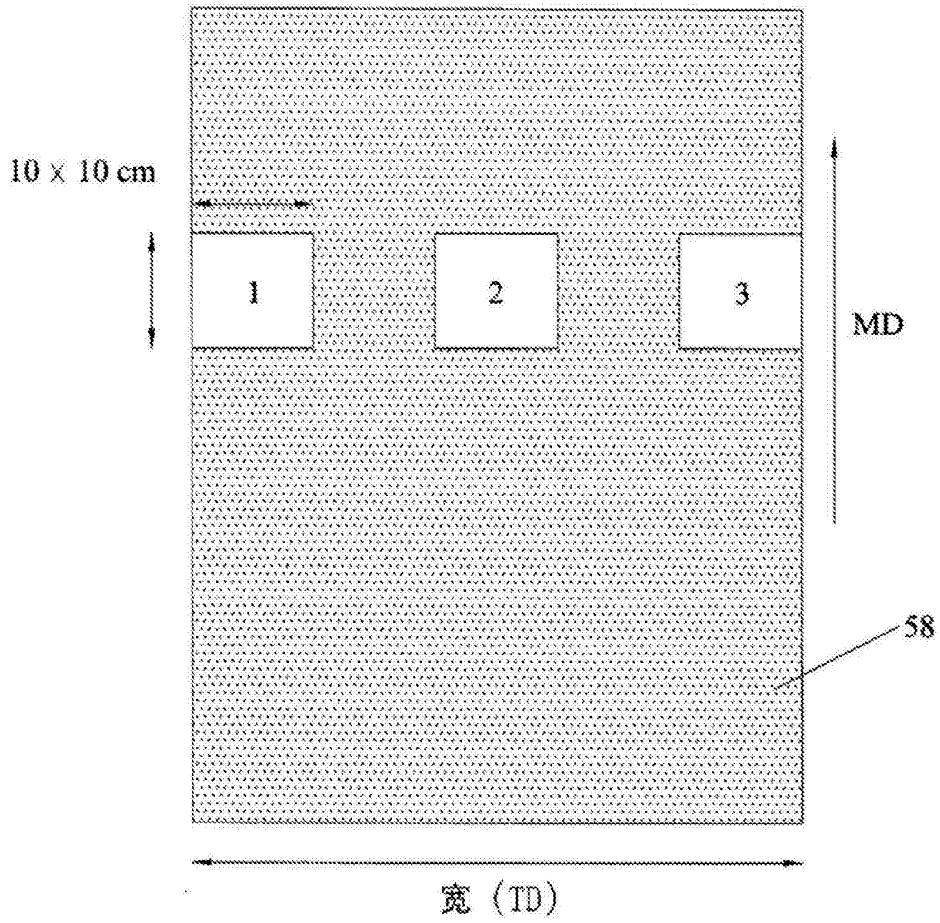


图3

Espacenet

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Electrolytic copper foil and manufacturing method therefor, current collector for lithium secondary battery comprising electrolytic copper foil, and lithium secondary battery

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Applicant(s): LS MTRON LTD ± (LS美创有限公司)

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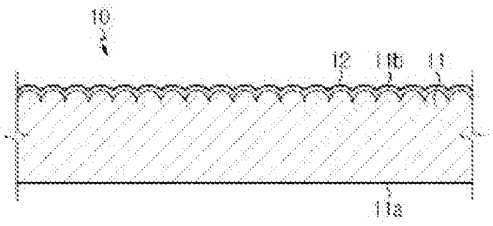
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Abstract of CN106536791 (A)

[图1]



An electrolytic copper foil according to one embodiment of the present invention is used as a current collector for a lithium secondary battery, and the electrolytic copper foil has a fracture characteristic coefficient (f) ranging from 5.0 to 18.0 after the electrolytic copper foil is annealed at 190 DEG C for an hour, wherein the fracture characteristic coefficient (f) is defined as f={(C-B)/A}*1000 where A denotes stress of the electrolytic copper foil at a moment when the fracture of the electrolytic copper foil is initiated, B denotes elongation at a moment when the fracture of the electrolytic copper foil is initiated, and C denotes elongation at a moment when the fracture of the electrolytic copper foil is terminated in a tension test of the electrolytic copper foil, wherein the moment when the fracture of the electrolytic copper foil is initiated corresponds to the moment when the stress, which has increased with an increase of the elongation of the electrolytic copper foil, begins to decrease in the tension test, and the moment when the fracture of the electrolytic copper foil is terminated corresponds to the moment when the electrolytic copper foil is broken into two or more fragments.

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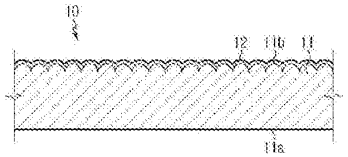
权利要求书1页 说明书8页 附图1页
按照条约第19条修改的权利要求书1页

(54)发明名称

电解铜箔及其制造方法、包含该电解铜箔的锂二次电池用的集电体及锂二次电池

(57)摘要

本发明一实施例的电解铜箔，是用作锂二次电池用的集电体的电解铜箔，上述电解铜箔在190℃退火1小时后，具有5.0～18.0范围的断裂特性系数f，上述断裂特性系数f定义为f＝{(C B)/A}×1000，上述A表示在上述电解铜箔的拉伸测试中，上述电解铜箔的断裂开始时该电解铜箔具有的应力，上述B表示上述电解铜箔的断裂开始时的延伸率，上述C表示上述电解铜箔的断裂结束时的延伸率，上述电解铜箔的断裂开始的时间相当于在拉伸测试中随着上述电解铜箔的延伸率的增加而增加的应力开始减小的时间，上述电解铜箔的断裂结束的时间相当于上述电解铜箔断裂成两个以上的碎片的时间。



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1.一种电解铜箔，其用作锂二次电池用的集电体，其特征在于，

上述电解铜箔在190℃的条件退火1小时后，具有5.0～18.0范围的断裂特性系数f，

上述断裂特性系数f定义为f＝{(C-B)/A}×1000，

上述A表示在上述电解铜箔的拉伸测试中，上述电解铜箔的断裂开始时该电解铜箔具有的应力，

上述B表示上述电解铜箔的断裂开始时的延伸率，

上述C表示上述电解铜箔的断裂结束时的延伸率，

上述电解铜箔的断裂开始的时间相当于在拉伸测试中随着上述电解铜箔的延伸率的增加而增加的应力开始减小的时间；

上述电解铜箔的断裂结束的时间相当于上述电解铜箔断裂成两个以上的碎片的时间。

2.根据权利要求1所述的电解铜箔，其特征在于，

上述电解铜箔具有在表面形成的保护层，

上述保护层由从铬酸盐、苯并三氮唑以及硅烷偶联剂中选择的至少任意一种组成。

3.根据权利要求1所述的电解铜箔，其特征在于，

上述电解铜箔的厚度小于20μm。

4.根据权利要求1所述的电解铜箔，其特征在于，

上述电解铜箔的表面粗糙度Rz为大于0μm且2μm以下。

5.一种电解铜箔的制造方法，其是在190℃的条件退火1小时后具有5.0～18.0范围的断裂特性系数f的电解铜箔的制造方法，其包括：

(a)制造铜浓度为70g/L～80g/L、硫酸浓度为80g/L～110g/L的硫酸铜水溶液的步骤；以及

(b)在温度为40℃～45℃、电流密度为40A/m^2～70A/m^2的条件下，将上述硫酸铜水溶液作为电解液，使铜电沉积在制箔机的滚筒表面的步骤。

6.根据权利要求5所述的电解铜箔制造方法，其特征在于，包括：

(c)在电沉积的铜层表面，形成由从铬酸盐、苯并三氮唑以及硅烷偶联剂中选择的至少任意一种组成的保护层的步骤。

7.一种锂二次电池用的电极集电体，其中，其由权利要求1～4中任一项所述的电解铜箔形成。

8.一种锂二次电池，其中，其包含权利要求7所述的锂二次电池用的电极集电体。

电解铜箔及其制造方法、包含该电解铜箔的锂二次电池用的集电体及锂二次电池

技术领域

[0001] 本发明涉及一种电解铜箔及其制造方法、包含该电解铜箔的锂二次电池用的集电体及锂二次电池，更具体地，涉及一种通过将断裂特性系数值限制在规定范围内，能够改善二次电池特征的电解铜箔及其制造方法、包含该电解铜箔的锂二次电池用的集电体及锂二次电池。

[0002] 本申请基于2014年07月10日申请的韩国专利申请第10-2014-0086970号主张优先权，并将相应申请的说明书及附图所公开的全部内容援引在本申请中。

背景技术

[0003] 相比于其他二次电池，锂二次电池不仅具有较高的能量密度、较高的工作电压，还具有优秀的保存及寿命特征等优点，因此，广泛应用于各种便携式电子设备，包括个人电脑、录像机、便携式电话、便携式CD播放机、个人数码助手(PDA，Personal Digital Assistant)等。

[0004] 通常，锂二次电池具有包括阳极、阴极以及位于阳极与阴极之间的电解质的结构。上述阳极具有阳极活性物质附着在阳极集电体的结构，上述阴极具有阴极活性物质附着在阴极集电体的结构。

[0005] 在锂二次电池中，作为阴极集电体的材料主要使用电解铜箔，该电解铜箔需具有良好的特性，以即便随着二次电池的充放电在二次电池内部反复形成苛刻的条件，也能够保持二次电池的性能。

[0006] 作为上述电解铜箔需要具备的特性，例如，可举出：即使反复充放电的严苛条件，也难以产生裂纹；随着充放电的实施，放电容量保持率的降低速度不能过快；不存在因内部过热产生二次电池的性能降低和/或安全事故的顾虑等。

[0007] 另外，可通过各种因素的调整确保所述电解铜箔的良好特性，但是在发现控制因素及其控制范围以得到想要的特性上，有很多困难。

发明内容

[0008] 发明所要解决的课题

[0009] 本发明是鉴于上述问题而完成的，其目的在于，通过找出能够使锂二次电池发挥良好性能的因素并控制该因素，使电解铜箔具有能使锂二次电池发挥良好性能的特性。

[0010] 但是，本发明要解决的技术课题不仅限于上述课题，通过以下记载的发明内容，本领域技术人员可明确理解在以上未提及的其他技术课题。

[0011] 解决课题的技术方案

[0012] 本发明人为解决上述课题进行了反复研究和实验，其结果，发现通过将适当调整了断裂特性系数的电解铜箔作为锂二次电池用的集电体，即使在反复充放电的情况下，也可保持锂二次电池的良好特性。

[0013] 如上所述，能够保持锂二次电池的良好特性的本发明一实施例的电解铜箔，是用作锂二次电池用的集电体的电解铜箔，且上述电解铜箔在190℃退火1小时后，具有5.0～18.0范围的断裂特性系数(f)。

[0014] 其中，上述断裂特性系数(f)定义为f＝{(C-B)/A}×1000，上述A表示在上述电解铜箔的拉伸测试中，上述电解铜箔的断裂开始时该电解铜箔所具有的应力；上述B表示在上述电解铜箔的断裂开始时的延伸率；上述C表示在上述电解铜箔的断裂结束时的延伸率；上述电解铜箔的断裂开始的时间相当于在拉伸测试中随着上述电解铜箔的延伸率的增加而增加的应力开始减小的时间；上述电解铜箔的断裂结束的时间相当于上述电解铜箔断裂成两个以上碎片的时间。

[0015] 上述电解铜箔具有形成在表面的保护层，上述保护层可由从铬酸盐(chromate)、苯并三氮唑(BTA，benzotriazole)以及硅烷偶联剂中选择的至少任意一种组成。

[0016] 上述电解铜箔的厚度可小于20μm。

[0017] 上述电解铜箔的表面粗糙度(Rz)可以是大于0且2μm以下。

[0018] 另外，上述电解铜箔可根据本发明一实施例的电解铜箔制造方法制造，所述本发明一实施例的电解铜箔制造方法是，在190℃退火1小时后，具有5.0～18.0范围的断裂特性系数(f)的电解铜箔的制造方法，包括：

[0019] (a)制造铜浓度为70g/L～80g/L、硫酸浓度为80g/L～110g/L的硫酸铜水溶液的步骤；以及

[0020] (b)在温度为40℃～45℃、电流密度为40A/m^2～70A/m^2的条件下，将上述硫酸铜水溶液作为电解液，使铜(Cu)电沉积在制箔机的滚筒表面的步骤。

[0021] 上述电解铜箔制造方法，还可包括：

[0022] (c)在电沉积的铜层表面形成由从铬酸盐(chromate)、苯并三氮唑(BTA，benzotriazole)以及硅烷偶联剂中选择的至少任意一种组成的保护层的步骤。

[0023] 另外，上述技术课题不仅可通过由上述电解铜箔形成的锂二次电池用电极集电体解决，还可通过包含该锂二次电池用电极集电体的锂二次电池解决。

[0024] 发明效果

[0025] 根据本发明，即使在由于锂二次电池的充放电而在锂二次电池内部反复发生的严苛条件下，也能够实现锂二次电池的容量保持率降低现象的最小化和/或防止因内部过热发生的起火，由此，能够确保二次电池性能的提高和/或确保二次电池使用上的安全性。

附图说明

[0026] 本说明书的以下附图用于例示本发明的优选实施例，并与下述本发明的详细说明一同起到更加深理解本发明技术思想的作用，因此，不应当仅限于附图的内容限定本发明。

[0027] 图1是表示本发明一实施例的电解铜箔的剖面图。

[0028] 图2是表示电解铜箔拉伸测试中电解铜箔断裂过程的图。

[0029] 图3是用于说明断裂特性系数的应力-延伸率曲线图。

具体实施方式

[0030] 以下，将参考附图，详细说明本发明的优选实施例。在此之前需要说明的是，本说

明书以及权利要求中所使用的术语及单词不应当限定在一般的意义或辞典上的意义去解释，而应当根据发明人为了以最合适的方法说明自己的发明而可以适当地定义术语概念的原则，解释为符合本发明技术思想的意思和概念。因此，本说明书记载的实施例和附图所示的构成仅是本发明最优选的部分实施例，不能代表本发明的所有技术思想，应当理解为在提出本申请时，所有能够替代该实施例的多种等同物和变形例。

[0031] 参考图1，说明本发明一实施例的电解铜箔10的构成。

[0032] 图1是表示本发明一实施例的电解铜箔的剖面图。

[0033] 参考图1，本发明一实施例的电解铜箔10，包括：铜层11；以及保护层12，选择性地形成在上述铜层11的表面。

[0034] 优选将上述电解铜箔10用作锂二次电池的阴极集电体。即，在锂二次电池中，作为与阴极活性物质结合的阴极集电体，优选使用电解铜箔10。相反，作为与阳极活性物质结合的阳极集电体，通常使用由铝(Al)构成的箔(foil)。

[0035] 因此，在本发明中，将使用了上述电解铜箔10的本发明实施例的二次电池集电体是阴极集电体的情况为例，说明本发明。

[0036] 上述电解铜箔10在用作锂二次电池的集电体的情况下，因反复充放电带来的电极体积的膨胀而受力，此时，即使施加超过电解铜箔10的断裂强度的拉力，也不会立即断裂。

[0037] 即，参考图2，电解铜箔10经过缩颈(necking)阶段、产生空隙(viod)阶段、空隙生长和结合阶段、以及在表面出现裂纹阶段，达到完全断裂。

[0038] 将上述断裂形态称作韧性断裂，参考图3，上述电解铜箔10在表示所述韧性断裂的应力-延伸率曲线图中，电解铜箔所具有的应力达到断裂强度后，随着延伸率的增加出现应力逐渐减小的倾向后，最终完全断裂。

[0039] 断裂特性系数(f)是指，应力达到断裂强度的时间点后到电解铜箔10完全断裂时的延伸率的变化量除以断裂开始时的应力值，即除以断裂强度值后乘以1000的值。

[0040] 参考图3，所述断裂特性系数(f)可用以下数学式表示：

[0041] $f=\{(C-B)/A\}\times 1000$

[0042] 其中，A表示上述电解铜箔的拉伸测验中，上述电解铜箔的断裂开始的时间点该电解铜箔所具有的应力；B表示在上述电解铜箔的拉伸测验中，上述电解铜箔的断裂开始的时间节点的延伸率；C表示在上述电解铜箔的拉伸测验中，上述电解铜箔的断裂结束的时间节点的延伸率。

[0043] 在图3的应力-延伸率曲线图中，上述电解铜箔的断裂开始的时间点是指，随着延伸率的增加而增加的应力反而开始减少的点(P1)所对应的时间点。

[0044] 另外，在如图3的应力-延伸率曲线图中，上述电解铜箔的断裂结束的时间点是指，随着延伸率的增加而减少的应力为0的点(P2)所对应的时间点，在此时间点，电解铜箔断裂成两个以上的碎片。

[0045] 当上述断裂特性系数(f)的值过于小的情况下，电解铜箔10在外力作用下断裂时，会在短时间内断裂，因此，当将电解铜箔10用作锂二次电池的集电体的情况下，会出现在反复充放电带来的二次电池内严苛条件下，难以保持二次电池的性能的问题。

[0046] 相反，当上述断裂特性系数(f)的值过大的情况下，电解铜箔10因长时间处于外力作用而即将断裂的不稳定的状态，可能会发生过热现象，因此，会出现电池性能低下的问题

以及难以确保二次电池使用上的安全性的问题。

[0047] 因此，上述断裂特性系数(f)需保持在适当的范围，优选保持在5.0～18.0的范围。

[0048] 所述断裂特性系数(f)是电解铜箔10在190℃退火1小时的状态下测量的，退火是为了使用作集电体的电解铜箔10，适用于在制造锂二次电池的过程中所要经过的高温条件。

[0049] 上述断裂特性系数(f)可通过以下改变进行调节：改变在电解铜箔10的制造过程中镀敷用镀敷液(电解液)中所含的铜、硫酸的浓度；改变可选择性添加到镀敷液中的各种添加剂(无机添加剂、平整剂、增白剂等)的浓度；改变镀敷时的电流密度；以及，改变镀敷液的温度等。

[0050] 另外，通过电镀制造的上述电解铜箔10，由表面粗糙度(Rz)(surface roughness)相对低的光泽面(Shiny surface)11a以及作为其相反面的通过山(Mountain)结构表面粗糙度(Rz)相对高的磨砂面(Matte surface)11b构成。

[0051] 上述光泽面11a的表面粗糙度(Rz)，由析出铜的圆筒形辊(阴极)的研磨程度决定，相反，磨砂面11b的表面粗糙度(Rz)可在电解铜箔10的制造过程中通过改变构成镀敷液的物质的组成、电解反应时的电流密度等来调节。

[0052] 另外，在所述电解铜箔10的磨砂面11b的表面粗糙度(Rz)过高的情况下，活性物质与电解铜箔10很难均匀接触，锂二次电池的放电容量保持率有可能降低。因此，需要将表面粗糙度(Rz)调整在适当的水平，优选将电解铜箔10的磨砂面11b的表面粗糙度(Rz)控制在约2μm以下。

[0053] 上述保护层12是为了电解铜箔10的防锈处理而在铜层11表面选择性形成的层，可由从铬酸盐(chromate)、苯并三氮唑(BTA，benzotriazole)以及硅烷偶联剂中选择的任意一种以上形成。上述保护层12不仅赋予电解铜箔10防锈特性，还能够起到赋予耐热性和/或增大与活性物质的结合力的作用。

[0054] 1.电解铜箔的制造

[0055] 表1

[0056]

	铜镀敷液(g/L)			添加剂(ppm)			电流密度(ASD)
	铜	硫酸	温度	无机金属	平整剂	增白剂	
实施例1	70	80	40	4	0	0	40
实施例2	80	80	45	4	0.5	0.5	70
实施例3	75	85	45	4.5	0.5	1	50
实施例4	70	110	40	4.5	1	2	40
实施例5	80	110	45	5	1	2	70
实施例6	70	100	45	4.5	2	0.5	70
比较例1	70	95	45	4	0.5	0.5	50
比较例2	80	105	45	5	1	1	70
比较例3	80	95	45	5	1	1.5	70
比较例4	70	105	45	4.5	0.5	1	70

[0057] 本发明一实施例的电解铜箔是，通过以硫酸铜水溶液为镀敷液(电解液)，在以规

定速度旋转的圆筒形阴极以及位于相反方向的阳极之间提供镀敷液，在旋转的圆筒形的阴极面电镀铜并进行还原析出而制造，其厚度为约小于20μm(电解铜箔的厚度越薄，附着有活性物质的集电体进入二次电池的量就越多，有利于高容量化，相反，电解铜箔的厚度越厚，适用到二次电池时的高容量化越难，因此，电解铜箔的厚度优选为不超过20μm)。适用于实施例与比较例的各个条件说明如下。

[0058] 一般来说，由电解镀敷生成的电解铜箔具有两个相互不同的面。即，电解铜箔具有：与阴极辊接触的面(shiny side(光面)，S面)和位于通过析出结晶粒生长的方向的面(Matt side(磨砂面)，M面)。该电解铜箔的S面和M面的表面粗糙度(Rz)在约2μm以下的范围。

[0059] (实施例)

[0060] 如表1，制造了铜浓度为70～80g/L、硫酸浓度为80～110g/L的镀敷液，添加各种添加剂(无机金属、平整剂、增白剂)，并在约40～45℃温度范围内，电流密度约为40～70ASD的条件下制造了电解铜箔(但是，并非一定要限定在上述范围内，在可达成本发明的目的范围内能够适当调整)。

[0061] 其中，作为无机添加剂，使用了Fe(铁)、W(钨)、Zn(锌)、Mo(钼)等；作为平整剂，使用了明胶、胶原蛋白和聚乙二醇(PEG，Polyethylene Glycol)；作为增白剂，使用了双(3-磺丙基)二硫化物(SPS)、巯基-丙烷磺酸(MPS)、3-N，N-二甲基氨基二硫代甲酰胺基丙烷磺酸(DPS)。

[0062] 另外，为保护(防锈等)在上述条件下制造的电解铜箔，在其表面进行了铬酸盐(Chromate)处理。

[0063] (比较例)

[0064] 如表1，在铜浓度为70～80g/L、硫酸浓度为95～105g/L的镀敷液，添加各种添加剂(与实施例相同的添加剂)，且在约45℃温度、电流密度约为50～70ASD的条件下制造了电解铜箔。

[0065] 2.断裂特性系数的测量

[0066] 对在上述工序条件下制造的本发明实施例的电解铜箔与比较例的电解铜箔，测量了断裂特性系数(f)。

[0067] 电解铜箔的断裂特性系数，是通过作为标准化测量方法的万能材料试验机(UTM，Universal Testing Machine)测量，测量时万能材料试验机(UTM，Universal Testing Machine)的条件为：标距长度50mm、宽度12.7mm、测量速度2mm/分钟。

[0068] 电解铜箔的断裂特性系数(f)的测量是将电解铜箔在190℃退火1小时后测量的，其目的是使通过上述条件制造的实施例/比较例的电解铜箔处于与完成的锂二次电池内的条件相同的条件。即，制造锂二次电池时，通常会经过在高温状态保持规定时间的过程，为创造与其相似的条件，对电解铜箔进行了退火。

[0069] 经过了所述退火过程的电解铜箔的断裂特性系数(f)测量结果，如下表2所示。

[0070] 表2

[0071]

	(A) 断裂强度 (kgf/mm^2)	(B)断裂开始 (C)断裂结束	D=C-B	(D/A)	f=(D /A)×1000
实施例 1	25.82973	19.452 19.608	0.156	0.0060	6.0
实施例 2	25.70626	17.829 17.971	0.142	0.0055	5.5
实施例 3	25.03256	16.162 16.287	0.125	0.0050	5.0
实施例 4	25.05213	13.066 13.441	0.375	0.0149	14.9
实施例 5	24.79587	12.304 12.728	0.424	0.0171	17.1
实施例 6	24.63445	12.106 12.549	0.443	0.0180	18.0
比较例 1	27.57101	10.818 10.860	0.04265	0.0015	1.5
比较例 2	27.33273	9.918 10.050	0.132	0.0048	4.8
比较例 3	33.62634	5.258 5.265	0.008	0.0002	0.2
比较例 4	24.5685	12.112 12.561	0.449	0.0183	18.3

[0072] 参考表2的结果可知,实施例1～6的电解铜箔显示出5.0～18.0范围的断裂特性系数值,相反,比较例1～3的电解铜箔显示出小于5.0的断裂特性系数值,且比较例4的电解铜箔显示出超过18.0的断裂特性系数值。

[0073] 3.锂二次电池的制造

[0074] -阳极板以及阴极板的制造

[0075] (阳极材料混合物的组成)

[0076] 阳极材料($LiCoO_2$):85wt%

[0077] 导电材料(乙炔黑):8wt%

[0078] 粘合剂(聚偏氟乙烯):7wt%

[0079] (阴极材料混合物的组成)

[0080] 阴极材料(石墨或碳材料):95～98wt%

[0081] 粘合剂(聚偏氟乙烯):2～5wt%

[0082] 在上述材料中添加N-甲基吡咯烷酮制作成浆液后,分别涂抹到由铝箔构成的阳极集电体以及由电解铜箔构成的阴极集电体表面,蒸发溶剂后,压延且切分成规定大小,制造了阳极板以及阴极板。

[0083] -锂二次电池的装配

[0084] 将阳极板、间隔体(经过亲水处理的多孔质聚乙烯膜)、阴极板3张依次叠层并卷起后,将其放入容器中并注入/密封电解液,制造了圆筒形电池。电池的规格为一般的圆柱形的18650型。

[0085] 其中,所使用的电解液为在将碳酸乙烯酯(EC)及碳酸二甲酯(DMC)以1:1体积比混

合后的溶剂中，溶解1M六氟磷酸锂($LiPF_6$)而成。

[0086] 4.充放电试验

[0087] 在根据上述条件制造的锂二次电池中，将通过采用如表1所示实施例1～6的电解铜箔的阴极集电体制造的锂二次电池(本发明实施例的二次电池)，分别作为实施例1～6的锂二次电池。

[0088] 同样，将通过采用如表1所示的比较例1～4的电解铜箔的阴极集电体制造的锂二次电池，分别作为比较例1～4的锂二次电池。

[0089] 以如上所述制备的锂二次电池为对象，进行500次循环充放电试验。此时，充电条件为：CCCV(恒流恒压)充电模式；充电电压为4.3V；充电电流为0.2C(充电5小时可完全充电的电流)，放电条件为：CC(恒流)放电模式；放电电压为3.0V；放电电流为0.5C(2小时内可完全放电的电流)。

[0090] 如上所述，循环充放电结束后，测定锂二次电池的容量保持率、发热程度以及构成集电体的电解铜箔是否出现裂纹，将测定结果示于下表3中。

[0091] 表3

[0092]

	1	2	3	4	5	6	1*	2*	3*	4*
是否出现裂纹	×	×	×	×	×	×	○	微小裂纹	○	×
容量保持率(%)	87	86	84	87	90	93	27	42	24	83
温度(℃)	25	26	26	28	25	27	25	26	25	41

[0093] (1～6：本发明的实施例；1*～4*：比较例)

[0094] 参考上述表3可知，电解铜箔的断裂特性系数(f)在5.0～18.0范围内的本发明实施例的锂二次电池(实施例1～6)，在完成500次循环充放电后，集电体上未发生裂纹现象，且容量保持率也在初始容量的约84%～93%，显示出高保持率(在循环500次充放电的情况下，容量保持率通常在80%～90%左右，在二次电池的内部发生问题的情况下，容量保持率会急剧下降，显示出与正常数值非常大的差异)。

[0095] 另外，实施例1～6的锂二次电池在恒温室内的充放电测试中进行的发热测定中，其表面温度约在25℃～28℃左右，也显示出正常的温度范围(约在30℃以下就可视为正常范围，即使是短暂温度上升的情况下，若无特别异常，温度也不会超过40℃)。

[0096] 相反，电解铜箔的断裂特性系数(f)小于5.0的比较例的锂二次电池(比较例1～3)，因循环充放电而在集电体出现了裂纹，且容量保持率也在初始容量的24%～42%的水平，表明丧失了较多作为二次电池的功能。集电体出现的裂纹，会成为导致附着在集电体的电极活性物质脱落的原因，因此，这种裂纹的出现会直接影响容量保持率的降低。

[0097] 另外，电解铜箔的断裂特性系数(f)大于18.0的比较例的锂二次电池(比较例4)，虽然其在循环充放电中未出现裂纹，且容量保持率也较高，但在发热测试中，显示出约为41℃的温度，远超出了通常视为正常范围的30℃。这种非正常的发热现象不仅降低锂二次电池的性能，还会增加发生安全事故的危险。

[0098] 从上述试验结果明确可知，在电解铜箔10的断裂特性系数(f)保持在规定范围内(5.0～18.0)的情况，即使在循环(反复)充放电引起的严苛条件下，也能够保持二次电池的

性能，由此，能够确保二次电池在使用上的安全性。

[0099] 以上，虽通过限定的实施例和附图来说明了本发明，但本发明不仅限于以上所述的内容，本领域普通技术人员在本发明的技术思想和以下记载的权利要求的等同范围内，可进行各种修改以及变形。

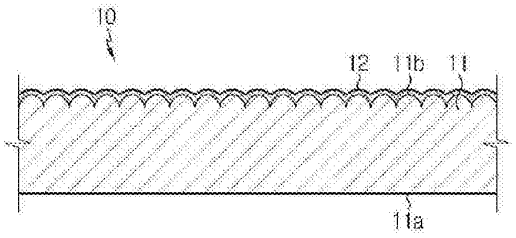

10
12
11b
11
11a

图1

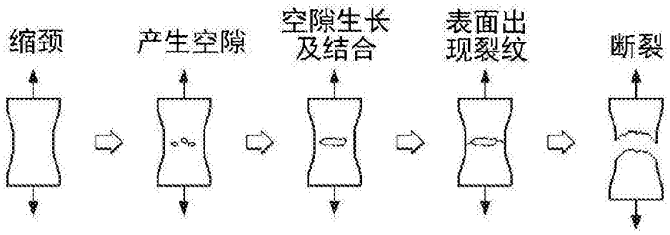

缩颈
产生空隙
空隙生长
及结合
表面出
现裂纹
断裂

图2

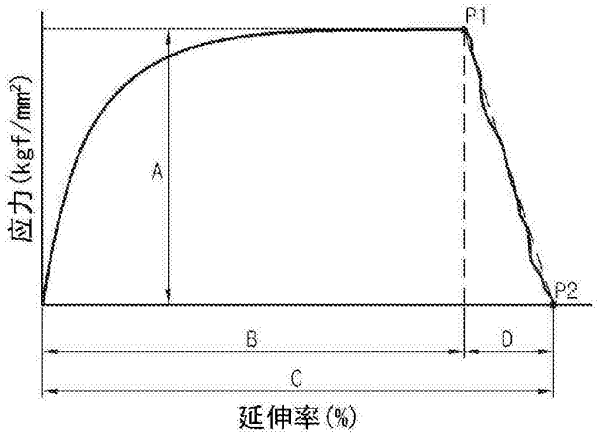

P1
P2
A
B
C
D
应力(kgf/mm²)
延伸率(%)

图3

1.一种电解铜箔，其用作锂二次电池用的集电体，其特征在于，

上述电解铜箔在190℃的条件退火1小时后，具有5.0～18.0范围的断裂特性系数f，

上述断裂特性系数f定义为f＝{(C-B)/A}×1000，

上述A表示在上述电解铜箔的拉伸测试中，上述电解铜箔的断裂开始时该电解铜箔具有的应力，应力单位是kgf/mm^2，

上述B表示上述电解铜箔的断裂开始时的延伸率，

上述C表示上述电解铜箔的断裂结束时的延伸率，

上述电解铜箔的断裂开始的时间相当于在拉伸测试中随着上述电解铜箔的延伸率的增加而增加的应力开始减小的时间；

上述电解铜箔的断裂结束的时间相当于上述电解铜箔断裂成两个以上的碎片的时间。

2.根据权利要求1所述的电解铜箔，其特征在于，

上述电解铜箔具有在表面形成的保护层，

上述保护层由从铬酸盐、苯并三氮唑以及硅烷偶联剂中选择的至少任意一种组成。

3.根据权利要求1所述的电解铜箔，其特征在于，

上述电解铜箔的厚度小于20μm。

4.根据权利要求1所述的电解铜箔，其特征在于，

上述电解铜箔的表面粗糙度Rz为大于0μm且2μm以下。

5.一种电解铜箔的制造方法，其是在190℃的条件退火1小时后具有5.0～18.0范围的断裂特性系数f的电解铜箔的制造方法，其包括：

(a)制造铜浓度为70g/L～80g/L、硫酸浓度为80g/L～110g/L的硫酸铜水溶液的步骤；以及

(b)在温度为40℃～45℃、电流密度为40ASD～70ASD的条件下，将上述硫酸铜水溶液作为电解液，使铜电沉积在制箔机的滚筒表面的步骤，

上述断裂特性系数f定义为f＝{(C-B)/A}×1000，

上述A表示在上述电解铜箔的拉伸测试中，上述电解铜箔的断裂开始时该电解铜箔具有的应力，应力单位是kgf/mm^2，

上述B表示上述电解铜箔的断裂开始时的延伸率，

上述C表示上述电解铜箔的断裂结束时的延伸率，

上述电解铜箔的断裂开始的时间相当于在拉伸测试中随着上述电解铜箔的延伸率的增加而增加的应力开始减小的时间；

上述电解铜箔的断裂结束的时间相当于上述电解铜箔断裂成两个以上的碎片的时间。

6.根据权利要求5所述的电解铜箔制造方法，其特征在于，包括：

(c)在电沉积的铜层表面，形成由从铬酸盐、苯并三氮唑以及硅烷偶联剂中选择的至少任意一种组成的保护层的步骤。

7.一种锂二次电池用的电极集电体，其中，其由权利要求1～4中任一项所述的电解铜箔形成。

8.一种锂二次电池，其中，其包含权利要求7所述的锂二次电池用的电极集电体。

Espacenet

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ELECTRIC COPPER FOIL, AND CURRENT COLLECTOR FOR LITHIUM SECONDARY BATTERY AND LITHIUM SECONDARY BATTERY INCLUDING THE SAME

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Applicant(s): LS MTRON LTD ± (LS美创有限公司, ; KCF技术有限公司)

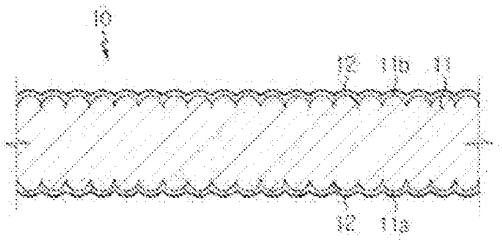
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Abstract of CN106887595 (A)



The invention discloses an electric copper foil, and current collector for a lithium secondary battery and a lithium secondary battery including the same. The electric copper foil is applied as a current collector for a lithium secondary battery, and in a peak curve with respect to a (111) plane appearing on an X-ray diffraction analysis graph (a graph in which an X-axis variable is a diffraction angle 2 [theta] and a Y-axis variable is an intensity of a diffracted X-ray) in a state where the electric copper foil is not thermally treated, the electric copper foil has a full width at half maximum (FWHM) of 0.08 or above and 0.15 or below.

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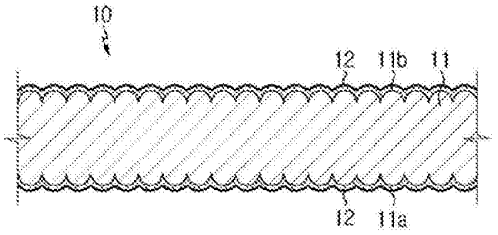
权利要求书1页 说明书7页 附图2页

(54)发明名称

用于锂二次电池的电铜箔和集电器及包括其的锂二次电池

(57)摘要

电铜箔被用作锂二次电池的集电器，并且在相对于(111)平面出现在X射线衍射分析图(X轴变量是衍射角2θ并且Y轴变量是衍射的X射线的强度的图)上的峰值曲线中，在未热处理电铜箔的状态下，电铜箔具有0.08或者以上和0.15或者以下的半峰宽(FWHM)。



CN 106887595 A

1.一种用作锂二次电池的集电器的电铜箔，

其中，在相对于(111)平面出现在X射线衍射分析图(X轴变量是衍射角2θ且Y轴变量是衍射的X射线的强度的图)上的峰值曲线中，在电铜箔未被热处理的状态下，所述电铜箔具有0.08或者以上以及0.15或者以下的半峰宽(FWHM)。

2.根据权利要求1所述的电铜箔，

其中，在相对于(111)平面出现在X射线衍射分析图(X轴变量是衍射角2θ并且Y轴变量是衍射的X射线的强度的图)上的峰值曲线中，在电铜箔在190℃下被热处理1小时的状态下，所述电铜箔具有0.099或者以上以及0.11或者以下的FWHM。

3.根据权利要求2所述的电铜箔，

其中，所述电铜箔具有形成在所述电铜箔的表面处的保护层，以及

其中，所述保护层由选自包括铬酸盐、BTA(苯并三唑)以及硅烷偶联剂的组中的至少一个制成。

4.根据权利要求2所述的电铜箔，

其中，所述电铜箔具有0.3μm或者以上以及1.5μm或者以下的表面粗糙度(Rz)。

5.根据权利要求2所述的电铜箔，

其中，所述电铜箔在M侧面的60度处具有20GU或者以上以及500GU或者以下的光泽度。

6.一种用于锂二次电池的电极集电器，所述电极集电器由根据权利要求2所述的电铜箔制成。

7.一种锂二次电池，包括根据权利要求6所述的锂二次电池的电极集电器。

8.一种用作锂二次电池的集电器的电铜箔，

其中，在相对于(111)平面出现在X射线衍射分析图(X轴变量是衍射角2θ并且Y轴变量是衍射的X射线的强度的图)上的峰值曲线中，在电铜箔在190℃被热处理1小时的状态下，所述电铜箔具有0.099或者以上以及0.11或者以下的FWHM。

用于锂二次电池的电铜箔和集电器及包括其的锂二次电池

技术领域

[0001] 本申请要求2015年10月21日在韩国提交的韩国专利申请第10-2015-0146488号的优先权，其公开内容通过引用合并于此。

[0002] 本公开涉及电铜箔和用于锂二次电池的集电器及包括电铜箔的锂二次电池，并且更具体地说，涉及可以借助于改善的质量来提高二次电池的特性的用于锂二次电池的电铜箔和集电器及包括电铜箔的锂二次电池。

背景技术

[0003] 与其他的二次电池相比，锂二次电池具有许多优点，例如相对较高的能量密度、高工作电压、优良的储藏性和长寿命，因此锂二次电池广泛地用于例如个人计算机、摄录一体机、蜂窝电话、CD播放器、PDA等各种便携式电子装置。

[0004] 通常，锂二次电池包括正极和负极，该正极和负极被布置为在二者之间插入有电解质。在这里，正极被配置为使得正极活性物质附接到正极集电器，并且负极被配置为使得负极活性物质附接到负极集电器。

[0005] 在锂二次电池中，负极集电器通常由电解铜箔制成，且电解铜箔应具有优良的特性，使得即使在二次电池被充电和放电时，在二次电池中重复地形成恶劣条件，仍可维持二次电池的性能。

[0006] 作为电铜箔所需要的特性，例如在电铜箔制造过程期间在电铜箔处不应出现褶皱，并且即使使用电铜箔所制造的二次电池被重复地充电和放电，放电容量保持率应该维持在某一水平处或者超过某一水平。

[0007] 同时，尽管通过调整电解铜箔的各种因素可以确保电解铜箔的这种优良的特性，但是难以发现应该调整哪个因素并且该因素应该调整多少以便获得期望的特性。

发明内容

[0008] 技术问题

[0009] 本公开设计为解决相关技术的问题，并且因此本公开旨在发现和控制用于显示锂二次电池的优良性能的重要因素，使得电铜箔可以具有显示锂二次电池的优良性能所需要的特性。

[0010] 然而，通过本公开实现的技术目的不限于上述，根据以下的详细描述可以清楚地理解以上未提及的其它目的。

[0011] 技术方案

[0012] 在为了实现以上目的进行研究后，本公开的发明人已经发现通过对于在室温下的电铜箔和在高温热处理的电铜箔的X射线衍射试验所获取的2θ(衍射角)强度图中，如果在相对于电铜箔的(111)平面的峰值曲线中的半峰宽(full width at half maximum,FWHM)被维持为具有一致的值，则可以得到具有优良特性的电铜箔。此外，本公开的发明人已经发现通过将具有优良特性的电铜箔应用至锂二次电池的集电器，在重复的充电和放电过程期

间也可以极好地维持锂二次电池的特性。

[0013] 根据本公开的实施例的电铜箔(其可以维持锂二次电池的特性为优良)是应用为用于锂二次电池的集电器的电铜箔,其中,在关于(111)平面的出现在X射线衍射分析图(X轴变量是衍射角2θ并且Y轴变量是衍射的X射线的强度的图)上的峰值曲线中,在电铜箔未被热处理的状态下,电铜箔具有0.08或者以上和0.15或者低于的半峰宽(FWHM)。

[0014] 在关于(111)平面的出现在X射线衍射分析图(X轴变量衍射角2θ并且Y轴变量是衍射的X射线的强度的图)上的峰值曲线中,在电铜箔以190℃热处理1小时的状态下,电铜箔可以具有0.099或者以上和0.11或者以下的FWHM。

[0015] 电铜箔可以具有形成在其表面的保护层,该保护层可以由选自包括铬酸盐、BTA(benzotriazole,苯并三唑)以及硅烷偶联剂的组中的至少一个制成。

[0016] 电铜箔可以具有0.3μm或者以上和1.5μm或者以下的表面粗糙度。

[0017] 电铜箔在M侧面的60度处可以具有20GU或者以上和500GU或者以下的光泽度。

[0018] 同时,根据本公开的实施例的用于锂二次电池的集电器由根据本公开的实施例的以上电铜箔制成,根据本公开的实施例的锂二次电池包括根据本公开的实施例的用于锂二次电池的电极集电器。

[0019] 有益效果

[0020] 根据本公开,尤其对于防止褶皱的出现,可以获得具有优良特性的电铜箔,并且即使锂二次电池被重复地充电和放电,也可以使锂二次电池的容量保持率的降低最小化。

附图说明

[0021] 附图示出了本公开的优选实施例连同前述公开,用作提供本公开的技术精神的进一步理解,并且因此,本公开不被解释为限制于附图。

[0022] 图1是示出了根据本公开的实施例的电铜箔的截面图。

[0023] 图2和图3是用于详细地说明半峰宽(FWHM)的含义的图。

[0024] 图4是用于确定在电铜箔处是否出现褶皱的实验方法的图。

具体实施方式

[0025] 以下,参考附图详细地描述本公开的优选实施例。在描述前,应当理解的是,在说明书和所附权利要求书中所使用的术语不应该被理解为限制于普通的和词典的含义,而是在发明人被允许为最好的解释而适当地限定术语的基础上基于与本公开的技术方案对应的含义和概念来解释。因此,本文中提出的描述仅仅是为了例示的目的的优选示例,不旨在限制本公开的范围,因此应当理解的是,在不脱离本公开范围的情况下能够对其做出其它等效例和变型。

[0026] 将参考图1描述根据本公开的实施例的电铜箔10。

[0027] 图1是示出了根据本公开的实施例的电铜箔的截面图。

[0028] 参考图1,根据本公开的实施例的电铜箔10包括铜层11和可选地形成在铜层11的表面11a、11b处的保护层12。

[0029] 电解铜箔10可以用作锂二次电池的负极集电器。换言之,在锂二次电池中,耦接到负极活性材料的负极集电器可以采用电解铜箔10。同时,耦接到正极活性材料的正极集电

器通常采用由铝(Al)制成的箔。

[0030] 因此，将基于根据本公开的实施例的用于二次电池的集电器的情形来描述本公开，该集电器采用电铜箔10，对应于负极集电器。

[0031] 根据本公开的实施例的电铜箔10被配置为使得在室温和/或高温处所测量的半峰宽(FWHM)被控制在预定范围内。

[0032] 这里，如图2所示，FWHM是可以使用在通过铜箔样品的X射线衍射实验所获得的图中与(111)平面对应的峰值曲线获得的值，该(111)平面是铜箔样品的晶面指数。详细地，FWHM表示与在关于(111)平面的峰值曲线中出现的最大强度的一半强度对应的两个不同的2θ值之间的差值。

[0033] 此外，如图3所示，当X射线以入射角θ照射到铜箔样品时，2θ值表示衍射输出角(diffracted output angle)。

[0034] 当在根据本公开的实施例的电铜箔10的制造过程期间在室温处对于(111)平面进行测量时，其具有大约0.08到0.15的FWHM。在这里，室温表示在电铜箔制造过程期间在没有热处理的情况下执行处理的温度，例如执行用于移动铜箔的卷到卷(roll-to-roll)处理的温度。

[0035] 在FWHM的以上范围中，可以阻止在铜箔处出现褶皱。这里，如果FWHM低于大约0.08，无法预期关于在铜箔处出现褶皱的进一步的改善。如果FWHM高于大约0.15，铜箔的晶粒太小，因此难以控制铜箔的强度和延伸率。

[0036] 如果在电铜箔的室温下FWHM处于以上范围以外，则当制造电铜箔和锂二次电池时，更可能在电铜箔处出现褶皱，并且如果如上述出现褶皱，集电器的表面不能均匀地涂覆有负极材料，这可能引起涂层厚度偏离和负极材料的不良外观，并且因此最终导致产品的质量劣化。

[0037] 同时，如果在根据本公开的实施例的电铜箔10的室温下FWHM处于以上范围内，则可以获得具有强烈抵抗褶皱出现的电铜箔，并且如果使用上述的具有强烈抵抗褶皱出现的电铜箔，则可以增加卷到卷处理的线速度(生产率)，这可以改进产品的总体生产率并且提高制成品(电铜箔和锂二次电池)的质量。

[0038] 同时，在根据本公开的实施例的电铜箔10中，在锂二次电池制造过程期间，在与用作负极集电器的电铜箔的高温环境相同或者类似的条件下，在热处理(在大约190℃热处理1小时)后对(111)平面所测量的FWHM在大约0.099到0.11的范围之内。

[0039] 在FWHM的这个范围中，当使用应用了根据本公开的实施例的电铜箔10的负极集电器所制造的锂二次电池被重复地充电和放电时，锂二次电池可以显示出极好的容量保持率。

[0040] 在电铜箔10的室温下的FWHM和在高温热处理后的FWHM可以与包含在电铜箔制造过程中用于电镀的电镀液(电解液)中的铜和硫酸盐的浓度变化、可选地添加到电镀液的各种添加剂(无机添加剂、均匀剂、增亮剂等)的浓度变化、在电镀工艺期间电流密度的变化以及电镀液的温度变化有关系。

[0041] 同时，根据本公开的实施例的电铜箔10通过以下步骤制备：在以预定速度旋转的圆柱状负极与位于相对侧的正极之间供应电镀液，并使用硫酸铜溶液作为电镀液(电解液)来以小于大约20μm的厚度(如果电铜箔具有较小的厚度，附着有活性材料的集电器可以被

更多地放入二次电池，这有利于提高容量，但是如果电铜箔具有更大的厚度，当被应用于二次电池时难以提高容量，因此电铜箔可以具有不大于20μm的厚度)将铜电镀、还原以及沉淀到旋转的圆柱状负极的表面。

[0042] 再次参考图1，借助于电镀所产生的电铜箔具有两个不同的侧面。换言之，电铜箔具有与负极鼓(drum)接触的光面(S侧面)11a和晶粒借助于沉积生长的无光面(M侧面)11b。电铜箔的S侧面和M侧面可以具有在大约0.3μm到1.5μm的范围内的表面粗糙度(Rz)。

[0043] 如果电铜箔具有比大约0.3μm更低的相当低的表面粗糙度，则活性材料和电铜箔之间的结合力劣化，这可能降低锂二次电池的放电容量保持率。同时，如果电铜箔具有比大约1.5μm高的相当高的表面粗糙度，活性材料和电铜箔不能均匀地接触，这也可能降低锂二次电池的放电容量保持率。

[0044] 此外，在根据本公开的实施例的电铜箔10的表面处测量的无光面(M侧面)的60度处的光泽度可以在大约20到500GU(光泽度单位)范围之内。这是因为，如果光泽度太低，该表面由于太高的表面粗糙度而极其不规则，如果光泽度太高，该表面由于太低的表面粗糙度而极其光滑。

[0045] 同时，保护层12选择性地形成在铜层11的表面上用于电铜箔10的腐蚀控制，并且可以由选自铬酸盐、BTA(benzotriazole，苯并三唑)以及硅烷偶联剂中的至少一个制成。除了电铜箔10的腐蚀控制之外，保护层12也可以具有提高耐热性质和/或与活性材料的结合力的作用。

[0046] 1.电铜箔的制备

[0047] 表1

[0048]

	铜电镀液 (g/L)			添加剂 (ppm)			电流密度
	铜	硫酸盐	温度	无机金属	均匀剂	增亮剂	(ASD)
示例1	70	80	40	4.5	0	1	45
示例2	75	80	45	4	0.5	1	50
示例3	80	110	45	4.5	0.5	0	55
示例4	70	110	40	4.5	0.5	0.5	60
示例5	70	100	45	5	1	1	65
对比例 1	80	95	45	1	2	1	50
对比例 2	70	105	45	1	2	1	50
对比例 3	80	95	45	1	1	2	55
对比例 4	70	110	45	3	2	1	60

[0049] 示例

[0050] 如在表1中，电镀液被制备为具有70-80g/L的铜浓度和80-110g/L的硫酸盐浓度，且其中添加各种添加剂(无机金属、均匀剂、增亮剂)以在大约40到45℃的温度和大约45到65ASD的电流密度的条件(只要本公开的目的可以完成，以上内容可以适当地调整，不限于以上范围)下制备电铜箔。

[0051] 这里，Fe、W、Zn、Mo等被应用为无机添加剂，凝胶、胶原蛋白和PEG(聚乙二醇)被用作均匀剂，以及SPS(双(3-磺丙基)硫化物)、MPS(硫氢基丙烷磺酸)DPS(3-N,N-二甲基氨基二硫代氨基甲酰基-1-丙磺酸)被用作增亮剂。

[0052] 同时，为了根据以上工艺条件所制备的电铜箔的保护(腐蚀控制)，铬酸盐被处理到电铜箔的表面。

[0053] 比较例

[0054] 如在表1中，各种添加剂(与该示例的那些添加剂相同)被加到具有70-80g/L的铜浓度和95-105g/L的硫酸盐浓度的电镀液，从而在大约45℃的温度和大约50-60ASD的电流密度的条件下制备电铜箔。

[0055] 2.电铜箔的FWHM的测量和根据FWHM的性能测试

[0056] 表2

[0057]

	FWHM (室温)	FWHM (高温)	室温效果 (褶皱)	高温效果 (电池容量保持率:%)
示例1	0.114	0.099	褶皱X	86
示例2	0.086	0.102	褶皱X	84
示例3	0.126	0.109	褶皱X	87
示例4	0.149	0.109	褶皱X	90
示例5	0.108	0.110	褶皱X	88
对比例1	0.064	0.083	褶皱O	42
对比例2	0.061	0.092	褶皱O	28
对比例3	0.062	0.080	褶皱O	32
对比例4	0.075	0.113	褶皱O	48

[0058] (1).FWHM测量方法

[0059] 在室温下的测量方法

[0060] 铜箔的X射线衍射分析的条件：

[0061] 型号名称:D-8Advance LynxEye(由BRUKER制造)

[0062] 在本公开中，使用具有以下规格的上述装置，但是可以使用任何装置，只要其允许X射线衍射分析即可。

[0063] 目标:Cu

[0064] 输出:40kV,40mA

[0065] 波长:1.5406A

[0066] 测量范围:20到100度

[0067] 扫描轴:θ-2θ

[0068] 扫描速度:2度/分

[0069] 基于上述规格执行X射线衍射分析，然后根据所获得的结果来计算在电解铜箔的(111)平面中出现的峰值处的FWHM。

[0070] 在高温下的测量方法

[0071] 在190℃下进行热处理1小时后，以与在室温处的测量方法相同的方法来执行X射线衍射分析，然后根据所获得的结果来计算在电解铜箔的(111)平面中出现的峰值处的FWHM。

[0072] (2).根据FWHM的效果

[0073] 在室温下的效果

[0074] 如图4所示，在第一辊和第二辊之间的角度被设置为1.5°以人为地产生错位(misalignment)，然后当铜箔前进时检查在铜箔处是否出现褶皱。

[0075] 参见表2中的测试结果，尤其是通过比较示例2与比较例4的结果，可以发现的是，将FWHM维持在大约0.08或者以上的范围内以便阻止出现褶皱是有利的。此外，尽管在表2的测试结果中未显示，如果FWHM比大约0.15大，则晶粒太小，因此难以控制铜箔的强度和伸张度。因此，将FWHM控制在大约0.15或者以下的范围内是有利的。

[0076] 在高温下的效果

[0077] 在对根据下列条件所制备的锂二次电池重复地执行500次充电/放电试验后，通过测量容量保持率来检查根据FWHM的在高温处的效果。此时，锂二次电池在4.3V的充电电压和0.2C的充电电流(允许在5小时内全充满的电流)的情况下以恒流恒压(CCCV)方式充电，并且在3.0V的放电电压和0.5C的放电电流(允许在2小时内完全放电的电流)的情况下以恒流(CC)方式放电。在如上所述重复地执行充电和放电后，测量锂二次电池的容量保持率。

[0078] 参见表2中的试验结果，尤其是通过比较示例1和比较例2的结果，可以发现的是，考虑到锂二次电池的容量保持率将FWHM维持在大约0.099或者以上的范围内是有利的。此外，通过比较示例5和比较例4的结果，可以发现的是，考虑到锂二次电池的容量保持率将FWHM维持在大约0.11或者以下的范围内是有利的。

[0079] 锂二次电池的制备：

[0080] -正极板和负极板的制备

[0081] (正极材料混合物的成分)

[0082] 正极材料($LiCoO_2$)：85wt％，导电剂(乙炔黑)：8wt％，粘合剂(聚偏二氟乙烯)：7wt％

[0083] (负极材料混合物的成分)

[0084] 负极材料(石墨或者碳材料)：95到98wt％，粘合剂(聚偏二氟乙烯)：2-5wt％

[0085] N-甲基吡咯烷酮被加到以上材料以制作料浆(slurry)，该料浆分别地涂敷到由铝箔制成的正极集电器的表面和由电铜箔制成的负极集电器的表面，并且在溶剂被蒸发后，最终产品被卷起并且切割为预定大小，以制备正极板和负极板。

[0086] -锂二次电池的装配

[0087] 正极板、分隔器(亲水处理的多孔聚乙烯薄膜)以及负极板顺序地层叠，然后卷起并且放进容器，然后该容器在电解液注入到该容器后被密封，从而完整地制成电池。该电池是圆柱状18650型电池，其在本领域中是常规的。在这里，通过将1M的$LiPF_6$溶解在碳酸亚乙酯(ethylene carbonate，EC)和碳酸二甲酯(dimethyl carbonate，DMC)以1:1的体积比混合的溶剂中来制备电解液。

[0088] 根据该实验结果，可以清楚地发现，如果FWHM在室温下和/或高温下被控制在预定范围内，可以具有电铜箔和锂二次电池的生产率，并且即使重复地执行充电和放电，锂二次电池具有高级别的容量保持率。

[0089] 已经详细地描述本公开。然而，应该理解的是，由于对于本领域技术人员而言根据这个详细的描述在本公开的范围内的各种变化和修改将变得明显，仅仅通过例示给出详细的描述和特定的示例，同时表明本公开的优选实施例。

[0090] 参考符号

[0091] 10:电铜箔 11:铜层

[0092] 11a:无光面 11b:光面

[0093] 12:保护层

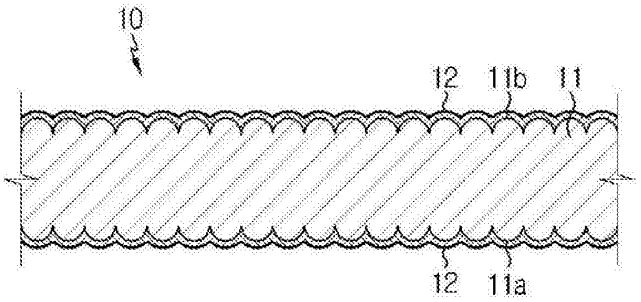


图1

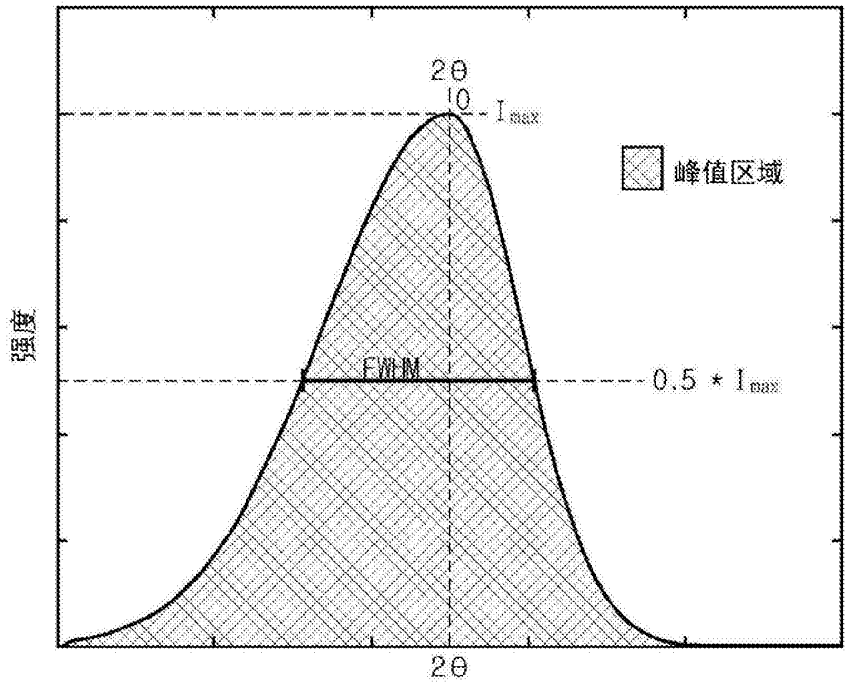


图2

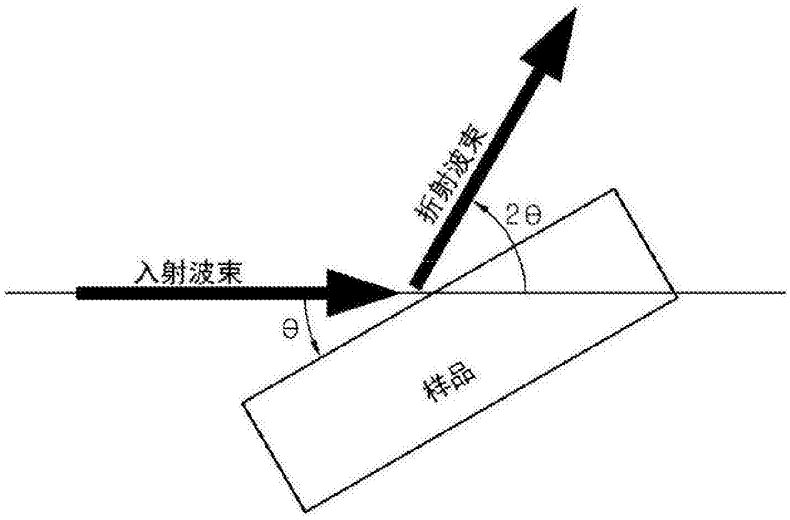


图3

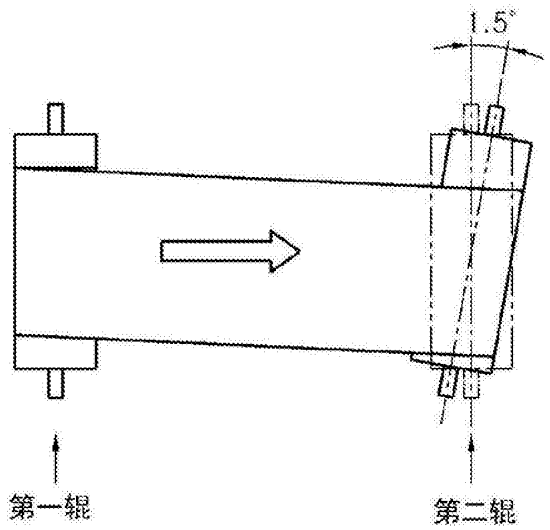


图4

Electronic Acknowledgement Receipt	
EFS ID:	44780569
Application Number:	16959352
International Application Number:	
Confirmation Number:	1067
Title of Invention:	ELECTROLYTIC COPPER FOIL HAVING EXCELLENT HANDLING CHARACTERISTICS IN POSTPROCESSING, AND MANUFACTURING METHOD THEREFOR
First Named Inventor/Applicant Name:	Seung Min KIM
Customer Number:	24573
Filer:	Matthew S. Dicke/US Patent Mail
Filer Authorized By:	Matthew S. Dicke
Attorney Docket Number:	0313221.00022
Receipt Date:	19-JAN-2022
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Application Type:	U.S. National Stage under 35 USC 371

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Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1	Transmittal Letter	00022_IDS_Trans.pdf	90614 49c7c4ea40b21f155d019e3a60c4217b14e8f4bb	no	3

Warnings:

Information:					
2	Information Disclosure Statement (IDS) Form (SB08)	00022_PTOsb08.pdf	1035223 c3d842cde01adb6f9aae337e6225e31603617d07	no	4
Warnings:					
Information:					
A U.S. Patent Number Citation or a U.S. Publication Number Citation is required in the Information Disclosure Statement (IDS) form for autoloading of data into USPTO systems. You may remove the form to add the required data in order to correct the Informational Message if you are citing U.S. References. If you chose not to include U.S. References, the image of the form will be processed and be made available within the Image File Wrapper (IFW) system. However, no data will be extracted from this form. Any additional data such as Foreign Patent Documents or Non Patent Literature will be manually reviewed and keyed into USPTO systems.					
3	Other Reference-Patent/App/Search documents	cn-oa.pdf	486197 58ea1287301ff71d78762880a03d030041853b14	no	15
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Information:					
5	Foreign Reference	CN106536791.pdf	971954 f3d9932ff8c24541435a92740d3042068c013a4a	no	14
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New Applications Under 35 U.S.C. 111

If a new application is being filed and the application includes the necessary components for a filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application.

National Stage of an International Application under 35 U.S.C. 371

If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course.

New International Application Filed with the USPTO as a Receiving Office

If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Applicant:	Seung Min KIM
Appl. No.:	16/959,352
Conf. No.:	1067
Filed:	June 30, 2020
Title:	ELECTROLYTIC COPPER FOIL HAVING EXCELLENT HANDLING CHARACTERISTICS IN POSTPROCESSING, AND MANUFACTURING METHOD THEREFOR
Art Unit:	1784
Examiner:	DUMBRIS, SETH M
Docket No.:	0313221.00022

Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

INFORMATION DISCLOSURE STATEMENT TRANSMITTAL LETTER

Sir:

Submitted herewith is an Information Disclosure Statement for consideration in the above-identified application. In accordance with the provisions of 37 C.F.R. 1.56, 37 C.F.R. 1.97, and 37 C.F.R. 1.98, Applicants request that a citation and examination of the references cited on the enclosed SB08 form be made during the course of examination of the above-identified application for United States patent.

This Information Disclosure Statement is submitted as follows:

Submission without Certification

[ ] Within three months of filing of a national application; within three months of the date of entry of the national stage as set forth in 37 C.F.R. §1.491 in an international application; before the mailing date of a first Office Action on the merits, or before the mailing of a first Office Action after the filing of a Request for Continued Examination.

[ ] After the period specified above, but before the mailing date of a Final Action under 37 CFR 1.113, a Notice of Allowance under 37 CFR 1.311, or an Action that otherwise closes prosecution in the application and is accompanied by payment of the fee set forth in 37 CFR 1.17(p).

Submission with Certification

[ ] Within three months of filing of a national application; within three months of the date of entry of the national stage as set forth in 37 C.F.R. §1.491 in an international application; before the mailing date of a first Office Action on the merits, or before the mailing of a first Office Action after the filing of a Request for Continued Examination.

[X] After the period specified above, but before the mailing date of a Final Action under 37 CFR 1.113, a Notice of Allowance under 37 CFR 1.311, or an Action that otherwise closes prosecution in the application and is accompanied by the Certification specified in 37 CFR 1.97(e) which is set forth below.

[ ] After the mailing date of a Final Action under 37 CFR 1.113, a Notice of Allowance under 37 CFR 1.311, or an Action that otherwise closes prosecution in the application and is accompanied by the fee set forth in 37 CFR 1.17(p) and the Certification specified in 37 CFR 1.97(e) which is set forth below.

Certification under 37 CFR 1.97(e)

[X] The undersigned counsel for applicant(s) hereby certifies that each item of information contained in the accompanying Information Disclosure Statement was first cited in any communication from a foreign patent office in a counterpart foreign application not more than **three months** prior to the filing of the Information Disclosure Statement.

[ ] The undersigned counsel for applicant(s) hereby certifies that no item of information contained in the accompanying Information Disclosure Statement was cited in a communication from a foreign patent office in a counterpart foreign application, and, to the knowledge of the undersigned, after making reasonable inquiry, no item of information contained in the accompanying Information Disclosure Statement was known to any individual designated in 37 CFR 1.56(c) more than **three months** prior to the filing of the Information Disclosure Statement.

Statement under 37 CFR 1.704(d)

[ ] The undersigned counsel for applicant(s) hereby states that each item of information contained in the accompanying Information Disclosure Statement was first cited in any communication from a patent office in a counterpart foreign or international application or from the Office, and/or is a communication that was issued by a patent office in a counterpart foreign or international application or by the Office, and this communication was not received by any individual designated in § 1.56(c) more than **thirty days** prior to the filing of the information disclosure statement.

[X] A copy of a Search Report from a corresponding foreign patent application is enclosed.

[ ] The Commissioner is hereby authorized to charge the amount of $ to cover the required fee to Deposit Account No. 02-1818.

[X] The Commissioner is hereby authorized to charge any additional fees which may be required, or credit any overpayment to Deposit Account No. 02-1818.

Respectfully submitted,

K&L GATES LLP

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Dated: January 19, 2022

UNITED STATES PATENT AND TRADEMARK OFFICE

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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
16/959,352	06/30/2020	Seung Min KIM	0313221.00022	1067

24573 7590 12/27/2021

K&L Gates LLP-Chicago
P.O. Box 1135
Chicago, IL 60690

EXAMINER
DUMBRIS, SETH M

ART UNIT	PAPER NUMBER
1784	

NOTIFICATION DATE	DELIVERY MODE
12/27/2021	ELECTRONIC

Please find below and/or attached an Office communication concerning this application or proceeding.

The time period for reply, if any, is set in the attached communication.

Notice of the Office communication was sent electronically on above-indicated "Notification Date" to the following e-mail address(es):

USpatentmail@klgates.com

Office Action Summary	Application No. 16/959,352	Applicant(s) KIM et al.	
	Examiner SETH DUMBRIS	Art Unit 1784	AIA (FITF) Status Yes

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTHS FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1)☑ Responsive to communication(s) filed on 28 September 2021.

☐ A declaration(s)/affidavit(s) under **37 CFR 1.130(b)** was/were filed on _____.

2a)☐ This action is **FINAL.** 2b) ☑ This action is non-final.

3)☐ An election was made by the applicant in response to a restriction requirement set forth during the interview on _____; the restriction requirement and election have been incorporated into this action.

4)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims*

5) ☑ Claim(s) 1-10 is/are pending in the application.

5a) Of the above claim(s) 8-10 is/are withdrawn from consideration.

6) ☐ Claim(s) _____ is/are allowed.

7) ☑ Claim(s) 1-7 is/are rejected.

8) ☐ Claim(s) _____ is/are objected to.

9) ☐ Claim(s) _____ are subject to restriction and/or election requirement

* If any claims have been determined allowable, you may be eligible to benefit from the **Patent Prosecution Highway** program at a participating intellectual property office for the corresponding application. For more information, please see http://www.uspto.gov/patents/init_events/pph/index.jsp or send an inquiry to **PPHfeedback@uspto.gov.**

Application Papers

10)☐ The specification is objected to by the Examiner.

11)☐ The drawing(s) filed on _____ is/are: a)☐ accepted or b)☐ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).

Priority under 35 U.S.C. § 119

12)☑ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

Certified copies:

a)☑ All b)☐ Some** c)☐ None of the:

1.☐ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. _____.

3.☑ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

** See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

1) ☑ Notice of References Cited (PTO-892)

2) ☑ Information Disclosure Statement(s) (PTO/SB/08a and/or PTO/SB/08b) Paper No(s)/Mail Date 30 June 2020; 30 September 2021.

3) ☐ Interview Summary (PTO-413) Paper No(s)/Mail Date _____.

4) ☐ Other: _____.

DETAILED ACTION

Notice of Pre-AIA or AIA Status

1. The present application, filed on or after March 16, 2013, is being examined under the first inventor to file provisions of the AIA.

Election/Restrictions

2. Applicant's election without traverse of Group I, claims 1-7, in the reply filed on 28 September 2021 is acknowledged. The requirement is still deemed proper and is therefore made FINAL.

3. Claims 8-10 are withdrawn from further consideration pursuant to 37 CFR 1.142(b) as being drawn to a nonelected invention, there being no allowable generic or linking claim. Election was made **without** traverse in the reply filed on 28 September 2021.

Double Patenting

4. The nonstatutory double patenting rejection is based on a judicially created doctrine grounded in public policy (a policy reflected in the statute) so as to prevent the unjustified or improper timewise extension of the "right to exclude" granted by a patent and to prevent possible harassment by multiple assignees. A nonstatutory double patenting rejection is appropriate where the conflicting claims are not identical, but at least one examined application claim is not patentably distinct from the reference claim(s) because the examined application claim is either anticipated by, or would have

been obvious over, the reference claim(s). See, e.g., *In re Berg*, 140 F.3d 1428, 46 USPQ2d 1226 (Fed. Cir. 1998); *In re Goodman*, 11 F.3d 1046, 29 USPQ2d 2010 (Fed. Cir. 1993); *In re Longi*, 759 F.2d 887, 225 USPQ 645 (Fed. Cir. 1985); *In re Van Ornum*, 686 F.2d 937, 214 USPQ 761 (CCPA 1982); *In re Vogel*, 422 F.2d 438, 164 USPQ 619 (CCPA 1970); *In re Thorington*, 418 F.2d 528, 163 USPQ 644 (CCPA 1969).

5. A timely filed terminal disclaimer in compliance with 37 CFR 1.321(c) or 1.321(d) may be used to overcome an actual or provisional rejection based on nonstatutory double patenting provided the reference application or patent either is shown to be commonly owned with the examined application, or claims an invention made as a result of activities undertaken within the scope of a joint research agreement. See MPEP § 717.02 for applications subject to examination under the first inventor to file provisions of the AIA as explained in MPEP § 2159. See MPEP § 2146 *et seq*. for applications not subject to examination under the first inventor to file provisions of the AIA. A terminal disclaimer must be signed in compliance with 37 CFR 1.321(b).

6. The USPTO Internet website contains terminal disclaimer forms which may be used. Please visit www.uspto.gov/patent/patents-forms. The filing date of the application in which the form is filed determines what form (e.g., PTO/SB/25, PTO/SB/26, PTO/AIA/25, or PTO/AIA/26) should be used. A web-based eTerminal Disclaimer may be filled out completely online using web-screens. An eTerminal Disclaimer that meets all requirements is auto-processed and approved immediately upon submission. For more information about eTerminal Disclaimers, refer to www.uspto.gov/patents/process/file/efs/guidance/eTD-info-I.jsp.

7. **Claims 1-7** are rejected on the ground of nonstatutory double patenting as being unpatentable over claims 12, 14 and 17 of U.S. Patent No. 10,547,081 in view of Song et al. (US 2017/0141404). Instant claim 1 recites an electrolytic copper foil with first and second surfaces and a texture coefficient (220) defined by Equation 1 ranging from 0.4-1.32 a difference (|Δ(Rz/Ra)|) of the first and second surfaces being less than 2.42 and a difference (|ΔPD|) of the first and second surfaces being 96 ea or less. This is patentably indistinct of claims 12 and 17 of the '081 patent which recites an electrolytic copper foil made by a method and having first and second surfaces with a first protective layer over the first surface and the first surface having a peak density (PD) of 3-110, a texture coefficient [TC(220)] of a (220) plane being 1.32 or less, a surface roughness (Rz) of 0.5-2.7 μm, the second surface having a PD or 3-110, a [TC(220)] of a (220) plane of 1.32 or less and a surface roughness of 0.5-2.7 microns, where the difference in PD's of the first and second surfaces is 85 or less, a difference is TC's is 0.53 or less, and a difference between Rz surface roughnesses is 0.8 μm or less. The difference between the instant claims and those of the '081 patent are the claimed Rz/Ra difference.

8. In a related field of endeavor, Song teaches electrolytic copper foils (abstract). The foil has a surfaced roughness Rz of the matte side from 1.2-1.7 μm (Paragraph 24), a Ra of the matte side being 0.18-0.3 μm (Paragraph 27), where the shiny side of the foil has a similar roughness to the matte side (Paragraph 30), and a ratio of the (220) peak to the (111) is 0.7-1.4 (Paragraph 35). Song teaches where the difference in roughness Rz between the matte and shiny sides is 0.5 μm or less and where uniformity

in roughness prevents degradation when the foil is incorporated into a battery (Paragraphs 30-31).

9. As the instant claims, the '081 patent, and Song are directed to copper foils they are considered analogous. As such, the instant claims would have been obvious to one of ordinary skill in the art in view of the '081 patent and the teachings of Song as Song teaches where minimization of a difference in roughness between first and second surfaces of a copper foil is known to prevent degradation and one would have had a reasonable expectation of success. While Song does not specifically teach the difference in terms of ($|\Delta(Rz/Ra)|$), Song teaches where the roughness of the first and second surfaces are similar (Paragraph 30) and where this difference is desired to be minimized (Paragraphs 30-31) (i.e. ~zero) which overlaps the claimed range. See MPEP 2144.05.

10. Claim 2 recites a Rz/Ra of a matte surface of 4.2-9.0 and Song teaches where Rz ranges from 1.2-1.7 μm (Paragraph 24) and Ra ranges from 0.18-0.3 (Paragraph 27). This corresponds to Rz/Ra of about 4-9.4 and is obvious in view of claims 12 and 17 of the '081 patent and Song. See MPEP 2144.05. Claim 3 recites a Rz/Ra of a shiny surface of 5.1-6.8 and Song teaches where Rz ranges from 1.2-1.7 μm (Paragraph 24) and Ra ranges from 0.18-0.3 (Paragraph 27) and where the shiny surface is similar to the matte in terms of roughness (Paragraph 30). This corresponds to Rz/Ra of about 4-9.4 and is obvious in view of claims 12 and 17 of the '081 patent and Song. See MPEP 2144.05. Claim 3 recites a tensile strength of 30-65 kgf/mm^2 and Song teaches where the tensile strength is 20 kgf/mm^2 or more at room temperature (Paragraph 23) and is obvious in view of claims 12 and 17 of the '081

patent and Song. See MPEP 2144.05. Instant claim 5 recites an elongation of 3% or more which overlaps claims 12 and 14 of the '081 patent. Instant claims 6-7 recite a lateral weight deviation and arithmetic mean measured height and these are considered to overlap the substantially identical copper foil of claims 12 and 17 of the '081 patent and Song, absent an objective showing, as substantially identical materials are expected to display substantially identical physical properties. See MPEP 2112.01.

Claim Objections

11. Claims 1 and 4 are objected to because of the following informalities: Claim 1 does not provide Equation 1 within the body of the claim. This appears to be a miss-copy in the amendment filed 28 September 2021. Claim 4 recites "kgf/mm2" and should be "kgf/mm^2" in superscript. Appropriate correction is required.

Allowable Subject Matter

12. Claims 1-7 may be placed in condition for allowance if a terminal disclaimer is signed to overcome the double patenting rejection of record.

13. The following is a statement of reasons for the indication of allowable subject matter: The closest prior art to the instant claims is that of Kim (US 2018/0062199) which teaches a similar foil, (220), and PD as that which is claimed. However, this document was published less than one year from the instant effectively filed date and has common inventors and a common assignee and is therefore excepted under 35 USC 102(a)(2) by 35 USC 102(b)(2)(c). See MPEP 2154.02(c).

14. Claims 8-10 currently cannot be rejoined as it is unclear if the "copper film" of claim 8 corresponds to the copper foil of claim 1 or not. Rejoinder may be reconsidered if claim 8 were amended to specially denote the formed film is the foil of claim 1, provided the product claims are in condition for allowance.

Conclusion

15. The prior art made of record and not relied upon is considered pertinent to applicant's disclosure. Suzuki et al. (US 2011/0171491) teaches copper foils with a minimal roughness difference between shiny and matte surfaces. Cheng et al. (US 2015/0030873) and Chou et al. (US 2015/0267313) teach a (220) texture similar to that which is claimed.

16. Any inquiry concerning this communication or earlier communications from the examiner should be directed to SETH DUMBRIS whose telephone number is (571)272-5105. The examiner can normally be reached M-F 6:00 AM - 3:30 PM.

Examiner interviews are available via telephone, in-person, and video conferencing using a USPTO supplied web-based collaboration tool. To schedule an interview, applicant is encouraged to use the USPTO Automated Interview Request (AIR) at http://www.uspto.gov/interviewpractice.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Humera Sheikh can be reached on 571-272-0604. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

Information regarding the status of published or unpublished applications may be obtained from Patent Center. Unpublished application information in Patent Center is

available to registered users. To file and manage patent submissions in Patent Center, visit: https://patentcenter.uspto.gov. Visit https://www.uspto.gov/patents/apply/patent-center for more information about Patent Center and https://www.uspto.gov/patents/docx for information about filing in DOCX format. For additional questions, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free). If you would like assistance from a USPTO Customer Service Representative, call 800-786-9199 (IN USA OR CANADA) or 571-272-1000.

SETH DUMBRIS
Primary Examiner
Art Unit 1784

/SETH DUMBRIS/
Primary Examiner, Art Unit 1784

Notice of References Cited	Application/Control No. 16/959,352	Applicant(s)/Patent Under Reexamination KIM et al.	
	Examiner SETH DUMBRIS	Art Unit 1784	Page 1 of 1

U.S. PATENT DOCUMENTS

*		Document Number Country Code-Number-Kind Code	Date MM-YYYY	Name	CPC Classification	US Classification
*	A	US-20110171491-A1	07-2011	Suzuki; Yuji	C25D1/04	428/687
*	B	US-20150030873-A1	01-2015	Cheng; Kuei-Sen	H01M10/0525	428/606
*	C	US-20150267313-A1	09-2015	Chou; Jui-Chang	C25D1/04	205/50
*	D	US-20170141404-A1	05-2017	SONG; Ki Deok	H01M4/661	1/1
*	E	US-20180062199-A1	03-2018	KIM; Seung Min	H01M10/0562	1/1
*	F	US-10547081-B2	01-2020	Kim; Seung Min	H01M10/0525	1/1
	G					
	H					
	I					
	J					
	K					
	L					
	M					

FOREIGN PATENT DOCUMENTS

*		Document Number Country Code-Number-Kind Code	Date MM-YYYY	Country	Name	CPC Classification
	N					
	O					
	P					
	Q					
	R					
	S					
	T					

NON-PATENT DOCUMENTS

*		Include as applicable: Author, Title Date, Publisher, Edition or Volume, Pertinent Pages)
	U	
	V	
	W	
	X	

*A copy of this reference is not being furnished with this Office action. (See MPEP § 707.05(a).)
Dates in MM-YYYY format are publication dates. Classifications may be US or foreign.

Search Notes	Application/Control No.	Applicant(s)/Patent Under Reexamination
	16/959,352	KIM et al.
	Examiner	Art Unit
	SETH DUMBRIS	1784

CPC - Searched*		
Symbol	Date	Examiner

CPC Combination Sets - Searched*		
Symbol	Date	Examiner

US Classification - Searched*			
Class	Subclass	Date	Examiner

* See search history printout included with this form or the SEARCH NOTES box below to determine the scope of the search.

Search Notes		
Search Notes	Date	Examiner
Inventor, applicant, and assignee searches	12/20/2021	SD
Reviewed IDS's and ISR	12/20/2021	SD
Global Dossier review	12/20/2021	SD
Searched B32B15/01 (text limited)	12/20/2021	SD
Searched C25D1/04; 3/38; 5/34, 48; 7/0614; 21/06 (text limited)	12/20/2021	SD
Searched H01M4/0404, 13, 66, 661, 667; 10/052, 0525; 2004/027 (text limited)	12/20/2021	SD
Searched Y02E60/10 (text limited)	12/20/2021	SD
Searched Y10T428/12431, 12438 (text limited)	12/20/2021	SD
Keyword search of USPat, USPgPub, USOCR, EPO, FPRS, JPO, and DERWENT	12/20/2021	SD

/SETH DUMBRIS/ Primary Examiner, Art Unit 1784	

Search Notes	Application/Control No.	Applicant(s)/Patent Under Reexamination
	16/959,352	KIM et al.
	Examiner	Art Unit
	SETH DUMBRIS	1784

Interference Search			
US Class/CPC Symbol	US Subclass/CPC Group	Date	Examiner

/SETH DUMBRIS/ Primary Examiner, Art Unit 1784	

EAST Search History (Prior Art)

Ref #	Hits	Search Query	DBs	Default Operator	Plurals	Time Stamp
L1	12	((("JIN") near3 ("Shan") near3 ("Hua"))).INV.	US-PGPUB; USPAT; USOCR	OR	ON	2021/11/16 07:05
L2	22	((("LEE") near3 ("An") near3 ("Na"))).INV.	US-PGPUB; USPAT; USOCR	OR	ON	2021/11/16 07:05
L3	114	((("KIM") near3 ("Seung") near3 ("Min"))).INV.	US-PGPUB; USPAT; USOCR	OR	ON	2021/11/16 07:05
L4	383	((("JIN") near3 ("Shan" or Hua or "shanhua" or "shan-hua"))).INV.	US-PGPUB; USPAT; USOCR	OR	ON	2021/11/16 07:05
L5	944	((("LEE") near3 ("An" or Na or "An-Na"))).INV.	US-PGPUB; USPAT; USOCR	OR	ON	2021/11/16 07:05
L6	18,038	((("KIM") near3 ("Seung" or Min or "SeungMin" or "Seung-Min"))).INV.	US-PGPUB; USPAT; USOCR	OR	ON	2021/11/16 07:05
L7	49	((("JIN") near3 ("Shan" or Hua or "shanhua" or "shan-hua"))).aanm.	US-PGPUB; USPAT; USOCR	OR	ON	2021/11/16 07:05
L8	110	((("LEE") near3 ("An" or Na or "An-Na"))).aanm.	US-PGPUB; USPAT; USOCR	OR	ON	2021/11/16 07:05
L9	2,032	((("KIM") near3 ("Seung" or Min or "SeungMin" or "Seung-Min"))).aanm.	US-PGPUB; USPAT; USOCR	OR	ON	2021/11/16 07:05
L10	19,294	L1 or L2 or L3 or L4 or L5 or L6 or L7 or L8 or L9	US-PGPUB; USPAT; USOCR	OR	ON	2021/11/16 07:05

EAST Search History (Prior Art)

L11	1,930	L10 and ((Cu or copper or "cu-alloy" or "cu-base" or "Cu-based" or "copper-base" or "copper-based" or "copper-alloy") with (foil or foiled or foiling or tape or ribbon or layer or layered or layering or film or filmed or filming or clad or claded or cladded or clading or cladding or coat or coated or coating or electroplate or electroplated or electroplating or electroless or electrolessly or electroform or electroformed or electroforming or electrodeposit or electrodeposited or electrodepositing or electrodeposition or "electro-plate" or "electro-plated" or "electro-plating" or "electro-less" or "electro-lessly" or "electro-form" or "electro-formed" or "electro-forming" or "electro-deposit" or "electro-deposited" or "electro-depositing" or "electro-deposition"))	US-PGPUB; USPAT; USOCR	OR	ON	2021/11/16 07:05
L12	11	L11 and (("220" or "[220]" or "{220}" or "(220)" or "<220>") near5 (texture or coefficient or index or Miller or hkl or "h, k,l"))	US-PGPUB; USPAT; USOCR	OR	ON	2021/11/16 07:05
L13	58	((KCF) near3 (tech or technol or technology)).as,aanm.	US-PGPUB; USPAT; USOCR	OR	ON	2021/11/16 07:15
L14	50	L13 not L12	US-PGPUB; USPAT; USOCR	OR	ON	2021/11/16 07:15
L15	4	(2015030873|20070098910|20110171491|20200181790|20180062180).did.	US-PGPUB; USPAT; USOCR	OR	ON	2021/11/16 07:30

EAST Search History (Prior Art)

L16	150,861	B32B15/01;C25D1/04;C25D 3/38;C25D5/34, 48;C25D7/0614;C25D21/06; H01M4/0404,13,66,661, 667;H01M10/052, 0525;H01M2004/027;Y02E6 0/10;Y10T428/12431,12438. cpc.	US-PGPU B; USPAT; USOCR	OR	ON	2021/11/16 07:37
L17	150,231	B32B15/01;C25D1/04;C25D 3/38;C25D5/34, 48;C25D21/06;H01M4/0404, 13,66,661,667;H01M10/052, 0525;H01M2004/027;Y02E6 0/10;Y10T428/12431,12438. cpc.	US-PGPU B; USPAT; USOCR	OR	ON	2021/11/16 07:38
L18	41,443	L17 and ((Cu or copper or "cu-alloy" or "cu-base" or "Cu-based" or "copper-base" or "copper-based" or "copper-alloy") near5 (foil or foiled or foiling or tape or ribbon or layer or layered or layering or film or filmed or filming or clad or claded or cladded or clading or cladding or coat or coated or coating or electroplate or electroplated or electroplating or electroless or electrolessly or electroform or electroformed or electroforming or electrodeposit or electrodeposited or electrodepositing or electrodeposition or "electro-plate" or "electro-plated" or "electro-plating" or "electro-less" or "electro-lessly" or "electro-form" or "electro-formed" or "electro-forming" or "electro-deposit" or "electro-deposited" or "electro-depositing" or "electro-deposition"))	US-PGPU B; USPAT; USOCR	OR	ON	2021/11/16 07:38

EAST Search History (Prior Art)

L19	41,443	L18 and ((Cu or copper or "cu-alloy" or "cu-base" or "Cu-based" or "copper-base" or "copper-based" or "copper-alloy") near5 (foil or foiled or foiling or tape or ribbon or layer or layered or layering or film or filmed or filming or clad or claded or cladded or clading or cladding or coat or coated or coating or electroplate or electroplated or electroplating or electroless or electrolessly or electroform or electroformed or electroforming or electrodeposit or electrodeposited or electrodepositing or electrodeposition or "electro-plate" or "electro-plated" or "electro-plating" or "electro-less" or "electro-lessly" or "electro-form" or "electro-formed" or "electro-forming" or "electro-deposit" or "electro-deposited" or "electro-depositing" or "electro-deposition"))	US-PGPUB; USPAT; USOCR	OR	ON	2021/11/16 07:38

EAST Search History (Prior Art)

L20	41,584	L16 and ((Cu or copper or "cu-alloy" or "cu-base" or "Cu-based" or "copper-base" or "copper-based" or "copper-alloy") near5 (foil or foiled or foiling or tape or ribbon or layer or layered or layering or film or filmed or filming or clad or claded or cladded or clading or cladding or coat or coated or coating or electroplate or electroplated or electroplating or electroless or electrolessly or electroform or electroformed or electroforming or electrodeposit or electrodeposited or electrodepositing or electrodeposition or "electro-plate" or "electro-plated" or "electro-plating" or "electro-less" or "electro-lessly" or "electro-form" or "electro-formed" or "electro-forming" or "electro-deposit" or "electro-deposited" or "electro-depositing" or "electro-deposition"))	US-PGPUB; USPAT; USOCR	OR	ON	2021/11/16 07:39
L21	81	L20 and (("220" or "[220]" or "{220}" or "(220)" or "<220>") near5 (texture or coefficient or index or Miller or hkl or "h, k,l"))	US-PGPUB; USPAT; USOCR	OR	ON	2021/11/16 07:39
L22	72	L21 not (L10 or L12)	US-PGPUB; USPAT; USOCR	OR	ON	2021/11/16 07:40
L23	90	L20 and (("220" or "[220]" or "{220}" or "(220)" or "<220>") near8 (texture or coefficient or index or Miller or hkl or "h, k,l"))	US-PGPUB; USPAT; USOCR	OR	ON	2021/11/16 08:08
L24	9	L23 not (L10 or L12 or L22)	US-PGPUB; USPAT; USOCR	OR	ON	2021/11/16 08:09

EAST Search History (Prior Art)

L25	144	L20 and (("220" or "[220]" or "{220}" or "(220)" or "<220>") with (texture or coefficient or index or Miller or hkl or "h,k, l"))	US-PGPUB; USPAT; USOCR	OR	ON	2021/11/16 08:12
L26	53	L25 not (L10 or L12 or L22 or L24)	US-PGPUB; USPAT; USOCR	OR	ON	2021/11/16 08:13
L27	429	L20 and ((peak near2 density) or PD.u/c.)	US-PGPUB; USPAT; USOCR	OR	ON	2021/11/16 08:19
L28	36	L20 and (((peak near2 density) or PD.u/c.) near5 (surface))	US-PGPUB; USPAT; USOCR	OR	ON	2021/11/16 08:23
L29	9	("20020153254"|"20150030873"|"20140342178"|"20160013493"|"20140017564"|"20140170489"|"20130108887"|"20110056840"|"20190078229"). PN.	US-PGPUB; USPAT; USOCR	OR	ON	2021/11/16 08:32
L30	53	L16 and (((peak near2 density) or PD.u/c.) near5 (surface or shiney or shiny or matt or matte or mat or matted))	US-PGPUB; USPAT; USOCR	OR	ON	2021/11/16 08:34
L31	17	L30 not (L10 or L12 or L22 or L24 or L28)	US-PGPUB; USPAT; USOCR	OR	ON	2021/11/16 08:34
L32	910,615	B32B15/01;C25D1/04;C25D3/38;C25D5/34,48;C25D7/0614;C25D21/06;H01M4/0404,13,66,661,667;H01M10/052,0525;H01M2004/027;Y02E60/10;Y10T428/12431,12438.cpc.	FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2021/11/16 08:39

EAST Search History (Prior Art)

L33	64	L32 and (((Cu or copper or "cu-alloy" or "cu-base" or "Cu-based" or "copper-base" or "copper-based" or "copper-alloy") with (foil or foiled or foiling or tape or ribbon or layer or layered or layering or film or filmed or filming or clad or claded or cladded or clading or cladding or coat or coated or coating or electroplate or electroplated or electroplating or electroless or electrolessly or electroform or electroformed or electroforming or electrodeposit or electrodeposited or electrodepositing or electrodeposition or "electro-plate" or "electro-plated" or "electro-plating" or "electro-less" or "electro-lessly" or "electro-form" or "electro-formed" or "electro-forming" or "electro-deposit" or "electro-deposited" or "electro-depositing" or "electro-deposition")) with (("220" or "[220]" or "{220}" or "(220)" or "<220>") with (texture or coefficient or index or Miller or hkl or "h,k, l")))	FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2021/11/16 08:39
L34	16	L32 and (((peak near2 density) or PD.u/c.) near5 (surface or shiney or shiny or matt or matte or mat or matted))	FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2021/11/16 08:47

EAST Search History (Prior Art)

L35	11	(((Cu or copper or "cu-alloy" or "cu-base" or "Cu-based" or "copper-base" or "copper-based" or "copper-alloy") with (foil or foiled or foiling or tape or ribbon or layer or layered or layering or film or filmed or filming or clad or claded or cladded or clading or cladding or coat or coated or coating or electroplate or electroplated or electroplating or electroless or electrolessly or electroform or electroformed or electroforming or electrodeposit or electrodeposited or electrodepositing or electrodeposition or "electro-plate" or "electro-plated" or "electro-plating" or "electro-less" or "electro-lessly" or "electro-form" or "electro-formed" or "electro-forming" or "electro-deposit" or "electro-deposited" or "electro-depositing" or "electro-deposition")) with (("220" or "[220]" or "{220}" or "(220)" or "<220>") with (texture or coefficient or index or Miller or hkl or "h,k, l"))) and (((peak near2 density) or PD.u/c.) near5 (surface or shiney or shiny or matt or matte or mat or matted))	FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2021/11/16 08:48
L36	0	L35 not L34	FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2021/11/16 08:48

EAST Search History (Prior Art)

L37	12	(((Cu or copper or "cu-alloy" or "cu-base" or "Cu-based" or "copper-base" or "copper-based" or "copper-alloy") with (foil or foiled or foiling or tape or ribbon or layer or layered or layering or film or filmed or filming or clad or claded or cladded or clading or cladding or coat or coated or coating or electroplate or electroplated or electroplating or electroless or electrolessly or electroform or electroformed or electroforming or electrodeposit or electrodeposited or electrodepositing or electrodeposition or "electro-plate" or "electro-plated" or "electro-plating" or "electro-less" or "electro-lessly" or "electro-form" or "electro-formed" or "electro-forming" or "electro-deposit" or "electro-deposited" or "electro-depositing" or "electro-deposition")) with (("220" or "[220]" or "{220}" or "(220)" or "<220>") with (texture or coefficient or index or Miller or hkl or "h,k, l"))) and (((peak near2 density) or PD.u/c.) with (surface or shiney or shiny or matt or matte or mat or matted))	FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2021/11/16 08:49
L38	1	L37 not L34	FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2021/11/16 08:49

EAST Search History (Prior Art)

L39	18	((Cu or copper or "cu-alloy" or "cu-base" or "Cu-based" or "copper-base" or "copper-based" or "copper-alloy") near5 (foil or foiled or foiling or tape or ribbon or layer or layered or layering or film or filmed or filming or clad or claded or cladded or clading or cladding or coat or coated or coating or electroplate or electroplated or electroplating or electroless or electrolessly or electroform or electroformed or electroforming or electrodeposit or electrodeposited or electrodepositing or electrodeposition or "electro-plate" or "electro-plated" or "electro-plating" or "electro-less" or "electro-lessly" or "electro-form" or "electro-formed" or "electro-forming" or "electro-deposit" or "electro-deposited" or "electro-depositing" or "electro-deposition")) near5 (((peak near2 density) or PD. u/c.) near5 (surface or shiney or shiny or matt or matte or mat or matted))	FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2021/11/16 08:51
L40	7	L39 not (L34 or L38)	FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2021/11/16 08:51

EAST Search History (Prior Art)

L41	20	((Cu or copper or "cu-alloy" or "cu-base" or "Cu-based" or "copper-base" or "copper-based" or "copper-alloy") with (foil or foiled or foiling or tape or ribbon or layer or layered or layering or film or filmed or filming or clad or claded or cladded or clading or cladding or coat or coated or coating or electroplate or electroplated or electroplating or electroless or electrolessly or electroform or electroformed or electroforming or electrodeposit or electrodeposited or electrodepositing or electrodeposition or "electro-plate" or "electro-plated" or "electro-plating" or "electro-less" or "electro-lessly" or "electro-form" or "electro-formed" or "electro-forming" or "electro-deposit" or "electro-deposited" or "electro-depositing" or "electro-deposition")) with (((peak near2 density) or PD. u/c.) near5 (surface or shiney or shiny or matt or matte or mat or matted))	FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2021/11/16 08:52
L42	1	L41 not (L34 or L38 or L40)	FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2021/11/16 08:52

EAST Search History (Prior Art)

L43	13	((Cu or copper or "cu-alloy" or "cu-base" or "Cu-based" or "copper-base" or "copper-based" or "copper-alloy") near5 (foil or foiled or foiling or tape or ribbon or layer or layered or layering or film or filmed or filming or clad or claded or cladded or clading or cladding or coat or coated or coating or electroplate or electroplated or electroplating or electroless or electrolessly or electroform or electroformed or electroforming or electrodeposit or electrodeposited or electrodepositing or electrodeposition or "electro-plate" or "electro-plated" or "electro-plating" or "electro-less" or "electro-lessly" or "electro-form" or "electro-formed" or "electro-forming" or "electro-deposit" or "electro-deposited" or "electro-depositing" or "electro-deposition")) near5 (((peak near2 density) or PD. u/c.) near5 (surface or shiney or shiny or matt or matte or mat or matted))	US-PGPUB; USPAT; USOCR	OR	ON	2021/11/16 08:52
L44	7	L43 not (L10 or L12 or L22 or L24 or L28 or L31)	US-PGPUB; USPAT; USOCR	OR	ON	2021/11/16 08:53

L45	16	((Cu or copper or "cu-alloy" or "cu-base" or "Cu-based" or "copper-base" or "copper-based" or "copper-alloy") near8 (foil or foiled or foiling or tape or ribbon or layer or layered or layering or film or filmed or filming or clad or claded or cladded or clading or cladding or coat or coated or coating or electroplate or electroplated or electroplating or electroless or electrolessly or electroform or electroformed or electroforming or electrodeposit or electrodeposited or electrodepositing or electrodeposition or "electro-plate" or "electro-plated" or "electro-plating" or "electro-less" or "electro-lessly" or "electro-form" or "electro-formed" or "electro-forming" or "electro-deposit" or "electro-deposited" or "electro-depositing" or "electro-deposition")) near8 (((peak near2 density) or PD. u/c.) near5 (surface or shiney or shiny or matt or matte or mat or matted))	US-PGPUB; USPAT; USOCR	OR	ON	2021/11/16 08:57
L46	3	L45 not (L10 or L12 or L22 or L24 or L28 or L31 or L44)	US-PGPUB; USPAT; USOCR	OR	ON	2021/11/16 08:57

EAST Search History (Prior Art)

L47	22	((Cu or copper or "cu-alloy" or "cu-base" or "Cu-based" or "copper-base" or "copper-based" or "copper-alloy") with (foil or foiled or foiling or tape or ribbon or layer or layered or layering or film or filmed or filming or clad or claded or cladded or clading or cladding or coat or coated or coating or electroplate or electroplated or electroplating or electroless or electrolessly or electroform or electroformed or electroforming or electrodeposit or electrodeposited or electrodepositing or electrodeposition or "electro-plate" or "electro-plated" or "electro-plating" or "electro-less" or "electro-lessly" or "electro-form" or "electro-formed" or "electro-forming" or "electro-deposit" or "electro-deposited" or "electro-depositing" or "electro-deposition")) with (((peak near2 density) or PD. u/c.) near5 (surface or shiney or shiny or matt or matte or mat or matted))	US-PGPUB; USPAT; USOCR	OR	ON	2021/11/16 08:59
L48	6	L47 not (L10 or L12 or L22 or L24 or L28 or L31 or L44 or L46)	US-PGPUB; USPAT; USOCR	OR	ON	2021/11/16 09:00

EAST Search History (Prior Art)

L49	30	(((Cu or copper or "cu-alloy" or "cu-base" or "Cu-based" or "copper-base" or "copper-based" or "copper-alloy") near5 (foil or foiled or foiling or tape or ribbon or layer or layered or layering or film or filmed or filming or clad or claded or cladded or clading or cladding or coat or coated or coating or electroplate or electroplated or electroplating or electroless or electrolessly or electroform or electroformed or electroforming or electrodeposit or electrodeposited or electrodepositing or electrodeposition or "electro-plate" or "electro-plated" or "electro-plating" or "electro-less" or "electro-lessly" or "electro-form" or "electro-formed" or "electro-forming" or "electro-deposit" or "electro-deposited" or "electro-depositing" or "electro-deposition")) near5 (("220" or "[220]" or "{220}" or "(220)" or "<220>") near5 (texture or coefficient or index or Miller or hkl or "h,k, l")))	FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2021/11/16 09:05

EAST Search History (Prior Art)

L50	41	(((Cu or copper or "cu-alloy" or "cu-base" or "Cu-based" or "copper-base" or "copper-based" or "copper-alloy") near5 (foil or foiled or foiling or tape or ribbon or layer or layered or layering or film or filmed or filming or clad or claded or cladded or clading or cladding or coat or coated or coating or electroplate or electroplated or electroplating or electroless or electrolessly or electroform or electroformed or electroforming or electrodeposit or electrodeposited or electrodepositing or electrodeposition or "electro-plate" or "electro-plated" or "electro-plating" or "electro-less" or "electro-lessly" or "electro-form" or "electro-formed" or "electro-forming" or "electro-deposit" or "electro-deposited" or "electro-depositing" or "electro-deposition")) near5 (("220" or "[220]" or "{220}" or "(220)" or "<220>") with (texture or coefficient or index or Miller or hkl or "h,k, l")))	FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2021/11/16 09:13
L51	13	L50 not L49	FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2021/11/16 09:14

EAST Search History (Prior Art)

L52	123	(((Cu or copper or "cu-alloy" or "cu-base" or "Cu-based" or "copper-base" or "copper-based" or "copper-alloy") with (foil or foiled or foiling or tape or ribbon or layer or layered or layering or film or filmed or filming or clad or claded or cladded or clading or cladding or coat or coated or coating or electroplate or electroplated or electroplating or electroless or electrolessly or electroform or electroformed or electroforming or electrodeposit or electrodeposited or electrodepositing or electrodeposition or "electro-plate" or "electro-plated" or "electro-plating" or "electro-less" or "electro-lessly" or "electro-form" or "electro-formed" or "electro-forming" or "electro-deposit" or "electro-deposited" or "electro-depositing" or "electro-deposition")) with (("220" or "[220]" or "{220}" or "(220)" or "<220>") with (texture or coefficient or index or Miller or hkl or "h,k, l")))	FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2021/11/16 09:19
L53	80	L52 not (L49 or L51)	FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2021/11/16 09:20
L54	1	("20180062199").did.	US-PGPUB; USPAT; USOCR	OR	ON	2021/11/16 09:45

L55	46	(((Cu or copper or "cu-alloy" or "cu-base" or "Cu-based" or "copper-base" or "copper-based" or "copper-alloy") near5 (foil or foiled or foiling or tape or ribbon or layer or layered or layering or film or filmed or filming or clad or claded or cladded or clading or cladding or coat or coated or coating or electroplate or electroplated or electroplating or electroless or electrolessly or electroform or electroformed or electroforming or electrodeposit or electrodeposited or electrodepositing or electrodeposition or "electro-plate" or "electro-plated" or "electro-plating" or "electro-less" or "electro-lessly" or "electro-form" or "electro-formed" or "electro-forming" or "electro-deposit" or "electro-deposited" or "electro-depositing" or "electro-deposition")) near5 (("220" or "[220]" or "{220}" or "(220)" or "<220>") near5 (texture or coefficient or index or Miller or hkl or "h,k, l")))	US-PGPUB; USPAT; USOCR	OR	ON	2021/11/16 09:49
L56	22	L55 not (L10 or L12 or L22 or L24 or L28 or L31 or L44 or L46 or L48)	US-PGPUB; USPAT; USOCR	OR	ON	2021/11/16 09:49

EAST Search History (Prior Art)

L57	58	(((Cu or copper or "cu-alloy" or "cu-base" or "Cu-based" or "copper-base" or "copper-based" or "copper-alloy") near8 (foil or foiled or foiling or tape or ribbon or layer or layered or layering or film or filmed or filming or clad or claded or cladded or clading or cladding or coat or coated or coating or electroplate or electroplated or electroplating or electroless or electrolessly or electroform or electroformed or electroforming or electrodeposit or electrodeposited or electrodepositing or electrodeposition or "electro-plate" or "electro-plated" or "electro-plating" or "electro-less" or "electro-lessly" or "electro-form" or "electro-formed" or "electro-forming" or "electro-deposit" or "electro-deposited" or "electro-depositing" or "electro-deposition")) near8 (("220" or "[220]" or "{220}" or "(220)" or "<220>") near8 (texture or coefficient or index or Miller or hkl or "h,k, l")))	US-PGPUB; USPAT; USOCR	OR	ON	2021/11/16 09:51
L58	10	L57 not (L10 or L12 or L22 or L24 or L28 or L31 or L44 or L46 or L48 or L56)	US-PGPUB; USPAT; USOCR	OR	ON	2021/11/16 09:52

EAST Search History (Prior Art)

L59	80	(((Cu or copper or "cu-alloy" or "cu-base" or "Cu-based" or "copper-base" or "copper-based" or "copper-alloy") near12 (foil or foiled or foiling or tape or ribbon or layer or layered or layering or film or filmed or filming or clad or claded or cladded or clading or cladding or coat or coated or coating or electroplate or electroplated or electroplating or electroless or electrolessly or electroform or electroformed or electroforming or electrodeposit or electrodeposited or electrodepositing or electrodeposition or "electro-plate" or "electro-plated" or "electro-plating" or "electro-less" or "electro-lessly" or "electro-form" or "electro-formed" or "electro-forming" or "electro-deposit" or "electro-deposited" or "electro-depositing" or "electro-deposition")) near12 (("220" or "[220]" or "{220}" or "(220)" or "<220>") near12 (texture or coefficient or index or Miller or hkl or "h,k, l")))	US-PGPUB; USPAT; USOCR	OR	ON	2021/11/16 09:53
L60	17	L59 not (L10 or L12 or L22 or L24 or L28 or L31 or L44 or L46 or L48 or L56 or L58)	US-PGPUB; USPAT; USOCR	OR	ON	2021/11/16 09:54
S1	12	((("JIN") near3 ("Shan") near3 ("Hua"))).INV.	US-PGPUB; USPAT; USOCR	OR	ON	2021/11/15 10:01
S2	22	((("LEE") near3 ("An") near3 ("Na"))).INV.	US-PGPUB; USPAT; USOCR	OR	ON	2021/11/15 10:01

EAST Search History (Prior Art)

S3	114	((("KIM") near3 ("Seung") near3 ("Min"))).INV.	US-PGPUB; USPAT; USOCR	OR	ON	2021/11/15 10:01
S4	383	((("JIN") near3 ("Shan" or Hua or "shanhua" or "shan-hua"))).INV.	US-PGPUB; USPAT; USOCR	OR	ON	2021/11/15 10:02
S5	942	((("LEE") near3 ("An" or Na or "An-Na"))).INV.	US-PGPUB; USPAT; USOCR	OR	ON	2021/11/15 10:02
S6	18,027	((("KIM") near3 ("Seung" or Min or "SeungMin" or "Seung-Min"))).INV.	US-PGPUB; USPAT; USOCR	OR	ON	2021/11/15 10:03
S7	49	((("JIN") near3 ("Shan" or Hua or "shanhua" or "shan-hua"))).aanm.	US-PGPUB; USPAT; USOCR	OR	ON	2021/11/15 10:03
S8	110	((("LEE") near3 ("An" or Na or "An-Na"))).aanm.	US-PGPUB; USPAT; USOCR	OR	ON	2021/11/15 10:03
S9	2,032	((("KIM") near3 ("Seung" or Min or "SeungMin" or "Seung-Min"))).aanm.	US-PGPUB; USPAT; USOCR	OR	ON	2021/11/15 10:03
S10	19,281	S1 or S2 or S3 or S4 or S5 or S6 or S7 or S8 or S9	US-PGPUB; USPAT; USOCR	OR	ON	2021/11/15 10:03

EAST Search History (Prior Art)

S12	1,930	S10 and ((Cu or copper or "cu-alloy" or "cu-base" or "Cu-based" or "copper-base" or "copper-based" or "copper-alloy") with (foil or foiled or foiling or tape or ribbon or layer or layered or layering or film or filmed or filming or clad or claded or cladded or clading or cladding or coat or coated or coating or electroplate or electroplated or electroplating or electroless or electrolessly or electroform or electroformed or electroforming or electrodeposit or electrodeposited or electrodepositing or electrodeposition or "electro-plate" or "electro-plated" or "electro-plating" or "electro-less" or "electro-lessly" or "electro-form" or "electro-formed" or "electro-forming" or "electro-deposit" or "electro-deposited" or "electro-depositing" or "electro-deposition"))	US-PGPUB; USPAT; USOCR	OR	ON	2021/11/15 10:04
S13	11	S12 and (("220" or "[220]" or "{220}" or "(220)" or "<220>") near5 (texture or coefficient or index or Miller or hkl or "h, k,l"))	US-PGPUB; USPAT; USOCR	OR	ON	2021/11/15 10:06
S14	58	((KCF) near3 (tech or technol or technology)).as,aanm.	US-PGPUB; USPAT; USOCR	OR	ON	2021/11/15 10:24
S15	50	S14 not S13	US-PGPUB; USPAT; USOCR	OR	ON	2021/11/15 10:24

EAST Search History (Prior Art)

S16	150,158	B32B15/01;C25D1/04;C25D 3/38;C25D5/34, 48;C25D21/06;H01M4/0404, 13,66,661,667;H01M10/052, 0525;H01M2004/027;Y02E6 0/10;Y10T428/12431,12438. cpc.	US-PGPU B; USPAT; USOCR	OR	ON	2021/11/15 10:53
S17	41,417	S16 and ((Cu or copper or "cu-alloy" or "cu-base" or "Cu-based" or "copper-base" or "copper-based" or "copper-alloy") near5 (foil or foiled or foiling or tape or ribbon or layer or layered or layering or film or filmed or filming or clad or claded or cladded or clading or cladding or coat or coated or coating or electroplate or electroplated or electroplating or electroless or electrolessly or electroform or electroformed or electroforming or electrodeposit or electrodeposited or electrodepositing or electrodeposition or "electro-plate" or "electro-plated" or "electro-plating" or "electro-less" or "electro-lessly" or "electro-form" or "electro-formed" or "electro-forming" or "electro-deposit" or "electro-deposited" or "electro-depositing" or "electro-deposition"))	US-PGPU B; USPAT; USOCR	OR	ON	2021/11/15 11:03
S18	81	S17 and (("220" or "[220]" or "{220}" or "(220)" or "<220>") near5 (texture or coefficient or index or Miller or hkl or "h, k,l"))	US-PGPU B; USPAT; USOCR	OR	ON	2021/11/15 11:04
S19	71	S18 not (S13 or S15)	US-PGPU B; USPAT; USOCR	OR	ON	2021/11/15 11:04

EAST Search History (Prior Art)

S20	90	S17 and (("220" or "[220]" or "{220}" or "(220)" or "<220>") near8 (texture or coefficient or index or Miller or hkl or "h, k,l"))	US-PGPUB; USPAT; USOCR	OR	ON	2021/11/15 11:20
S21	9	S20 not (S13 or S15 or S19)	US-PGPUB; USPAT; USOCR	OR	ON	2021/11/15 11:20
S22	34	S16 and (((Cu or copper or "cu-alloy" or "cu-base" or "Cu-based" or "copper-base" or "copper-based" or "copper-alloy") with (foil or foiled or foiling or tape or ribbon or layer or layered or layering or film or filmed or filming or clad or claded or cladded or clading or cladding or coat or coated or coating or electroplate or electroplated or electroplating or electroless or electrolessly or electroform or electroformed or electroforming or electrodeposit or electrodeposited or electrodepositing or electrodeposition or "electro-plate" or "electro-plated" or "electro-plating" or "electro-less" or "electro-lessly" or "electro-form" or "electro-formed" or "electro-forming" or "electro-deposit" or "electro-deposited" or "electro-depositing" or "electro-deposition")) with (("220" or "[220]" or "{220}" or "(220)" or "<220>") with (texture or coefficient or index or Miller or hkl or "h,k, l")))	US-PGPUB; USPAT; USOCR	OR	ON	2021/11/15 11:21
S23	1	S22 not (S13 or S15 or S19 or S21)	US-PGPUB; USPAT; USOCR	OR	ON	2021/11/15 11:22

EAST Search History (Prior Art)

S24	907,698	B32B15/01;C25D1/04;C25D 3/38;C25D5/34, 48;C25D21/06;H01M4/0404, 13,66,661,667;H01M10/052, 0525;H01M2004/027;Y02E6 0/10;Y10T428/12431,12438. cpc.	FPRS; EPO; JPO; DERWEN T; IBM_TDB	OR	ON	2021/11/15 11:22
S25	64	S24 and (((Cu or copper or "cu-alloy" or "cu-base" or "Cu-based" or "copper-base" or "copper-based" or "copper-alloy") with (foil or foiled or foiling or tape or ribbon or layer or layered or layering or film or filmed or filming or clad or claded or cladded or clading or cladding or coat or coated or coating or electroplate or electroplated or electroplating or electroless or electrolessly or electroform or electroformed or electroforming or electrodeposit or electrodeposited or electrodepositing or electrodeposition or "electro-plate" or "electro-plated" or "electro-plating" or "electro-less" or "electro-lessly" or "electro-form" or "electro-formed" or "electro-forming" or "electro-deposit" or "electro-deposited" or "electro-depositing" or "electro-deposition")) with (("220" or "[220]" or "{220}" or "(220)" or "<220>") with (texture or coefficient or index or Miller or hkl or "h,k, l")))	FPRS; EPO; JPO; DERWEN T; IBM_TDB	OR	ON	2021/11/15 11:22

S26	17,447	S24 and ((Cu or copper or "cu-alloy" or "cu-base" or "Cu-based" or "copper-base" or "copper-based" or "copper-alloy") near5 (foil or foiled or foiling or tape or ribbon or layer or layered or layering or film or filmed or filming or clad or claded or cladded or clading or cladding or coat or coated or coating or electroplate or electroplated or electroplating or electroless or electrolessly or electroform or electroformed or electroforming or electrodeposit or electrodeposited or electrodepositing or electrodeposition or "electro-plate" or "electro-plated" or "electro-plating" or "electro-less" or "electro-lessly" or "electro-form" or "electro-formed" or "electro-forming" or "electro-deposit" or "electro-deposited" or "electro-depositing" or "electro-deposition"))	FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2021/11/15 11:29
S27	60	S26 and (("220" or "[220]" or "{220}" or "(220)" or "<220>") near5 (texture or coefficient or index or Miller or hkl or "h, k,l"))	FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2021/11/15 11:29
S28	9	S27 not S25	FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2021/11/15 11:29
S29	73	S26 and (("220" or "[220]" or "{220}" or "(220)" or "<220>") with (texture or coefficient or index or Miller or hkl or "h,k, l"))	FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2021/11/15 11:30

EAST Search History (Prior Art)

S30	0	S29 not (S25 or S28)	FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2021/11/15 11:30
S31	21,626	S24 and ((Cu or copper or "cu-alloy" or "cu-base" or "Cu-based" or "copper-base" or "copper-based" or "copper-alloy") with (foil or foiled or foiling or tape or ribbon or layer or layered or layering or film or filmed or filming or clad or claded or cladded or clading or cladding or coat or coated or coating or electroplate or electroplated or electroplating or electroless or electrolessly or electroform or electroformed or electroforming or electrodeposit or electrodeposited or electrodepositing or electrodeposition or "electro-plate" or "electro-plated" or "electro-plating" or "electro-less" or "electro-lessly" or "electro-form" or "electro-formed" or "electro-forming" or "electro-deposit" or "electro-deposited" or "electro-depositing" or "electro-deposition"))	FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2021/11/15 11:30
S32	74	S31 and (("220" or "[220]" or "{220}" or "(220)" or "<220>") with (texture or coefficient or index or Miller or hkl or "h,k, l"))	FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2021/11/15 11:30
S33	1	S32 not (S25 or S28)	FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2021/11/15 11:31

EAST Search History (Prior Art)

S34	30	(((Cu or copper or "cu-alloy" or "cu-base" or "Cu-based" or "copper-base" or "copper-based" or "copper-alloy") near5 (foil or foiled or foiling or tape or ribbon or layer or layered or layering or film or filmed or filming or clad or claded or cladded or clading or cladding or coat or coated or coating or electroplate or electroplated or electroplating or electroless or electrolessly or electroform or electroformed or electroforming or electrodeposit or electrodeposited or electrodepositing or electrodeposition or "electro-plate" or "electro-plated" or "electro-plating" or "electro-less" or "electro-lessly" or "electro-form" or "electro-formed" or "electro-forming" or "electro-deposit" or "electro-deposited" or "electro-depositing" or "electro-deposition")) near5 (("220" or "[220]" or "{220}" or "(220)" or "<220>") near5 (texture or coefficient or index or Miller or hkl or "h,k, l")))	FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2021/11/15 11:31
S35	6	S34 not (S25 or S28 or S33)	FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2021/11/15 11:31

EAST Search History (Prior Art)

S36	123	(((Cu or copper or "cu-alloy" or "cu-base" or "Cu-based" or "copper-base" or "copper-based" or "copper-alloy") with (foil or foiled or foiling or tape or ribbon or layer or layered or layering or film or filmed or filming or clad or claded or cladded or clading or cladding or coat or coated or coating or electroplate or electroplated or electroplating or electroless or electrolessly or electroform or electroformed or electroforming or electrodeposit or electrodeposited or electrodepositing or electrodeposition or "electro-plate" or "electro-plated" or "electro-plating" or "electro-less" or "electro-lessly" or "electro-form" or "electro-formed" or "electro-forming" or "electro-deposit" or "electro-deposited" or "electro-depositing" or "electro-deposition")) with (("220" or "[220]" or "{220}" or "(220)" or "<220>") with (texture or coefficient or index or Miller or hkl or "h,k, l")))	FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2021/11/15 11:32
S37	53	S36 not (S25 or S28 or S33 or S35)	FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2021/11/15 11:32

EAST Search History (Prior Art)

S38	46	(((Cu or copper or "cu-alloy" or "cu-base" or "Cu-based" or "copper-base" or "copper-based" or "copper-alloy") near5 (foil or foiled or foiling or tape or ribbon or layer or layered or layering or film or filmed or filming or clad or claded or cladded or clading or cladding or coat or coated or coating or electroplate or electroplated or electroplating or electroless or electrolessly or electroform or electroformed or electroforming or electrodeposit or electrodeposited or electrodepositing or electrodeposition or "electro-plate" or "electro-plated" or "electro-plating" or "electro-less" or "electro-lessly" or "electro-form" or "electro-formed" or "electro-forming" or "electro-deposit" or "electro-deposited" or "electro-depositing" or "electro-deposition")) near5 (("220" or "[220]" or "{220}" or "(220)" or "<220>") near5 (texture or coefficient or index or Miller or hkl or "h,k, l")))	US-PGPUB; USPAT; USOCR	OR	ON	2021/11/15 12:17
S39	22	S38 not (S13 or S15 or S19 or S21 or S23)	US-PGPUB; USPAT; USOCR	OR	ON	2021/11/15 12:18

EAST Search History (Prior Art)

S40	112	(((Cu or copper or "cu-alloy" or "cu-base" or "Cu-based" or "copper-base" or "copper-based" or "copper-alloy") with (foil or foiled or foiling or tape or ribbon or layer or layered or layering or film or filmed or filming or clad or claded or cladded or clading or cladding or coat or coated or coating or electroplate or electroplated or electroplating or electroless or electrolessly or electroform or electroformed or electroforming or electrodeposit or electrodeposited or electrodepositing or electrodeposition or "electro-plate" or "electro-plated" or "electro-plating" or "electro-less" or "electro-lessly" or "electro-form" or "electro-formed" or "electro-forming" or "electro-deposit" or "electro-deposited" or "electro-depositing" or "electro-deposition")) with (("220" or "[220]" or "{220}" or "(220)" or "<220>") with (texture or coefficient or index or Miller or hkl or "h,k, l")))	US-PGPUB; USPAT; USOCR	OR	ON	2021/11/15 12:22
S41	56	S40 not (S13 or S15 or S19 or S21 or S23 or S39)	US-PGPUB; USPAT; USOCR	OR	ON	2021/11/15 12:22
S42	44	S17 and (("220" or "[220]" or "{220}" or "(220)" or "<220>") near5 (stress))	US-PGPUB; USPAT; USOCR	OR	ON	2021/11/15 13:19
S43	2	S24 and (("220" or "[220]" or "{220}" or "(220)" or "<220>") near5 (stress))	FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2021/11/15 13:21

EAST Search History (Prior Art)

S44	3	S24 and (("111" or "[111]" or "{111}" or "(111)" or "<111>") near5 (stress))	FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2021/11/15 13:22
S45	48	S24 and (("200" or "[200]" or "{200}" or "(200)" or "<200>") near5 (stress))	FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2021/11/15 13:23
S46	0	S24 and (("311" or "[311]" or "{311}" or "(311)" or "<311>") near5 (stress))	FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2021/11/15 13:24

EAST Search History (Prior Art)

S47	89	((Cu or copper or "cu-alloy" or "cu-base" or "Cu-based" or "copper-base" or "copper-based" or "copper-alloy") near5 (foil or foiled or foiling or tape or ribbon or layer or layered or layering or film or filmed or filming or clad or claded or cladded or clading or cladding or coat or coated or coating or electroplate or electroplated or electroplating or electroless or electrolessly or electroform or electroformed or electroforming or electrodeposit or electrodeposited or electrodepositing or electrodeposition or "electro-plate" or "electro-plated" or "electro-plating" or "electro-less" or "electro-lessly" or "electro-form" or "electro-formed" or "electro-forming" or "electro-deposit" or "electro-deposited" or "electro-depositing" or "electro-deposition")) and (("111" or "[111]" or "{111}" or "(111)" or "<111>" or "200" or "[200]" or "{200}" or "(200)" or "<200>" or "220" or "[220]" or "{220}" or "(220)" or "<220>" or "311" or "[311]" or "{311}" or "(311)" or "<311>") near5 (residual near2 stress))	US-PGPUB; USPAT; USOCR	OR	ON	2021/11/15 13:27

EAST Search History (Prior Art)

S48	127	((Cu or copper or "cu-alloy" or "cu-base" or "Cu-based" or "copper-base" or "copper-based" or "copper-alloy") near8 (foil or foiled or foiling or tape or ribbon or layer or layered or layering or film or filmed or filming or clad or claded or cladded or clading or cladding or coat or coated or coating or electroplate or electroplated or electroplating or electroless or electrolessly or electroform or electroformed or electroforming or electrodeposit or electrodeposited or electrodepositing or electrodeposition or "electro-plate" or "electro-plated" or "electro-plating" or "electro-less" or "electro-lessly" or "electro-form" or "electro-formed" or "electro-forming" or "electro-deposit" or "electro-deposited" or "electro-depositing" or "electro-deposition")) and (("111" or "[111]" or "{111}" or "(111)" or "<111>" or "200" or "[200]" or "{200}" or "(200)" or "<200>" or "220" or "[220]" or "{220}" or "(220)" or "<220>" or "311" or "[311]" or "{311}" or "(311)" or "<311>") near8 (residual near2 stress))	US-PGPUB; USPAT; USOCR	OR	ON	2021/11/15 13:30
S49	38	S48 not S47	US-PGPUB; USPAT; USOCR	OR	ON	2021/11/15 13:30

EAST Search History (Prior Art)

S50	257	((Cu or copper or "cu-alloy" or "cu-base" or "Cu-based" or "copper-base" or "copper-based" or "copper-alloy") with (foil or foiled or foiling or tape or ribbon or layer or layered or layering or film or filmed or filming or clad or claded or cladded or clading or cladding or coat or coated or coating or electroplate or electroplated or electroplating or electroless or electrolessly or electroform or electroformed or electroforming or electrodeposit or electrodeposited or electrodepositing or electrodeposition or "electro-plate" or "electro-plated" or "electro-plating" or "electro-less" or "electro-lessly" or "electro-form" or "electro-formed" or "electro-forming" or "electro-deposit" or "electro-deposited" or "electro-depositing" or "electro-deposition")) and (("111" or "[111]" or "{111}" or "(111)" or "<111>" or "200" or "[200]" or "{200}" or "(200)" or "<200>" or "220" or "[220]" or "{220}" or "(220)" or "<220>" or "311" or "[311]" or "{311}" or "(311)" or "<311>") with (residual near2 stress))	US-PGPUB; USPAT; USOCR	OR	ON	2021/11/15 13:31
S51	130	S50 not (S47 or S49)	US-PGPUB; USPAT; USOCR	OR	ON	2021/11/15 13:32

S52	23	((Cu or copper or "cu-alloy" or "cu-base" or "Cu-based" or "copper-base" or "copper-based" or "copper-alloy") with (foil or foiled or foiling or tape or ribbon or layer or layered or layering or film or filmed or filming or clad or claded or cladded or clading or cladding or coat or coated or coating or electroplate or electroplated or electroplating or electroless or electrolessly or electroform or electroformed or electroforming or electrodeposit or electrodeposited or electrodepositing or electrodeposition or "electro-plate" or "electro-plated" or "electro-plating" or "electro-less" or "electro-lessly" or "electro-form" or "electro-formed" or "electro-forming" or "electro-deposit" or "electro-deposited" or "electro-depositing" or "electro-deposition")) and (("111" or "[111]" or "{111}" or "(111)" or "<111>" or "200" or "[200]" or "{200}" or "(200)" or "<200>" or "220" or "[220]" or "{220}" or "(220)" or "<220>" or "311" or "[311]" or "{311}" or "(311)" or "<311>") with (residual near2 stress))	FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2021/11/15 13:36
S53	4	(20090095515|20160260980|9209485|9562298).did.	US-PGPUB; USPAT; USOCR	OR	ON	2021/11/15 13:47

Doc code: IDS
Doc description: Information Disclosure Statement (IDS) Filed

PTO/SB/08a (03-15)
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INFORMATION DISCLOSURE STATEMENT BY APPLICANT
(Not for submission under 37 CFR 1.99)

Application Number	
Filing Date	
First Named Inventor	Seung Min KIM
Art Unit	
Examiner Name	
Attorney Docket Number	0313221.00022

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	1	20170126775	KR	A	2017-11-20	LS MTRON LTD		
	2	20160102147	KR	A	2016-08-29	LS MTRON LTD.		
	3	20150050266	KR	A	2015-05-08	KOREA IND TECH INST		

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INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)		
	Application Number	
	Filing Date	
	First Named Inventor	Seung Min KIM
	Art Unit	
	Examiner Name	
	Attorney Docket Number	0313221.00022

	4	H06146066	JP	A	1994-05-27	NIPPON KOKAN KK		
	5	2017063185	JP	A	2017-03-30	FUJI ELECTRIC CO LTD.		
	6	I533496	TW	B	2016-05-11	CHANG CHUN PETROCHEMICAL CO		

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Examiner Initials*	Cite No	Include name of the author (in CAPITAL LETTERS), title of the article (when appropriate), title of the item (book, magazine, journal, serial, symposium, catalog, etc), date, pages(s), volume-issue number(s), publisher, city and/or country where published.	T[5]
	1	International Search Report for related International Application No. PCT/KR2019/001069; report dated August 8, 2019; (5 pages)	
	2	Written Opinion for related International Application No. PCT/KR2019/001069; report dated August 8, 2019; (5 pages)	

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EXAMINER SIGNATURE

Examiner Signature	/SETH DUMBRIS/	Date Considered	11/16/2021

*EXAMINER: Initial if reference considered, whether or not citation is in conformance with MPEP 609. Draw line through a citation if not in conformance and not considered. Include copy of this form with next communication to applicant.

[1] See Kind Codes of USPTO Patent Documents at www.USPTO.GOV or MPEP 901.04. [2] Enter office that issued the document, by the two-letter code (WIPO Standard ST.3). [3] For Japanese patent documents, the indication of the year of the reign of the Emperor must precede the serial number of the patent document. [4] Kind of document by the appropriate symbols as indicated on the document under WIPO Standard ST.16 if possible. [5] Applicant is to place a check mark here if English language translation is attached.

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INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)		
	Application Number	
	Filing Date	
	First Named Inventor	Seung Min KIM
	Art Unit	
	Examiner Name	
	Attorney Docket Number	0313221.00022

CERTIFICATION STATEMENT

Please see 37 CFR 1.97 and 1.98 to make the appropriate selection(s):

That each item of information contained in the information disclosure statement was first cited in any communication from a foreign patent office in a counterpart foreign application not more than three months prior to the filing of the information disclosure statement. See 37 CFR 1.97(e)(1).

OR

☐ That no item of information contained in the information disclosure statement was cited in a communication from a foreign patent office in a counterpart foreign application, and, to the knowledge of the person signing the certification after making reasonable inquiry, no item of information contained in the information disclosure statement was known to any individual designated in 37 CFR 1.56(c) more than three months prior to the filing of the information disclosure statement. See 37 CFR 1.97(e)(2).

See attached certification statement.

The fee set forth in 37 CFR 1.17 (p) has been submitted herewith.

☒ A certification statement is not submitted herewith.

SIGNATURE

A signature of the applicant or representative is required in accordance with CFR 1.33, 10.18. Please see CFR 1.4(d) for the form of the signature.

Signature	/Matthew S. Dicke/	Date (YYYY-MM-DD)	2020-06-30
Name/Print	Matthew S. Dicke	Registration Number	58819

This collection of information is required by 37 CFR 1.97 and 1.98. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.14. This collection is estimated to take 1 hour to complete, including gathering, preparing and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

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5. A record related to an International Application filed under the Patent Cooperation Treaty in this system of records may be disclosed, as a routine use, to the International Bureau of the World Intellectual Property Organization, pursuant to the Patent Cooperation Treaty.

6. A record in this system of records may be disclosed, as a routine use, to another federal agency for purposes of National Security review (35 U.S.C. 181) and for review pursuant to the Atomic Energy Act (42 U.S.C. 218(c)).

7. A record from this system of records may be disclosed, as a routine use, to the Administrator, General Services, or his/her designee, during an inspection of records conducted by GSA as part of that agency's responsibility to recommend improvements in records management practices and programs, under authority of 44 U.S.C. 2904 and 2906. Such disclosure shall be made in accordance with the GSA regulations governing inspection of records for this purpose, and any other relevant (i.e., GSA or Commerce) directive. Such disclosure shall not be used to make determinations about individuals.

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Bibliographic Data

Application No: 16/959,352

Foreign Priority claimed: (•) Yes ( ) No

35 USC 119 (a-d) conditions met: [✓] Yes [ ] No [ ] Met After Allowance

Verified and Acknowledged: /SETH DUMBRIS/ Examiner's Signature | Initials

Title: ELECTROLYTIC COPPER FOIL HAVING EXCELLENT HANDLING CHARACTERISTICS IN POSTPROCESSING, AND MANUFACTURING METHOD THEREFOR

FILING or 371(c) DATE	CLASS	GROUP ART UNIT	ATTORNEY DOCKET NO.
06/30/2020	428	1784	0313221.00022
RULE			

APPLICANTS

KCF Technologies Co., Ltd., Anyang-si, Gyeonggi-do, KOREA, REPUBLIC OF

INVENTORS

Seung Min KIM, Anyang-si, Gyeonggi-do, KOREA, REPUBLIC OF

Shan Hua JIN, Anyang-si, Gyeonggi-do, KOREA, REPUBLIC OF

CONTINUING DATA

This application is a 371 of PCT/KR2019/001069 01/25/2019

FOREIGN APPLICATIONS

KOREA, REPUBLIC OF KR10-2018-0012179 01/31/2018

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(Not for submission under 37 CFR 1.99)

Application Number	16959352
Filing Date	2020-06-30
First Named Inventor	Seung Min KIM
Art Unit	1795
Examiner Name	WITTENBERG, STEFANIE S
Attorney Docket Number	0313221.00022

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	2	2004162144	JP	A	2004-06-10	NIPPON DENKAI KK		

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INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)		
	Application Number	16959352
	Filing Date	2020-06-30
	First Named Inventor	Seung Min KIM
	Art Unit	1795
	Examiner Name	WITTENBERG, STEFANIE S
	Attorney Docket Number	0313221.00022

	3	2012140660	JP	A	2012-07-26	NIPPON DENKAI KK			

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	1	Extended European Search Report for related European Application No. 19746587.5; action dated September 16, 2021; (8 pages)	

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Signature	/Matthew S. Dicke/	Date (YYYY-MM-DD)	2021-09-30
Name/Print	Matthew S. Dicke	Registration Number	58819

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Bibliographic data: EP3663438 (A1) — 2020-06-10

ANTI-CREASING COPPER FOIL, ELECTRODE COMPRISING SAME, SECONDARY BATTERY COMPRISING SAME, AND MANUFACTURING METHOD THEREFOR

Inventor(s): JIN SHAN HUA [KR]; LEE AN NA [KR]; KIM SEUNG MIN [KR] + (JIN, Shan Hua, ; LEE, An Na, ; KIM, Seung Min)

Applicant(s): KCF TECH CO LTD [KR] + (KCF Technologies Co., Ltd, ; SK Nexilis Co., Ltd)

Classification: - international: *C25D1/04; C25D21/06; C25D3/38; C25D5/34; C25D5/48; H01M10/052; H01M4/13; H01M4/66*
- cooperative: C25D1/04 (EP, KR, US); C25D21/06 (KR); C25D3/38 (EP, KR, US); C25D5/34 (KR, US); C25D5/48 (KR, US); C25D7/0614 (US); H01M10/052 (KR, US); H01M10/0525 (EP); H01M4/0404 (EP); H01M4/13 (KR, US); H01M4/66 (US); H01M4/661 (EP, KR); H01M4/667 (KR); H01M2004/027 (EP); Y02E60/10 (EP)

Application number: EP20180841167 20180725 Global Dossier

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Also published as: EP3663438 (A4) CN110997983 (A) JP2020530878 (A) KR20190012922 (A) TW201910558 (A) more

Abstract of EP3663438 (A1)

Disclosed is a copper foil including a copper layer having a matte surface and a shiny surface, and an anticorrosive layer disposed on the copper layer, wherein the copper foil has a residual stress of 0.5 to 25 Mpa, based on absolute value, and the copper layer has a plurality of crystal planes, wherein a ratio [TCR (220)] of a texture coefficient (TC) of (220) crystal plane of the copper layer to a total of texture coefficients (TC) of (111), (200), (220) and (311) crystal planes of the copper layer is 5 to 30%.

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(71) Applicant: **KCF Technologies Co., Ltd.**
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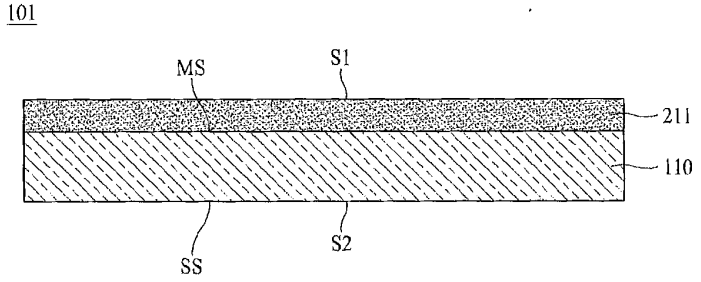
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(54) ANTI-CREASING COPPER FOIL, ELECTRODE COMPRISING SAME, SECONDARY BATTERY COMPRISING SAME, AND MANUFACTURING METHOD THEREFOR

(57) Disclosed is a copper foil including a copper layer having a matte surface and a shiny surface, and an anticorrosive layer disposed on the copper layer, wherein the copper foil has a residual stress of 0.5 to 25 Mpa, based on absolute value, and the copper layer has a plurality of crystal planes, wherein a ratio [TCR (220)] of a texture coefficient (TC) of (220) crystal plane of the copper layer to a total of texture coefficients (TC) of (111), (200), (220) and (311) crystal planes of the copper layer is 5 to 30%.

FIG. 1



EP 3 663 438 A1

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Description

BACKGROUND

Technical Field

[0001] The present disclosure relates to a copper foil free from generation of wrinkles or curls, an electrode including the same, a secondary battery including the same and a method for manufacturing the same.

Description of the Related Art

[0002] A secondary battery is an energy converter that changes electric energy into chemical energy and stores the chemical energy, and converts the chemical energy back into electric energy when electricity is needed, to generate electricity. A secondary battery is also called a "rechargeable battery" in that it can be charged repeatedly.

[0003] Among secondary batteries, a lithium secondary battery has high operation voltage, high energy density and excellent lifespan characteristics. Recent trends towards increasing use of portable electronic devices such as smart phones and notebooks as well as commercialized electric vehicles have brought about rapidly increasing demand for lithium secondary batteries. Such a secondary battery includes an anode current collector made of a copper foil. Among copper foils, electrolyte copper foils are widely used as anode current collectors. In accordance with not only increasing demand for lithium secondary batteries, but also increasing demand for secondary batteries with high capacity, high capacity and high quality, copper foils capable of improving characteristics of secondary batteries are required. In particular, there is a need for copper foils that can impart high capacity to secondary batteries and enable secondary batteries to stably maintain capacity.

[0004] Meanwhile, as the thickness of copper foil decreases, the amount of active material contained in the predetermined area may increase, the number of current collectors may increase and the capacity of secondary batteries may thus increase. However, as the thickness of copper foil decreases, curling is readily generated, and an edge of copper foil is curled when the copper foil is rolled, which causes defects such as tears or wrinkles of the copper foil. For this reason, there is difficulty in manufacturing very thin film-type copper foils. Hence, in order to manufacture very thin copper foils, curling of copper foils should be prevented.

[0005] Meanwhile, electrolyte copper foils used as anode current collectors have a tensile strength of about 30 to 40 kgf/mm^2. To manufacture high-capacity lithium secondary batteries, high-capacity metal or composite active materials have recently attracted attention. Since the metal active materials or composite active materials are greatly volumetrically expanded during charge/discharge, copper foils should withstand volume expansion of the active materials.

[0006] Taking these points into consideration, in the step of manufacturing copper foils, as well as in the step of manufacturing electrodes for secondary batteries or the secondary batteries, the copper foils should be free from generation of curls, wrinkles or tears. In particular, during rolling or coating of active materials, in the step of manufacturing copper foils or secondary batteries using the copper foils by a roll-to-roll process, defects, wherein, for example, edges of copper foils are torn, should be prevented.

DETAILED DESCRIPTION OF THE INVENTION

Technical Subject

[0007] Therefore, the present disclosure has been made in view of the above problems, and the present disclosure is directed to providing a copper foil, an electrode including the same, a secondary battery including the same, and a method for manufacturing the same.

[0008] It is one object of the present disclosure to provide a copper foil that is capable of preventing occurrence of curls, wrinkles or tears in the manufacturing process in spite of small thickness thereof. In addition, it is another object of the present disclosure to provide a copper foil that is capable of preventing occurrence of curls, wrinkles or tears in the process of manufacturing an electrode for a secondary battery or the secondary battery using a copper foil.

[0009] It is a further object of the present disclosure to provide an electrode for secondary batteries including the copper foil and a secondary battery including the electrode for secondary batteries.

[0010] It is another object of the present disclosure to provide a method for manufacturing a copper foil that is capable of preventing occurrence of curls, wrinkles or tears.

[0011] Apart from the aspects of the present disclosure mentioned above, other features and advantages of the present disclosure will be described below and would be clearly understood from the description by those skilled in the art.

Technical Solution

[0012] According to the one embodiment of the present disclosure, curling of a copper foil can be controlled by controlling a crystal orientation of a copper layer constituting the copper foil. In addition, curling of the copper foil can be minimized by reducing residual stress in the copper foil.

[0013] In accordance with the present disclosure, the above and other objects can be accomplished by the provision of a copper foil including a copper layer having a matte surface and a shiny surface, and an anticorrosive layer disposed on the copper layer, wherein the copper foil has a residual stress of 0.5 to 25 Mpa, based on absolute value, and the copper layer has a plurality of crystal planes, wherein a ratio [TCR(220)] of a texture coefficient (TC) of (220) crystal plane of the copper layer to a total of texture coefficients (TC) of (111), (200), (220) and (311) crystal planes of the copper layer is 5 to 30%.

[0014] The residual stress may be measured in at least one of the (111), (200), (220) and (311) planes.

[0015] The residual stress may be measured in the (311) plane.

[0016] The copper foil may have an elongation of 2 to 20% after heat-treatment at 130°C for 30 minutes.

[0017] The copper foil may have a first surface corresponding to the direction of the matte surface and a second surface corresponding to the direction of the shiny surface, wherein a difference in surface roughness (Ra) between the first surface and the second surface is 0.5 μm or less.

[0018] The copper foil may have a thickness of 4 to 20 μm.

[0019] The anticorrosive layer may include at least one of chromium, a silane compound or a nitrogen compound.

[0020] In accordance with another aspect of the present disclosure, there is provided an electrode for secondary batteries including the copper foil according to the present disclosure and an active material layer disposed on the copper foil.

[0021] In accordance with another aspect of the present disclosure, there is provided a secondary battery including a cathode, an anode facing the cathode, an electrolyte disposed between the cathode and the anode to provide an environment enabling lithium ions to move, and a separator to electrically insulate (isolate) the cathode from the anode, wherein the anode includes the copper foil according to the present disclosure and an active material layer disposed on the copper foil.

[0022] In accordance with another aspect of the present disclosure, there is provided a method for manufacturing a copper foil including preparing an electrolyte including copper ions and applying a current density of 30 to 70 ASD (A/dm^2) to an electrode plate and a rotary electrode drum spaced from each other in the electrolyte, to form a copper layer, wherein the electrolyte includes 70 to 100 g/L of copper ions, 70 to 150 g/L of sulfuric acid, 1 to 60 ppm of chlorine (Cl), 2 g/L or less of arsenic (As) ions and an organic additive, wherein the organic additive includes at least one of a polishing agent (ingredient A), a speed reducer (ingredient B), a leveling agent (ingredient C) and a roughness regulator (ingredient D), wherein the polishing agent (ingredient A) includes sulfonic acid or a metal salt thereof, the speed reducer (ingredient B) includes a non-ionic water-soluble polymer, the leveling agent (ingredient C) includes at least one of nitrogen (N) and sulfur (S), and the roughness regulator (ingredient D) includes a nitrogen-containing heterocyclic quaternary ammonium salt or a derivative thereof.

[0023] The organic additive may have a concentration of 1 to 150 ppm.

[0024] The polishing agent includes at least one selected from a bis-(3-sulfopropyl)-disulfide disodium salt (SPS), 3-mercapto-1-propanesulfonic acid, a 3-(N,N-dimethylthiocarbamoyl)-thiopropanesulfonate sodium salt, a 3-[(amino-iminomethyl)thio]-1-propanesulfonate sodium salt, an o-ethyldithiocarbonato-S-(3-sulfopropyl)-ester sodium salt, a 3-(benzothiazolyl-2-mercapto)-propyl-sulfonic acid sodium salt and an ethylenedithiodipropylsulfonic acid sodium salt.

[0025] The polishing agent may have a concentration of 1 to 50 ppm.

[0026] The speed reducer may include at least one non-ionic water-soluble polymer selected from polyethylene glycol (PEG), polypropylene glycol, a polyethylene-polypropylene copolymer, polyglycerine, polyethylene glycol dimethyl ether, hydroxyethyl cellulose, polyvinyl alcohol, stearic acid polyglycol ether and stearyl alcohol polyglycol ether.

[0027] The non-ionic water-soluble polymer may have a number average molecular weight of 500 to 25,000.

[0028] The speed reducer may have a concentration of 5 to 50 ppm.

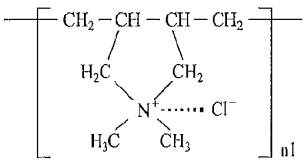
[0029] The leveling agent may include at least one selected from thiourea (TU), diethylthiourea, ethylene thiourea, acetylene thiourea, dipropylthiourea, dibutylthiourea, N-trifluoroacetylthiourea, N-ethylthiourea, N-cyanoacetyl thiourea, N-allylthiourea, o-tolylthiourea, N,N'-butylene thiourea, thiazolidinethiol, 4-thiazolinethiol, 4-methyl-2-pyrimidinethiol, 2-thiouracil, 3-(benzotriazole-2-mercapto)-pyrosulfuric acid, 2-mercaptopyridine, 3-(5-mercapto-1H-tetrazole)benzenesulfonate, 2-mercaptobenzothiazole, dimethylpyridine, 2,2'-bipyridine, 4,4'-bipyridine, pyrimidine, pyridazine, pyrinoline, oxazole, thiazole, 1-methylimidazole, 1-benzylimidazole, 1-methyl-2-methylimidazole, 1-benzyl-2-methylimidazole, 1-ethyl-4-methylimidazole, N-methylpyrrole, N-ethylpyrrole, N-butylpyrrole, N-methylpyrroline, N-ethylpyrroline, N-butylpyrroline, purine, quinoline, isoquinoline, N-methylcarbazole, N-ethylcarbazole and N-butylcarbazole.

[0030] The leveling agent may have a concentration of 1 to 20 ppm.

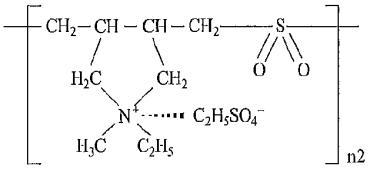
[0031] The roughness regulator may include at least one of compounds represented by the following Formulae 1 to 5:

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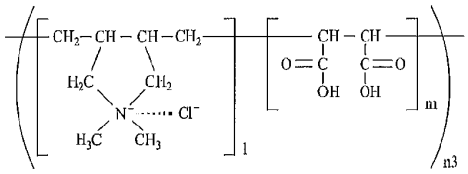
[Formula 1]



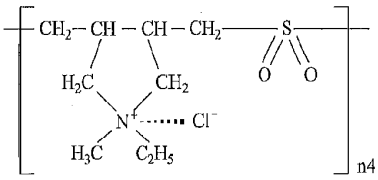
[Formula 2]



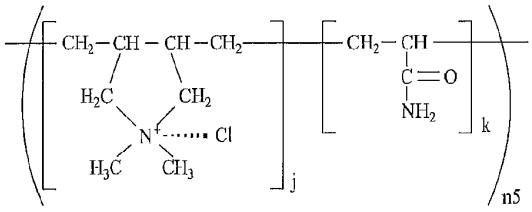
[Formula 3]



[Formula 4]



[Formula 5]



wherein j, k, 1, m and n1 to n5 each represent repeat units, are an integer of 1 or higher and are identical to or different from one another.

[0032] The compounds represented by Formulae 1 to 5 may each have a number average molecular weight of 500 to 50,000.

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[0033] The roughness regulator may have a concentration of 1 to 30 ppm.

[0034] The electrolyte may have a total organic carbon (TOC) concentration of 200 ppm or less.

[0035] The step of forming a copper layer may include at least one of filtering the electrolyte through activated carbon, filtering the electrolyte through diatomite, and treating the electrolyte with ozone (O_3).

[0036] The step of preparing an electrolyte may include heat-treating a copper wire, cleaning the heat-treated copper wire with an acid, cleaning the acid-cleaned copper wire with water, and injecting the water-cleaned copper wire into sulfuric acid for an electrolyte.

[0037] The method may further include forming an anticorrosive layer on the copper layer.

[0038] The general description of the present disclosure given above is provided only for illustration or description of the present disclosure and should not be construed as limiting the scope of the present disclosure.

EFFECT OF THE INVENTION

[0039] According to an embodiment of the present disclosure, the crystal orientation of the copper layer constituting the copper foil is controlled, residual stress in the copper foil is reduced and curl of the copper foil is thus suppressed. As a result, occurrence of curls, wrinkles or tears is prevented in the process of manufacturing the copper foil. In addition, when such a copper foil is used, occurrence of curls, wrinkles or tears in the copper foil is prevented in the process of manufacturing an electrode for a secondary battery or the secondary battery.

BRIEF DESCRIPTION OF THE SEVARAL VEIWS OF THE DRAWINGS

[0040] The above and other objects, features and other advantages of the present disclosure will be more clearly understood from the following detailed description taken in conjunction with the accompanying drawings, in which:

FIG. 1 is a schematic sectional view illustrating a copper foil according to an embodiment of the present disclosure;
FIG. 2A shows an example of an XRD graph of the copper foil;
FIG. 2B shows an example of an XRD graph showing residual stress in the copper foil;
FIG. 3 is a schematic sectional view illustrating a copper foil according to another embodiment of the present disclosure;
FIG. 4 is a schematic sectional view illustrating an electrode for secondary batteries according to another embodiment of the present disclosure;
FIG. 5 is a schematic sectional view illustrating an electrode for secondary batteries according to another embodiment of the present disclosure;
FIG. 6 is a schematic sectional view illustrating a secondary battery according to another embodiment of the present disclosure; and
FIG. 7 is a schematic view illustrating a method for manufacturing the copper foil shown in FIG. 3.

DETAILED DESCRIPTION OF THE DISCLOSURE

[0041] Reference will now be made in detail to the preferred embodiments of the present disclosure, examples of which are illustrated in the accompanying drawings.

[0042] Those skilled in the art will appreciate that various modifications, additions and substitutions are possible, without departing from the scope and spirit of the disclosure as disclosed in the accompanying claims. Accordingly, the present disclosure encompasses the disclosure defined in the claims and modifications and alterations that fall within the scope of the equivalents thereto.

[0043] The shapes, sizes, ratios, angles and numbers disclosed in the drawings for describing embodiments of the present disclosure are merely examples, and thus the present disclosure is not limited to the illustrated details. Like reference numerals refer to like elements throughout the specification.

[0044] In the case in which "comprise," "have," and "include" described in the present specification are used, another part may also be present unless "only" is used. The terms in a singular form may include plural forms unless noted to the contrary. In construing an element, the element is construed as including an error region although there is no explicit description thereof.

[0045] In describing a positional relationship, for example, when the positional order is described as "on," "above," "below," and "next," the case of no contact therebetween may be included, unless "just" or "direct" is used.

[0046] In describing a temporal relationship, for example, when the temporal order is described as "after," "subsequent," "next," and "before," a case which is not continuous may be included, unless "just" or "direct" is used.

[0047] It will be understood that, although the terms "first," "second," etc. may be used herein to describe various elements, these elements should not be limited by these terms. These terms are only used to distinguish one element

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from another. For example, a first element could be termed a second element, and, similarly, a second element could be termed a first element, without departing from the scope of the present disclosure.

[0048] It should be understood that the term "at least one" includes all combinations related with any one item.

[0049] Features of various embodiments of the present disclosure may be partially or overall coupled to or combined with each other, and may be variously inter-operated with each other and driven technically as those skilled in the art can sufficiently understand. The embodiments of the present disclosure may be carried out independently from each other, or may be carried out together in a co-dependent relationship.

[0050] FIG. 1 is a schematic sectional view illustrating a copper foil 101 according to an embodiment of the present disclosure.

[0051] The copper foil 101 according to the embodiment of the present disclosure includes a copper layer 110. The copper layer 110 has a matte surface MS and a shiny surface SS opposite to the matte surface MS.

[0052] The copper layer 110 may be, for example, formed on a rotary electrode drum by electroplating (see FIG. 7). At this time, the shiny surface SS refers to a surface of the copper layer 110 which contacts the rotary electrode drum during electroplating and the matte surface MS refers to a surface which is disposed opposite to the shiny surface SS.

[0053] The shiny surface SS generally has a lower surface roughness Rz than that of the matte surface MS, but the embodiment of the present disclosure is not limited thereto. The surface roughness Rz of the shiny surface SS may be equal to or higher than the surface roughness Rz of the matte surface MS. For example, regarding the rotary electrode drum 12 (see FIG. 7) used for manufacturing the copper layer 110, the surface roughness of the shiny surface SS may be lower or higher than the surface roughness Rz of the matte surface MS. The surface of the rotary electrode drum 12 may be polished with a polishing brush having a grit of #800 to #3000.

[0054] Referring to FIG. 1, the copper foil 101 may further include an anticorrosive layer 211 disposed on the copper layer 110. The anticorrosive layer 211 may be omitted.

[0055] The anticorrosive layer 211 may be disposed on at least one of the matte surface MS or the shiny surface SS of the copper layer 110. Referring to FIG. 1, the anticorrosive layer 211 is disposed on the matte surface MS, but the embodiments of the present disclosure are not limited thereto. That is, the anticorrosive layer 211 may be disposed only on the shiny surface SS, or both on the matte surface MS and the shiny surface SS.

[0056] The anticorrosive layer 211 protects the copper layer 110 to prevent the copper layer 110 from being oxidized or denatured upon storage or distribution. Accordingly, the anticorrosive layer 211 is also called a "protective layer".

[0057] According to an embodiment of the present disclosure, the anticorrosive layer 211 may include at least one of chromium (Cr), a silane compound or a nitrogen compound.

[0058] For example, the anticorrosive layer 211 may be prepared from a chromium (Cr)-containing anticorrosive liquid, that is, a chromate compound-containing anticorrosive liquid.

[0059] According to an embodiment of the present disclosure, the copper foil 101 has a first surface S1 which is a surface of the direction of the matte surface MS based on the copper layer 110 and a second surface S2 which is a surface of the direction of the shiny surface SS. Referring to FIG. 1, the first surface S1 of the copper foil 101 is a surface of the anticorrosive layer 211 and the second surface S2 thereof is the shiny surface SS. According to an embodiment of the present disclosure, the anticorrosive layer 211 may be omitted. When the anticorrosive layer 211 is omitted, the matte surface MS of the copper layer 110 corresponds to the first surface S1 of the copper foil 101.

[0060] According to an embodiment of the present disclosure, the copper layer has a plurality of crystal planes and a ratio of a texture coefficient (TC) of (220) crystal plane of the copper layer to a total of texture coefficients (TCs) of (111), (200), (220) and (311) planes, which are crystal planes of the copper layer, is 5 to 30%.

[0061] More specifically, the copper layer 110 has a plurality of crystal planes and the crystal planes can be represented by Miller indices. Specifically, the crystal planes of the copper layer 110 can be represented by (hkl) planes. These crystal planes each have texture coefficients (TC), which can be measured or calculated by X-ray diffraction (XRD).

[0062] Hereinafter, referring to FIG. 2A, a method for measuring and calculating texture coefficients of crystal planes of the copper layer 110 constituting the copper foil 101 will be described below.

[0063] FIG. 2A shows an example of an XRD graph of a copper foil. More specifically, FIG. 2A is an XRD graph of the copper layer 110 constituting the copper foil 101. The peaks of FIG. 2A each correspond to crystal planes.

[0064] For measurement of texture coefficients (TCs), first, an XRD graph having peaks corresponding to n crystal planes is obtained by X-ray diffraction (XRD) in a diffraction angle (2θ) range of 30° to 95° [Target: copper K alpha 1, 2θ interval: 0.01°, 2θ scan speed: 3°/min]. For example, referring to FIG. 2A, an XRD graph including four peaks corresponding to (111), (200), (220) and (311) planes is obtained. In this case, n is 4.

[0065] Then, XRD diffraction intensity [I(hkl)] of each crystal plane (hkl) is obtained from this graph. In addition, XRD diffraction intensities [I_0(hkl)] of n respective crystal planes of a standard copper powder regulated by Joint Committee on Powder Diffraction Standards (JCPDS) are obtained. Subsequently, the arithmetic mean value of "I(hkl)/I_0(hkl)" of n crystal planes is calculated.

[0066] For example, the texture coefficient of (111) plane [TC(111)] of the copper layer 110 is obtained by dividing I(111)/I_0(111) of the (111) plane by the arithmetic mean value. That is, the texture coefficient of (111) plane [TC(111)]

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is calculated based on the following Equation 1:

[Equation 1]

$$TC(111) = \frac{\frac{I(111)}{I_0(111)}}{\frac{1}{n}\sum\frac{I(hkl)}{I_0(hkl)}}$$

[0067] In the same manner, the texture coefficient of (200) plane [TC(200)] is calculated based on the following Equation 2:

[Equation 2]

$$TC(200) = \frac{\frac{I(200)}{I_0(200)}}{\frac{1}{n}\sum\frac{I(hkl)}{I_0(hkl)}}$$

[0068] In the same manner, the texture coefficient of (220) plane [TC(220)] is calculated based on the following Equation 3:

[Equation 3]

$$TC(220) = \frac{\frac{I(220)}{I_0(220)}}{\frac{1}{n}\sum\frac{I(hkl)}{I_0(hkl)}}$$

[0069] In the same manner, the texture coefficient of (311) plane [TC(311)] is calculated based on the following Equation 4:

[Equation 4]

$$TC(311) = \frac{\frac{I(311)}{I_0(311)}}{\frac{1}{n}\sum\frac{I(hkl)}{I_0(hkl)}}$$

[0070] According to an embodiment of the present disclosure, a ratio of a texture coefficient (TC) of (220) crystal plane of the copper layer to a total of texture coefficients (TC) of (111), (200), (220) and (311) planes of crystal planes of the copper layer 110 is designated by TCR(220) and the TCR(220) can be calculated in accordance with the following Equation 5:

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[Equation 5]

$$TCR(220) = \frac{TC(220)}{TC(111) + TC(200) + TC(220) + TC(311)}$$

[0071] When the ratio of a texture coefficient (TC) of (220) plane [TC(220)] of the copper layer to a total of texture coefficients (TC) of (111), (200), (220) and (311) planes of the copper layer 110 [TCR(220)] is less than 5%, growth of (111) and (200) planes in the copper layer 110 is relatively facilitated, and the (111) and (200) planes are first orientated, thus causing the crystal texture of the copper layer 110 to be excessively fine and increasing incorporation of impurities. As a result, the residual stress of the copper foil 101 may be increased and curling of the copper foil 101 may be increased.

[0072] When the ratio of a texture coefficient (TC) of (220) plane [TC(220)] of the copper layer to a total of texture coefficients (TC) of (111), (200), (220) and (311) planes of the copper layer 110 [TCR (220)] is higher than 30%, growth of (111) and (200) planes in the copper layer 110 is relatively deteriorated, the fine crystal texture of the copper layer 110 is reduced and the strength of the copper foil 101 is thus decreased.

[0073] For this reason, according to an embodiment of the present disclosure, regarding the crystal structure of the copper layer 110, the ratio of a texture coefficient (TC) of (220) plane [TC(220)] to a total of texture coefficients (TC) of (111), (200), (220) and (311) planes [TCR(220)] is adjusted in the range of 5 to 30%.

[0074] As such, according to an embodiment of the present disclosure, by controlling the crystal orientation of the copper layer 110, curling of the copper foil 101 can be prevented and, as a result, wrinkling of the copper foil 101 can be prevented.

[0075] According to an embodiment of the present disclosure, the copper foil 101 has a residual stress of 0.5 to 25 Mpa, based on absolute value.

[0076] Residual stress refers to stress that remains in an object, although no external force is applied to the object. The residual stress may be stress generated in a processed or heat-treated object and be present in the form of tensile stress or compressive stress in the object depending on treatment method applied to the object. Such residual stress may cause the object to be broken or damaged.

[0077] When the copper foil 101 has a great residual stress, based on absolute value, curling of the copper foil becomes worse. Since the phenomenon of curling seriously occurs in thin film-type copper foils, it is important to control the phenomenon of curling in the process of producing thin film-type copper foils.

[0078] According to an embodiment of the present disclosure, curling of the copper foil is prevented by controlling the residual stress of the copper foil.

[0079] Specifically, a residual stress having a positive value indicates presence of tensile stress in the copper foil 101, while a residual stress having a negative value indicates presence of compressive stress in the copper foil 101. Depending on the composition of organic additive used in the process of manufacturing the copper foil 101, the copper foil may have a tensile stress- or compressive stress-type residual stress.

[0080] When the residual stress of the copper foil 101 is lower than 0.5 Mpa, the surface of the copper foil 101 may become rough due to non-uniformity of crystal cross-sectional surfaces during plating for forming the copper layer 110. In this case, in the process of manufacturing an electrode for secondary batteries using the copper foil 101, the surface of the copper foil 101 may not be uniformly coated with an active material and charge/discharge capacity maintenance or stability of secondary batteries may be deteriorated.

[0081] Due to partial incorporation of hydrogen or self-growth of crystal grains during plating for manufacturing the copper layer 110 constituting the copper foil 101, the copper foil 101 can have a residual stress of 0.5 Mpa or more, based on absolute value. When the absolute value of the residual stress of the copper foil 101 is higher than 25 Mpa, in the process of manufacturing secondary batteries, the copper foil 101 may be curled, wrinkled or the like, which causes deterioration in workability and increased defects of secondary batteries.

[0082] Hence, according to an embodiment of the present disclosure, the residual stress of the copper foil 101 is adjusted in the range of 0.5 to 25 Mpa, based on absolute value. For this purpose, the crystal orientation of the copper layer 110 can be regulated. That is, according to an embodiment of the present disclosure, the TCR (220) of the copper layer 110 is adjusted to the range of 5 to 30%, so that the residual stress of the copper foil 101 can be adjusted to the range of 0.5 to 25 Mpa, based on absolute value.

[0083] The residual stress of the copper foil 101 can be measured on at least one of crystal planes of the copper layer 110. That is, residual stress measured on at least one of crystal planes of the copper layer 110 may be the residual stress of the copper foil 101. For example, the residual stress of the copper foil 101 is measured in at least one of (111), (200), (220) and (311) planes of crystal planes of the copper layer 110. That is, the residual stress of the copper foil 101 measured in at least one of (111), (200), (220) and (311) planes may be the residual stress of the copper foil 101.

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[0084] According to an embodiment of the present disclosure, the residual stress of the copper foil 101 can be measured with an X-ray diffraction (XRD) residual stress measurement device. More specifically, the residual stress of respective crystal planes of the copper layer 110 can be measured with a residual stress measurement device using X-ray diffraction (XRD) of crystal planes of the copper layer 110.

[0085] For example, the residual stress of the copper foil 101 may be measured using D8 DISCOVER™ available from Bruker Corporation, as the X-ray diffraction (XRD) residual stress measurement device. At this time, X-ray diffraction analysis conditions are set as follows:

Target: 3 kW X-ray tube with Cu target

Power: 40 kV, 40 mA

Wavelength: 1.5406Å

Measurement range: 30 to 100 degrees

Scan axis: Theta-2Theta

Scan speed: 2 deg/min

[0086] FIG. 2B shows an example of an XRD graph regarding a residual stress in the copper foil. In particular, FIG. 2B illustrates XRD results for measurement of the residual stress of (311) plane of the copper layer 110.

[0087] Upon measurement of residual stress, any one is selected from crystal planes of copper and residual stress is measured in the plane at a constant 2θ while changing only θ within 360°. Residual stress can be measured in each of (111), (200), (220) and (311) planes, four main crystal planes of the copper layer 110.

[0088] In particular, in the XRD graph, the residual stress of the crystal plane having low intensity, yet good resolution may be measured and the measured value may be determined to be residual stress of the copper foil 101. For example, the (311) plane of the copper layer 110 has an excellent measurement resolution and a high reliability at a high angle. Accordingly, the residual stress measured in the (311) plane of the copper layer 110 may be the residual stress of the copper foil 101.

[0089] According to an embodiment of the present disclosure, the copper foil 101 has an elongation of 2 to 20% after heat-treating at 130°C for 30 minutes. The elongation may be measured with a universal testing machine (UTM) in accordance with the regulations of the IPC-TM-650 test method manual. According to an embodiment of the present disclosure, the elongation is measured with a universal testing machine available from Instron corporation. At this time, the width of a sample for measuring elongation is 12.7 mm, the distance between grips is 50 mm and the measurement speed is 50 mm/min.

[0090] When the elongation of the copper foil 101 is less than 2% after heat-treating at 130°C for 30 minutes, the copper foil 101 cannot sufficiently extend in response to great volumetric expansion of an active material for high capacity when used as a current collector for secondary batteries, and thus be torn. On the other hand, when the elongation is excessively high, that is, higher than 20%, the copper foil 101 is readily extended in the process of manufacturing an electrode for secondary batteries, which may cause the electrode to be deformed.

[0091] In addition, the copper foil 101 may have an elongation of 2 to 20% at room temperature of 25±15°C.

[0092] According to an embodiment of the present disclosure, the copper foil 101 has a difference in surface roughness Ra between the first surface S1 and the second surface S2, of 0.5 μm or less.

[0093] The surface roughness Ra according to an embodiment of the present disclosure is referred to as an "arithmetic average roughness". In the surface roughness profile, the surface roughness Ra is determined by calculating a total area of upper and lower parts from the center line of a measurement region (base length) and dividing the total area by the length of the measurement area. Surface roughness Ra may be measured using a surface roughness measurement device (M300, Mahr) in accordance with specifications of JIS B 0601-2001.

[0094] In the case where the difference in surface roughness Ra between the first surface S1 and the second surface S2 of the copper foil 101 is higher than 0.5 μm, when the copper foil 101 is used as a current collector for electrodes for secondary batteries, due to the difference in surface roughness Ra between the first surface S1 and the second surface S2, the active material is not uniformly coated on both surfaces of the first surface S1 and the second surface S2. As a result, upon charge/discharge of secondary batteries, differences in electric and physical properties between both the surfaces S1 and S2 may occur, which may cause deterioration in capacity maintenance rate and lifespan of secondary batteries.

[0095] In addition, according to an embodiment of the present disclosure, the first surface S1 and the second surface S2 of the copper foil 101 may each have a surface roughness Ra, of not less than 0.12 μm and not more than 0.86 μm.

[0096] According to an embodiment of the present disclosure, the copper foil 101 has a thickness of 4 μm to 20 μm. When the copper foil 101 is used as a current collector of an electrode for secondary batteries, reduced thickness of the copper foil 101 enables more current collects to be accommodated in the same area, which is advantageous for providing high capacity of secondary batteries. However, when the thickness of the copper foil 101 is less than 4 μm, workability is deteriorated in the process of manufacturing an electrode for secondary batteries or the secondary batteries using the copper foil 101.

[0097] Meanwhile, when the thickness of the copper foil 101 is higher than 20 μm, the thickness of the electrode for secondary batteries using the copper foil 101 is increased and the increased thickness may make it difficult to impart high capacity to secondary batteries.

[0098] FIG. 3 is a schematic sectional view illustrating a copper foil 102 according to another embodiment of the present disclosure. Hereinafter, description of constituent components given above will be omitted to avoid repetition.

[0099] Referring to FIG. 3, the copper foil 102 according to another embodiment of the present disclosure includes a copper layer 110, and two anticorrosive layers 211 and 212 respectively disposed on the matte surface MS and the shiny surface SS of the copper layer 110. Compared with the copper foil 101 shown in FIG. 1, the copper foil 102 shown in FIG. 3 further includes the anticorrosive layer 212 disposed on the shiny surface SS of the copper layer 110.

[0100] For convenience of description, among two anticorrosive layers 211 and 212, the anticorrosive layer 211 disposed on the matte surface MS of the copper layer 110 is referred to as a "first protective layer" and the anticorrosive layer 212 disposed on the shiny surface SS is referred to as a "second protective layer".

[0101] In addition, the copper foil 102 shown in FIG. 3 has a first surface S1, which is a surface of the direction of the matte surface MS, based on the copper layer 110, and a second surface S2 which is a surface of the direction of the shiny surface SS. Here, the first surface S1 of the copper foil 102 corresponds to the surface of the anticorrosive layer 211 disposed on the matte surface MS, and the second surface S2 corresponds to the surface of the anticorrosive layer 212 disposed on the shiny surface SS.

[0102] According to another embodiment of the present disclosure, each of two anticorrosive layers 211 and 212 may include at least one of chromium (Cr), a silane compound and a nitrogen compound.

[0103] The copper layer 110 of the copper foil 102 shown in FIG. 3 has a crystal structure and a ratio [TCR(220)] of a texture coefficient (TC) of (220) plane [TC(220)] to a total texture coefficient (TC) of (111), (200), (220) and (311) planes, of 5 to 30%.

[0104] The copper foil 102 has a residual stress of 0.5 to 25 Mpa, based on absolute value. The residual stress may be measured in at least one of (111), (200), (220) and (311) plans of crystal planes of the copper layer 110. More specifically, the residual stress may be measured in the (311) plane.

[0105] The copper foil 102 has an elongation of 2 to 20% after heat-treating at 130°C for 30 minutes and has a difference in surface roughness Ra between the first surface S1 and the second surface S2, of 0.5 μm or less.

[0106] The copper foil 102 shown in FIG. 3 has a thickness of 4 μm to 30 μm.

[0107] FIG. 4 is a schematic sectional view illustrating an electrode 103 for secondary batteries according to another embodiment of the present disclosure. The electrode 103 for secondary batteries shown in FIG. 4 may be, for example, applied to the secondary battery 105 shown in FIG. 6.

[0108] Referring to FIG. 4, the electrode 103 for secondary batteries according to another embodiment of the present disclosure includes a copper foil 101 and an active material layer 310 disposed on the copper foil 101. In this case, the copper foil 101 includes a copper layer 110 and an anticorrosive layer 211 disposed on the copper layer 110, and is used as a current collector.

[0109] Specifically, the copper foil 101 has a first surface S1 and a second surface S2, and the active material layer 310 is disposed on at least one of the first surface S1 and the second surface S2. The active material layer 310 may be disposed on the anticorrosive layer 211.

[0110] FIG. 4 shows an example in which the copper foil 101 of FIG. 1 is used as a current collector. However, another embodiment of the present disclosure is not limited thereto and the copper foil 102 shown in FIG. 3 may be used as a current collector of the electrode 103 for secondary batteries.

[0111] In addition, the configuration in which the active material layer 310 is disposed only on the first surface S1 of the copper foil 100 is illustrated in FIG. 4, but other embodiments of the present disclosure are not limited thereto. The active material layer 310 may be disposed on both the first surface S1 and the second surface S2 of the copper foil 101. In addition, the active material layer 310 may be disposed only on the second surface S2 of the copper foil 101.

[0112] The active material layer 310 shown in FIG. 4 includes an electrode active material, in particular, an anode active material. That is, the electrode 103 for secondary batteries shown in FIG. 4 may be used as an anode.

[0113] The active material layer 310 may include at least one of carbon, a metal, a metal oxide, or a composite of a metal and carbon. The metal may include at least one of Ge, Sn, Li, Zn, Mg, Cd, Ce, Ni or Fe. In addition, in order to increase charge/discharge capacity of secondary batteries, the active material layer 310 may include silicon (Si).

[0114] The repeated charge/discharge of secondary batteries causes the active material layer 310 to be alternately shrink and expand, which results in separation of the active material layer 310 and the copper foil 100, and deterioration

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in charge/discharge efficiency of the secondary battery. In particular, the active material layer 310 including silicon (Si) undergoes significant expansion and shrinkage.

[0115] According to another embodiment of the present disclosure, the copper foil 101 used as a current collector can shrink and expand in response to shrinkage and expansion of the active material layer 310 and thus is neither deformed nor torn, although the active material layer 310 shrinks and expands. As a result, separation between the copper foil 101 and the active material layer 310 does not occur. Hence, a secondary battery including the electrode 103 for secondary batteries has excellent charge/discharge efficiency and superior capacity maintenance rate.

[0116] FIG. 5 is a schematic sectional view illustrating an electrode 104 for secondary batteries according to another embodiment of the present disclosure.

[0117] The electrode 104 for secondary batteries according to another embodiment of the present disclosure includes a copper foil 102, and active material layers 310 and 320 disposed on the copper foil 102. The copper foil 102 includes a copper layer 110, and two anticorrosive layers 211 and 212 disposed on opposite surfaces of the copper layer 110.

[0118] Specifically, the electrode 104 for secondary batteries shown in FIG. 5 includes two active material layers 310 and 320 each disposed on the first surface S1 and the second surface S2 of the copper foil 102. Here, the active material layer 310 disposed on the first surface S1 of the copper foil 102 is referred to as a "first active material layer" and the active material layer 320 disposed on the second surface S2 of the copper foil 102 is referred to a "second active material layer".

[0119] The two active material layers 310 and 320 can be produced in the same manner and using the same material, or in different manners and using different materials.

[0120] FIG. 6 is a schematic sectional view illustrating a secondary battery 105 according to another embodiment of the present disclosure. The secondary battery 105 shown in FIG. 6 is, for example, a lithium secondary battery.

[0121] Referring to FIG. 6, the secondary battery 105 includes a cathode 370, an anode 340 facing the cathode 370, an electrolyte 350 disposed between the cathode 370 and the anode 340 to provide an environment enabling ions to move, and a separator 360 to electrically insulate (isolate) the cathode 370 from the anode 340. Here, the ions that pass through the cathode 370 and the anode 340 are for example lithium ions. The separator 360 separates the cathode 370 from the anode 340 to prevent current charges generated at one electrode via the secondary battery 105 from moving to another electrode and then being unnecessarily consumed. Referring to FIG. 6, the separator 360 is disposed in the electrolyte 350.

[0122] The cathode 370 includes a cathode current collector 371 and a cathode active material layer 372. The cathode current collector 371 may be an aluminum foil.

[0123] The anode 340 includes an anode current collector 341 and an active material layer 342. The active material layer 342 of the anode 340 includes an anode active material.

[0124] The copper foil 101 or 102 shown in FIG. 1 or 3 may be used as the anode current collector 341. In addition, the electrode 103 or 104 for secondary batteries shown in FIG. 4 or 5, respectively, may be used as the anode 340 of the secondary battery 105 shown in FIG. 6.

[0125] Hereinafter, a method for manufacturing a copper foil 102 according to another embodiment of the present disclosure will be described in detail with reference to FIG. 7.

[0126] FIG. 7 is a schematic view illustrating a method for manufacturing a copper foil 102 shown in FIG. 3.

[0127] In order to manufacture the copper foil 102, first, an electrolyte 11 containing copper ions is prepared. The electrolyte 11 is accommodated in an electrolyte bath 10.

[0128] Then, a current density of 30 to 70 ASD (A/dm^2) is applied to an electrode plate 13 and a rotary electrode drum 12 spaced from each other in an electrolyte 11 to form a copper layer 110. The copper layer 110 is formed by electroplating. The gap between the electrode plate 13 and the rotary electrode drum 12 can be adjusted in the range of 8 to 13 mm.

[0129] When the current density applied to the electrode plate 13 and the rotary electrode drum 12 is less than 30 ASD, production of crystal grains is facilitated in the copper layer 110, and when the current density is higher than 70 ASD, crystal grains rapidly become finer. More specifically, the current density may be adjusted to 40 ASD or more.

[0130] Surface characteristics of the shiny surface SS of the copper layer 110 can be changed depending on buffing or polishing degree of the surface of the rotary electrode drum 12. In order to control surface characteristics of the shiny surface SS of the copper layer 110, for example, the surface of the rotary electrode drum 12 may be polished with a brush having a grit of #800 to #3000.

[0131] In the step of forming the copper layer 110, the electrolyte 11 is maintained at a temperature of 40 to 70°C. More specifically, the temperature of the electrolyte 11 is maintained at 50°C or more. At this time, the composition of the electrolyte 11 is controlled, so that physical, chemical and electric properties of the copper layer 110 can be controlled.

[0132] According to an embodiment of the present disclosure, the electrolyte 11 includes 70 to 100 g/L of copper ions, 70 to 150 g/L of sulfuric acid, 1 to 60 ppm of chlorine (Cl), 2 g/L or less of arsenic (As) ions and an organic additive.

[0133] To facilitate formation of the copper layer 110 through copper plating, the concentrations of copper ions and sulfuric acid in the electrolyte 11 are adjusted to 70 to 100 g/L and 70 to 150 g/L, respectively.

[0134] According to one embodiment of the present invention, chlorine (Cl) includes all of chlorine ions (Cl^-) and

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chlorine atoms present in a molecule. Chlorine (Cl) can, for example, be used to remove silver (Ag) ions incorporated into the electrolyte 11 in the process of forming the copper layer 110. Specifically, chlorine (Cl) induces precipitation of silver (Ag) ions in the form of silver chloride (AgCl). The silver chloride (AgCl) can be removed by filtration.

[0135] When the concentration of chlorine (Cl) is less than 1 ppm, silver (Ag) ions cannot be removed well. On the other hand, when the concentration of chlorine (Cl) is higher than 60 ppm, unnecessary reaction may occur due to the excessive chlorine (Cl). Accordingly, the concentration of chlorine (Cl) in the electrolyte 11 is controlled to the range of 1 to 60 ppm. More specifically, the concentration of chlorine (Cl) may be controlled to 25 ppm or less, for example, the range of 5 to 25 ppm.

[0136] The concentration of arsenic (As) ions in the electrolyte 11 is controlled to 2 g/L or less. The arsenic (As) in the electrolyte 11 may be, for example, present as a trivalent ion (As^{3+}), but one embodiment of the present disclosure is not limited thereto.

[0137] Arsenic (As) ions function as an accelerator to facilitate reduction reaction of copper (Cu) within a predetermined concentration range. When the concentration of arsenic (As) ions is 2 g/L or less, in the step of forming the copper layer 110, the (220) plane is first grown, based on crystal planes.

[0138] On the other hand, when the concentration of arsenic (As) ions is higher than 2 g/L, insoluble compounds may be produced during reduction of copper ions such as Cu^{2+} or Cu^{+} into copper (Cu) and may be deposited (incorporated) together with impurities on the copper layer 110. In addition, when the concentration of arsenic (As) ions is high, in the step of forming the copper layer 110, (311), (111) and (100) planes, based on crystal planes, may be grown first, while growth of the (220) plane may be suppressed.

[0139] Accordingly, in order to adjust the ratio of a texture coefficient (TC) of (220) plane [TC(220)] to a total of texture coefficients (TC) of (111), (200), (220) and (311) planes [TCR(220)] to the range of 5 to 30%, in the crystal structure of the copper layer 110, the concentration of arsenic (As) ions in the electrolyte 11 is adjusted to 2 g/L or less.

[0140] Meanwhile, according to an embodiment of the present disclosure, for crystal orientation of the copper layer 110, arsenic (As) ions in the electrolyte 11 may have a concentration of 0.1 g/L or more. That is, arsenic (As) ions in the electrolyte 11 may have a concentration of 0.1 to 2 g/L.

[0141] The organic additive included in the electrolyte 11 includes at least one of a polishing agent (ingredient A), a speed reducer (ingredient B), a leveling agent (ingredient C) or a roughness regulator (ingredient D). The organic additive in the electrolyte 11 has a concentration of 1 to 150 ppm.

[0142] The organic additive may include two or more of the polishing agent (ingredient A), the speed reducer (ingredient B), the leveling agent (ingredient C) or the roughness regulator (ingredient D), and may include all of the four ingredients. In any case, the concentration of the organic additive is 150 ppm or less. When the organic additive includes all of the polishing agent (ingredient A), the speed reducer (ingredient B), the leveling agent (ingredient C) and the roughness regulator (ingredient D), the organic additive may have a concentration of 10 to 150 ppm.

[0143] The polishing agent (ingredient A) includes sulfonic acid or a metal salt thereof. The polishing agent (ingredient A) may have a concentration of 1 to 50 ppm in the electrolyte 11.

[0144] The polishing agent (ingredient A) can increase the amount of electric charges of the electrolyte 11 to improve the plating speed of copper, and can enhance curl characteristics of the copper foil and luster of the copper foil 102. When the concentration of polishing agent (ingredient A) is less than 1 ppm, the luster of the copper foil 102 is deteriorated and, when the concentration is higher than 50 ppm, roughness of the copper foil 102 may be improved and strength thereof may be deteriorated.

[0145] More specifically, the polishing agent (ingredient A) may have a concentration of 5 to 30 ppm in the electrolyte 11.

[0146] The polishing agent includes, for example, at least one selected from a bis-(3-sulfopropyl)-disulfide disodium salt (SPS), 3-mercapto-1-propanesulfonic acid, a 3-(N,N-dimethylthiocarbamoyl)-thiopropanesulfonate sodium salt, a 3-[(amino-iminomethyl)thio]-1-propanesulfonate sodium salt, an o-ethyldithiocarbonato-S-(3-sulfopropyl)-ester sodium salt, a 3-(benzothiazolyl-2-mercapto)-propyl-sulfonic acid sodium salt and an ethylenedithiodipropylsulfonic acid sodium salt.

[0147] The speed reducer (ingredient B) includes a non-ionic water-soluble polymer. The speed reducer (ingredient B) may have a concentration of 5 to 50 ppm in the electrolyte 11.

[0148] The speed reducer (ingredient B) reduces the plating speed of copper to prevent a rapid increase in roughness and deterioration in strength of the copper foil 102. Such a speed reducer (ingredient B) is also called an "inhibitor" or "suppressor".

[0149] When the concentration of the speed reducer (ingredient B) is lower than 5 ppm, there may occur problems in which the roughness of the copper foil 102 is rapidly increased and the strength of the copper foil 102 is deteriorated. On the other hand, although the concentration of speed reducer (ingredient B) is higher than 50 ppm, there is almost no variation in physical properties such as appearance, luster, roughness, strength and elongation of the copper foil 102. Accordingly, without increasing manufacturing costs and wasting raw materials due to unnecessary increase in concentration of the speed reducer (ingredient B), the concentration of the speed reducer (ingredient B) can be adjusted to the range of 5 to 50 ppm.

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[0150] The speed reducer (ingredient B) may, for example, include at least one non-ionic water-soluble polymer selected from polyethylene glycol (PEG), polypropylene glycol, a polyethylene-polypropylene copolymer, polyglycerine, polyethylene glycol dimethyl ether, hydroxyethyl cellulose, polyvinyl alcohol, stearic acid polyglycol ether and stearyl alcohol polyglycol ether. However, the type of the speed reducer is not limited thereto and other non-ionic water-soluble polymers that can be used to manufacture the high-strength copper foil 102 can be used as a speed reducer.

[0151] The non-ionic water-soluble polymer used as the speed reducer (ingredient B) may have a number average molecular weight of 500 to 25,000. When the number average molecular weight of the speed reducer (ingredient B) is lower than 500, the effects of the speed reducer (ingredient B) on preventing a rapid increase in roughness and a deterioration in strength of the copper foil 102 are insufficient and, when the molecular weight of ingredient B is higher than 25,000, the copper layer 110 cannot be readily formed due to high molecular weight of the speed reducer (ingredient B).

[0152] More specifically, the non-ionic water-soluble polymer used as the speed reducer (ingredient B) may have a molecular weight of 1,000 to 10,000.

[0153] The leveling agent (ingredient C) includes at least one of nitrogen (N) and sulfur (S). That is, the leveling agent (ingredient C) may include one or more nitrogen atoms (N), or one or more sulfur atoms (S) in one molecule and may include one or more nitrogen atoms (N) and one or more sulfur atoms (S). For example, the leveling agent (ingredient C) is an organic compound including at least one of nitrogen (N) and sulfur (S).

[0154] The leveling agent (ingredient C) prevents formation of excessively high peaks or excessively large protrusions in the copper layer 110 to enable the copper layer 110 to be entirely even. The leveling agent (ingredient C) may have a concentration of 1 to 20 ppm in the electrolyte 11.

[0155] When the concentration of the leveling agent (ingredient C) is less than 1 ppm, the strength of the copper foil 102 is deteriorated, which makes it difficult to manufacture a high-strength copper foil 102. On the other hand, when the concentration of the leveling agent (ingredient C) is higher than 20 ppm, strength may be deteriorated due to excessively increased surface roughness of the copper foil 102, and separation of the manufactured copper foil 102 from a winder (WR) may be difficult due to pinholes or curl generated on the surface of the copper foil 102.

[0156] The leveling agent (ingredient C) may include, for example, at least one selected from thiourea (TU), diethylthiourea, ethylene thiourea, acetylene thiourea, dipropylthiourea, dibutylthiourea, N-trifluoroacetylthiourea, N-ethylthiourea, N-cyanoacetyl thiourea, N-allylthiourea, o-tolylthiourea, N,N'-butylene thiourea, thiazolidinethiol, 4-thiazolinethiol, 4-methyl-2-pyrimidinethiol, 2-thiouracil, 3-(benzotriazole-2-mercapto)-pyrosulfuric acid, 2-mercaptopyridine, 3-(5-mercapto-1H-tetrazole)benzenesulfonate, 2-mercaptobenzothiazole, dimethylpyridine, 2,2'-bipyridine, 4,4'-bipyridine, pyrimidine, pyridazine, pyrinoline, oxazole, thiazole, 1-methylimidazole, 1-benzylimidazole, 1-methyl-2-methylimidazole, 1-benzyl-2-methylimidazole, 1-ethyl-4-methylimidazole, N-methylpyrrole, N-ethylpyrrole, N-butylpyrrole, N-methylpyrroline, N-ethylpyrroline, N-butylpyrroline, purine, quinoline, isoquinoline, N-methylcarbazole, N-ethylcarbazole and N-butylcarbazole.

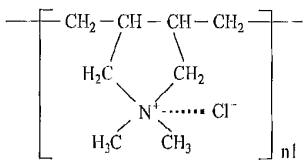
[0157] The roughness regulator (ingredient D) includes a nitrogen-containing heterocyclic quaternary ammonium salt or a derivative thereof.

[0158] The roughness regulator (ingredient D) improves gloss (luster) and evenness of the copper foil 102. The roughness regulator (ingredient D) may have a concentration of 1 to 30 ppm in the electrolyte 11.

[0159] When the concentration of the roughness regulator (ingredient D) is less than 1 ppm, the effects of improving gloss (luster) and evenness of the copper foil 102 may not be obtained. On the other hand, when the concentration of the roughness regulator (ingredient D) is higher than 30 ppm, problems of non-uniform surface luster and rapidly increased surface roughness may occur in the direction of the first surface S1, that is, the matte surface MS of the copper foil 100 and it may be difficult to secure the desired roughness range. More specifically, the roughness regulator (ingredient D) may have a concentration of 3 to 20 ppm in the electrolyte 11.

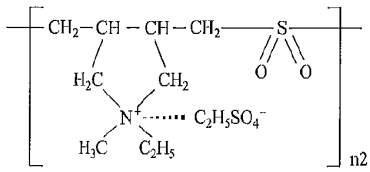
[0160] The roughness regulator (ingredient D) may include at least one of the compounds represented by the following Formulae 1 to 5:

[Formula 1]

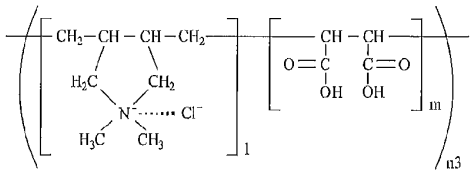


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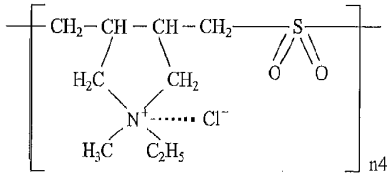
[Formula 2]



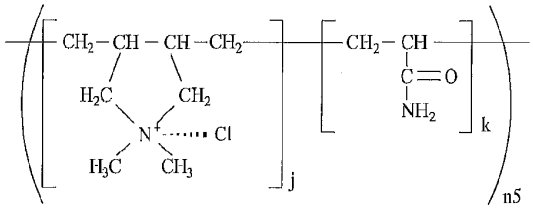
[Formula 3]



[Formula 4]



[Formula 5]



[0161] wherein j, k, 1, m and n1 to n5 each represent repeat units, are an integer of 1 or higher and are identical to or different from one another.

[0162] According to an embodiment of the present disclosure, the compounds represented by Formulae 1 to 5 may each have a number average molecular weight of 500 to 50,000.

[0163] When the number average molecular weight of compounds represented by Formulae 1 to 5 used as the roughness regulator is less than 500, surface roughness of the copper foil 102 is increased due to high ratio of monomers. When the content of the roughness regulator is low, luster and evenness may be deteriorated due to high surface roughness of the matte surface of the copper layer 110.

[0164] When the number average molecular weight of the compounds represented by Formulae 1 to 5 is higher than 50,000, the surface roughness deviation of the copper foil 102 is increased. In this case, although the concentration of other additives is controlled, it is difficult to suppress an increase in surface roughness deviation in the direction of the matte surface of the copper foil 102.

[0165] The compounds represented by Formulae 1 to 5 may, for example, be prepared by polymerization or copoly-

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merization using diallyl dimethyl ammonium chloride (DDAC).

[0166] The compound represented by Formula 1 may be PAS-H-1L (MW 8500, Nitto Boseki Co., Ltd.) or the like.

[0167] The compound represented by Formula 2 may be, for example, PAS-2451 (MW 30,000, Nitto Boseki Co., Ltd.), PAS-2401 (MW 2,000, Nitto Boseki Co., Ltd.) or the like.

[0168] The compound represented by Formula 3 may be, for example, PAS-2351 (MW 25,000, Nitto Boseki Co., Ltd.) or the like.

[0169] The compound represented by Formula 4 may be, for example, PAS-A-1 (MW 5,000, Nitto Boseki Co., Ltd.), PAS-A-5 (MW 4,000, Nitto Boseki Co., Ltd.) or the like.

[0170] The compound represented by Formula 5 may be, for example, PAS-J-81L (MW 10,000, Nitto Boseki Co., Ltd.), PAS-J-41 (MW 10,000, Nitto Boseki Co., Ltd.) or the like.

[0171] As the concentration of TOC in the electrolyte 11 increases, the amount of carbon (C) incorporated into the copper layer 110 increases, which causes an increase in the total amount of elements detached from the copper layer 110 during heat-treatment and thus deterioration in the strength of the copper foil 102.

[0172] According to an embodiment of the present disclosure, by controlling the concentration of the organic additive, in particular, the organic additive including nitrogen (N) or sulfur (S), a predetermined amount of carbon (C), hydrogen (H), nitrogen (N) or sulfur (S) can be incorporated into the copper layer 110. This incorporation enables the crystal orientation of the copper layer 110 to be regulated.

[0173] The step of forming the copper layer may include at least one of filtering the electrolyte through activated carbon, filtering the electrolyte through diatomite, and treating the electrolyte with ozone (O_3).

[0174] Specifically, so as to filter the electrolyte 11, the electrolyte 11 may be circulated at a flow rate of 35 to 45 m^3/hour. That is, in order to remove solid impurities present in the electrolyte 11 during electroplating to form the copper layer 110, the filtering may be conducted at a flow rate of 35 to 45 m^3/hour. At this time, activated carbon or diatomite may be used.

[0175] In order to maintain clearness of the electrolyte 11, the electrolyte 11 may be treated with ozone (O_3).

[0176] In addition, in order to maintain clearness of the electrolyte 11, a copper (Cu) wire used as a raw material for the electrolyte 11 may be cleaned.

[0177] According to an embodiment of the present disclosure, the step of preparing an electrolyte may include heat-treating a copper wire, cleaning the heat-treated copper wire with an acid, cleaning the acid-cleaned copper wire with water, and injecting the water-cleaned copper wire into sulfuric acid for an electrolyte.

[0178] More specifically, in order to maintain clearness of the electrolyte 11, a Cu wire with a high purity (99.9% or more) is heat-treated in an electric furnace at 750°C to 850°C to burn various organic impurities present on the Cu wire, the heat-treated Cu wire is acid-cleaned with a 10% sulfuric acid solution for 10 to 20 minutes, and the acid-cleaned Cu wire is then water-cleaned with distilled water, thereby obtaining a copper for manufacturing the electrolyte 11. The water-cleaned Cu wire is injected into sulfuric acid for an electrolyte to produce an electrolyte 11.

[0179] According to an embodiment of the present disclosure, so as to satisfy the requirements for the copper foil 102, the concentration of total organic carbon (TOC) in the electrolyte 11 is adjusted to 200 ppm or less. That is, the electrolyte 11 may have a total organic carbon (TOC) concentration of 200 ppm or less.

[0180] The copper layer 110 thus produced may be cleaned in a cleaning bath 20.

[0181] For example, acid cleaning to remove impurities, for example, resin ingredients or natural oxide on the surface of the copper layer 110 and water cleaning to remove the acidic solution used for acid cleaning may be sequentially conducted. The cleaning process may be omitted.

[0182] Then, anticorrosive layers 211 and 212 are formed on the copper layer 110.

[0183] Referring to FIG. 7, the copper layer 110 is dipped in an anticorrosive liquid 31 contained in an anticorrosion bath 30, to form anticorrosive layers 211 and 212 on the copper layer 110. Here, the anticorrosive liquid 31 includes chromium and chromium (Cr) may be present in the form of an ion in the anticorrosive liquid 31.

[0184] The anticorrosive liquid 31 may include 1 to 10 g/L of chromium. So as to form the anticorrosive layers 211 and 212, the temperature of the anticorrosive solution 31 can be maintained at 20 to 40°C. The copper layer 110 may be dipped in the anticorrosive liquid 31 for about 1 to about 30 seconds.

[0185] Meanwhile, the anticorrosive layers 211 and 212 may include a silane compound via treatment with silane and a nitrogen compound via treatment with nitrogen.

[0186] The copper foil 200 is produced by formation of these anticorrosive layers 211 and 212.

[0187] Then, the copper foil 200 is cleaned in a cleaning bath 40. Such a cleaning process may be omitted.

[0188] Then, a drying process is preformed and the copper foil 200 is then wound on a winder (WR).

[0189] Hereinafter, the present disclosure will be described in more detail with reference to Production examples and Comparative Examples. The following Production examples and Comparative Examples are only provided only for better understanding of the present disclosure and should not be construed as limiting the scope of the present disclosure.

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Production examples 1-4 and Comparative Examples 1-4

[0190] A copper foil was produced using a foil making machine which included an electrolytic bath 10, a rotary electrode drum 12 disposed in the electrolytic bath 10, and an electrode plate 13 spaced from the rotary electrode drum 12. The electrolyte 11 was a copper sulfate solution, the copper ion concentration of the electrolyte 11 was 87 g/L, a sulfuric acid concentration was 110 g/L, the temperature of the electrolyte 11 was maintained at 55°C and current density was set at 60 ASD.

[0191] In addition, concentrations of arsenic (As) ions (As^{3+}), chlorine (Cl) and organic additive included in the electrolyte 11 are shown in the following Table 1.

[0192] Regarding the organic additive, the polishing agent (ingredient A) used herein was bis-(3-sulfopropyl)-disulfide disodium salt (SPS), the speed reducer (ingredient B) used herein was polyethylene glycol (PEG), the leveling agent (ingredient C) used herein was ethylene thiourea (ETU) and N-ethyl thiourea (NETU), and the roughness regulator (ingredient D) used herein was a triaryl methyl ethyl ammonium ethyl sulfide maleic acid copolymer (PAS-2451™, Nitto Boseki Co., Ltd., MW. 30,000).

[0193] A current density of 60 ASD was applied between the rotary electrode drum 12 and the electrode plate 13 to form a copper layer 110. Then, the copper layer 110 was dipped in an anticorrosive liquid for about 2 seconds to treat the surface of the copper layer 110 with chromium, to thereby form anticorrosive layers 211 and 212. As a result, a copper foil 102 was produced. An anticorrosive liquid including chromium (Cr) as a main ingredient was used as the anticorrosive liquid 31, and the concentration of chromate was 5 g/L.

[0194] As a result, copper foils according to Production examples 1-4 and Comparative Examples 1-4 were produced.

TABLE 1

	AS^{3+} (g/L)	Cl (ppm)	SPS (ingredient A) (ppm)	PEG (ingredient B) (ppm)	ETU (ingredient C) (ppm)	NETU (ingredient C) (ppm)	PAS-2451 (ingredient D) (ppm)
Production example 1	0.3	17	5	15	1	-	5
Production example 2	1	22	25	30	-	10	-
Production example 3	0.6	5	-	-	-	2	-
Production example 4	1.9	45	10	12	8	-	-
Comparative Example 1	2.1	20	5	15	22	-	10
Comparative Example 2	0.5	18	55	35	-	-	35
Comparative Example 3	1.2	5	-	-	-	25	-
Comparative Example 4	2.5	70	15	15	3		5

ETU: Ethylene thiourea
NETU: (N-ethyl thiourea)
PAS-2451: triaryl methyl ethyl ammonium ethyl sulfide maleic acid copolymer (Nitto Boseki Co., Ltd., MW 30, 000)

[0195] (i) Residual stress, (ii) ratio [TCR(220)] of texture coefficient of (220) plane [TC(220)], (iii) elongation after heat-treating, (iv) difference in surface roughness Ra between first and second surfaces of the copper foil, and (v) curl of the copper foil, of the copper foils of Production examples 1-4 and Comparative Examples thus produced were measured.

[0196] In addition, secondary batteries were manufactured using the copper foils, were charged and discharged, were then disassembled, and (vi) whether or not wrinkles occurred was observed.

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(i) Measurement of residual stress

[0197] Residual stress of the copper foils was measured using X-ray diffraction (XRD). More specifically, the residual stress of each crystal plane was measured using X-ray diffraction (XRD) of the crystal plane of the copper layer 110.

[0198] X-ray diffraction analysis conditions regarding the copper foil at room temperature are given below:

Measurement device (model name): Bruker D8 DISCOVER

Target: 3 kW X-ray tube with Cu target

Power: 40 kV, 40 mA

Wavelength: 1.5406Å

Measurement range: 30 to 100 degrees

Scan axis: Theta-2Theta

Scan speed: 2 deg/min

[0199] Specifically, residual stress measurement conditions of crystal planes of the copper layer 110 constituting the copper foil are shown in the following Table 2.

TABLE 2

Anode material	Cu
K-Alphal wavelength	1.540598
K-Alpha2 wavelength	1.544426
Ratio K-Alpha2/K-Alpha1	0.5
Divergence slit	Fixed 3.00 mm
Monochromator used	YES
Generator voltage	40
Tube current	20
Scan axis	Psi
Scan range	-74.75 to 74.75
Scan step size	0.5
No. of points	299
Scan type	CONTINUOUS
2Theta	89.9805
Omega	44.9903
Phi	0
X	2
Y	4
Z	9.175
Time per step	3

(ii) Measurement of ratio [TCR(220)] of texture coefficient of (220) plane [TC(220)]

[0200] The ratio [TCR(220)] of a texture coefficient (TC) of (220) plane [TC(220)] to a total of texture coefficients (TC)

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of (111), (200), (220) and (311) planes, which were crystal planes of the copper layer 110 constituting the copper foils produced in Production examples 1-4 and Comparative Examples 1-4, was measured.

[0201] First, an XRD graph having peaks corresponding to n crystal planes was obtained by X-ray diffraction (XRD) within a diffraction angle (2θ) range of 30° to 95° [Target: Copper K alpha 1, 2θ interval: 0.01°, 2θ scan speed: 3°/min]. Referring to FIG. 2A, in the case of the copper layer 110, an XRD graph including four peaks corresponding to (111), (200), (220) and (311) planes was obtained. In this case, n was 4.

[0202] Then, from this graph, XRD diffraction intensity [I(hkl)] of each crystal plane (hkl) was obtained. Subsequently, XRD diffraction intensities [I_0(hkl)] of n respective crystal planes of a standard copper powder regulated by Joint Committee On Powder Diffraction Standards (JCPDS) were obtained. Subsequently, the arithmetic mean value of "I(hkl)/I_0(hkl)" of n crystal planes was calculated and I(111)/I_0(111) of the (111) plane was divided by the arithmetic mean value to calculate the texture coefficient of (111) plane [TC(111)]. That is, the texture coefficient of (111) plane [TC(111)] was calculated based on the following Equation 1:

[Equation 1]

$$TC(111) = \frac{\frac{I(111)}{I_0(111)}}{\frac{1}{n}\sum\frac{I(hkl)}{I_0(hkl)}}$$

[0203] In the same manner, the texture coefficient of (200) plane [TC(200)] was calculated based on the following Equation 2:

[Equation 2]

$$TC(200) = \frac{\frac{I(200)}{I_0(200)}}{\frac{1}{n}\sum\frac{I(hkl)}{I_0(hkl)}}$$

[0204] In the same manner, the texture coefficient of (220) plane [TC(220)] was calculated based on the following Equation 3:

[Equation 3]

$$TC(220) = \frac{\frac{I(220)}{I_0(220)}}{\frac{1}{n}\sum\frac{I(hkl)}{I_0(hkl)}}$$

[0205] In the same manner, the texture coefficient of (311) plane [TC(311)] is calculated based on the following Equation 4:

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[Equation 4]

$$TC(311) = \frac{\frac{I(311)}{I_0(311)}}{\frac{1}{n}\sum\frac{I(hkl)}{I_0(hkl)}}$$

[0206] Then, a ratio TCR(220) of a texture coefficient (TC) of (220) crystal plane of the copper layer to a total of texture coefficients (TC) of (111), (200), (220) and (311) planes of crystal planes of the copper layer 110 was calculated in accordance with the following Equation 5:

[Equation 5]

$$TCR(220) = \frac{TC(220)}{TC(111) + TC(200) + TC(220) + TC(311)}$$

(iii) Measurement of elongation after heat-treatment

[0207] The elongations of the copper foils 101 produced in Production examples 1-4 and Comparative Examples 1-4 were measured after heat-treatment at 130°C for 30 minutes.

[0208] The elongation was measured with a universal testing machine (UTM) in accordance with the regulations of the IPC-TM-650 test method manual. Specifically, the elongation was measured with a universal testing machine available from instron corporation. At this time, the width of a sample for measuring elongation was 12.7 mm, the distance between grips was 50 mm and the measurement speed was 50 mm/min.

(iv) Difference (Δ Ra) in surface roughness Ra between first and second surfaces of copper foil

[0209] Surface roughness (Ra) of the first surface S1 and the second surface S2 of the copper foils produced in Production examples 1-4 and Comparative Examples 1-4 was measured using a surface roughness measurement device (M300, Mahr) in accordance with the specifications of JIS B 0601-2001. The difference (Δ Ra) in surface roughness Ra between the first surface S1 and the second surface S2 of the copper foil was calculated using the measured results.

(v) Measurement of curl of copper foil

[0210] The copper foils produced in Production examples 1-4 and Comparative Examples 1-4 were cut in a width direction to produce samples (30 cm X 30cm). Each sample was disposed on a support such that a first surface S1 disposed in the direction of a matte surface MS of the sample was directed upward and the height of the sample from the support was measured. An average of heights measured at four spots of the sample was calculated and a curl value of copper foil was determined.

(vi) Observation of wrinkles and tears

1) Anode production

[0211] 100 parts by weight of a commercially available silicon/carbon composite anode material for an anode active material was mixed with 2 parts by weight of styrene butadiene rubber (SBR) and 2 parts by weight of carboxymethyl cellulose (CMC), and a slurry for an anode active material was prepared using distilled water as a solvent. Copper foils with a width of 10 cm produced in Production examples 1-4 and Comparative Examples 1-4 were coated to a thickness of 40 μm with the slurry for an anode active material using a doctor blade, dried at 120°C, and pressed at a pressure of 1 ton/cm^2 to produce an anode for secondary batteries.

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2) Electrolyte production

[0212] $LiPF_6$ as a solute was dissolved at a concentration of 1M in a non-aqueous organic solvent consisting of ethylene carbonate (EC) and ethyl methyl carbonate (EMC) mixed in a ratio of 1:2 to prepare a basic electrolyte. 99.5% by weight of the basic electrolyte was mixed with 0.5% by weight of succinic anhydride to prepare a non-aqueous electrolyte.

3) Cathode production

[0213] Lithium manganese oxide ($Li_{1.1}Mn_{1.85}Al_{0.05}O_4$) was mixed with lithium manganese oxide (o-$LiMnO_2$) having an orthorhombic crystal structure in a weight ratio of 90:10 to produce a cathode active material. The cathode active material, carbon black, and PVDF [poly(vinylidene fluoride)] as a binder were mixed in a weight ratio of 85:10:5, and the resulting mixture was mixed with NMP as an organic solvent to prepare a slurry. Both surfaces of an Al foil with a thickness of 20 μm were coated with the slurry thus prepared and then dried to produce a cathode.

4) Production of lithium secondary battery for testing

[0214] The cathode and the anode were disposed in an aluminum can such that the cathode and the anode were insulated with the aluminum can, and a non-aquecus electrolyte and a separator were disposed therebetween to produce a coin-type lithium secondary battery. The separator used herein was polypropylene (Celgard 2325; thickness: 25 μm, average pore size: Φ28 nm, porosity: 40%).

5) Charge/discharge of secondary battery

[0215] The lithium secondary battery thus produced was operated at a charge voltage of 4.3V and a discharge voltage of 3.4V and were subjected to 100 charge-discharge cycles at a high temperature of 50°C at a current rate (C-rate) of 0.2C.

6) Observation of occurrence of wrinkles or tears

[0216] After 100 charge/discharge cycles, the lithium secondary battery was disassembled and whether or not wrinkles or tears occurred in the copper foil was observed. In particular, a case in which wrinkles or tears occurred is designated as "occurrence", while a case in which wrinkles or tears did not occur was designated as "no".

[0217] Test results are shown in Tables 3 and 4 below.

TABLE 3

Item	Residual stress (Mpa)				TCR (220) (%)	Elongation after heat-treatment
	(111) plane	(200) plane	(220) plane	(311) plane		
Example 1	2.9	2.4	2.4	2.2	15.4	8.6
Example 2	16.2	15.7	16.1	15.1	7.9	6.5
Example 3	7.8	8.9	7.9	8.2	22.2	5.8
Example 4	23.1	23.5	22.5	24.3	19.3	3.6
Comparative Example 1	27.1	16.6	17.6	17.2	2.1	2.9
Comparative Example 2	33.1	28.8	29.9	31.1	7.7	3.4
Comparative Example 3	25.5	28.2	27.1	27.2	14.6	1.9
Comparative Example 4	-7.7	-8.1	-7.9	-8.3	2.6	2.4

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TABLE 4

Item	Ra of first surface (μm)	Ra of second surface (μm)	ΔRa (μm)	Curl (mm)	Wrinkle	Tear
Example 1	0.26	0.24	0.02	10	No	No
Example 2	0.27	0.25	0.02	8	No	No
Example 3	0.24	0.25	0.01	18	No	No
Example 4	0.26	0.27	0.01	9	No	No
Comparative Example 1	0.31	0.19	0.12	19	No	Occurrence
Comparative Example 2	0.66	0.14	0.52	26	Occurrence	Occurrence
Comparative Example 3	0.33	0.22	0.11	Curled	No	Occurrence
Comparative Example 4	0.28	0.26	0.02	5	Occurrence	Occurrence

[0218] The following results can be seen from Tables 1, 3 and 4.

[0219] The copper foil of Comparative Example 1 produced from the electrolyte including excessive amounts of arsenic (As) ions and the leveling agent (ingredient C) was torn.

[0220] The copper foil of Comparative Example 2 produced from the electrolyte including excessive amounts of polishing agent (ingredient A) and roughness regulator (ingredient D) had a high residual stress and was both curled and torn.

[0221] The copper foil of Comparative Example 3 produced from the electrolyte including only an excessive amount of leveling agent (ingredient C) as an organic additive had a high residual stress, and was both curled and torn.

[0222] The copper foil of Comparative Example 4 produced from the electrolyte including excessive amounts of arsenic (As) ions and chlorine (Cl) was wrinkled and torn.

[0223] On the other hand, copper foils of Production examples 1-4 according to the present disclosure showed a curl of 20 mm or less, and were neither wrinkled nor torn.

[0224] Although the preferred embodiments of the present disclosure have been disclosed for illustrative purposes, those skilled in the art will appreciate that various modifications, additions and substitutions are possible, without departing from the scope and spirit of the disclosure as disclosed in the accompanying claims.

[Reference Numerals]

[0225]

101, 102: copper foil
211, 212: anticorrosive layer
310, 320: active material layer
103: 104: electrode for secondary batteries
MS: matte surface
SS: shiny surface

Claims

1. A copper foil comprising:

a copper layer having a matte surface and a shiny surface; and
an anticorrosive layer disposed on the copper layer,
wherein the copper foil has a residual stress of 0.5 to 25 Mpa, based on absolute value, and
the copper layer has a plurality of crystal planes,
wherein a ratio [TCR(220)] of a texture coefficient (TC) of (220) crystal plane of the copper layer to a total of texture coefficients (TC) of (111), (200), (220) and (311) crystal planes of the copper layer is 5 to 30%.

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2. The copper foil according to claim 1, wherein the residual stress is measured in at least one of the (111), (200), (220) and (311) planes.

3. The copper foil according to claim 1, wherein the residual stress is measured in the (311) plane.

4. The copper foil according to claim 1, wherein the copper foil has an elongation of 2 to 20% after heat-treatment at 130°C for 30 minutes.

5. The copper foil according to claim 1, wherein the copper foil has a first surface corresponding to the direction of the matte surface and a second surface corresponding to the direction of the shiny surface,
wherein a difference in surface roughness (Ra) between the first surface and the second surface is 0.5 μm or less.

6. The copper foil according to claim 1, wherein the copper foil has a thickness of 4 to 20 μm.

7. The copper foil according to claim 1, wherein the anticorrosive layer comprises at least one of chromium, a silane compound or a nitrogen compound.

8. An electrode for secondary batteries comprising:

a copper foil; and
an active material layer disposed on the copper foil,
wherein the copper foil is the copper foil according to any one of claims 1 to 7.

9. A secondary battery comprising:

a cathode;
an anode facing the cathode;
an electrolyte disposed between the cathode and the anode to provide an environment enabling lithium ions to move; and
a separator to electrically insulate (isolate) the cathode from the anode,
wherein the anode comprises:

the copper foil according to any one of claims 1 to 7; and
an active material layer disposed on the copper foil.

10. A method for manufacturing a copper foil comprising:

preparing an electrolyte comprising copper ions; and
applying a current density of 30 to 70 ASD (A/dm^2) to an electrode plate and a rotary electrode drum spaced from each other in the electrolyte, to form a copper layer,
wherein the electrolyte comprises:

70 to 100 g/L of the copper ions;
70 to 150 g/L of sulfuric acid;
1 to 60 ppm of chlorine (Cl);
2 g/L or less of arsenic (As) ions; and
an organic additive,

wherein the organic additive comprises at least one of a polishing agent (ingredient A), a speed reducer (ingredient B), a leveling agent (ingredient C) or a roughness regulator (ingredient D),
wherein the polishing agent (ingredient A) comprises sulfonic acid or a metal salt thereof,
the speed reducer (ingredient B) comprises a non-ionic water-soluble polymer,
the leveling agent (ingredient C) comprises at least one of nitrogen (N) or sulfur (S), and
the roughness regulator (ingredient D) comprises a nitrogen-containing heterocyclic quaternary ammonium salt or a derivative thereof.

11. The method according to claim 10, wherein the organic additive has a concentration of 1 to 150 ppm.

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12. The method according to claim 10, wherein the polishing agent comprises at least one selected from a bis-(3-sulfopropyl)-disulfide disodium salt (SPS), 3-mercapto-1-propanesulfonic acid, a 3-(N,N-dimethylthiocarbamoyl)-thiopropanesulfonate sodium salt, a 3-[(amino-iminomethyl)thio]-1-propanesulfonate sodium salt, an o-ethyldithiocarbonato-S-(3-sulfopropyl)-ester sodium salt, a 3-(benzothiazolyl-2-mercapto)-propyl-sulfonic acid sodium salt and an ethylenedithiodipropylsulfonic acid sodium salt.

13. The method according to claim 10, wherein the polishing agent has a concentration of 1 to 50 ppm.

14. The method according to claim 10, wherein the speed reducer comprises at least one non-ionic water-soluble polymer selected from polyethylene glycol (PEG), polypropylene glycol, a polyethylene-polypropylene copolymer, polyglycerine, polyethylene glycol dimethyl ether, hydroxyethyl cellulose, polyvinyl alcohol, stearic acid polyglycol ether and stearyl alcohol polyglycol ether.

15. The method according to claim 14, wherein the non-ionic water-soluble polymer has a number average molecular weight of 500 to 25,000.

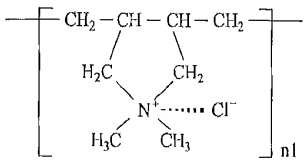
16. The method according to claim 10, wherein the speed reducer has a concentration of 5 to 50 ppm.

17. The method according to claim 10, wherein the leveling agent comprises at least one selected from thiourea (TU), diethylthiourea, ethylene thiourea, acetylene thiourea, dipropylthiourea, dibutylthiourea, N-trifluoroacetylthiourea, N-ethylthiourea, N-cyanoacetyl thiourea, N-allylthiourea, o-tolylthiourea, N,N'-butylene thiourea, thiazolidinethiol, 4-thiazolinethiol, 4-methyl-2-pyrimidinethiol, 2-thiouracil, 3-(benzotriazole-2-mercapto)-pyrosulfuric acid, 2-mercaptopyridine, 3-(5-mercapto-1H-tetrazole)benzenesulfonate, 2-mercaptobenzothiazole, dimethylpyridine, 2,2'-bipyridine, 4,4'-bipyridine, pyrimidine, pyridazine, pyrinoline, oxazole, thiazole, 1-methylimidazole, 1-benzylimidazole, 1-methyl-2-methylimidazole, 1-benzyl-2-methylimidazole, 1-ethyl-4-methylimidazole, N-methylpyrrole, N-ethylpyrrole, N-butylpyrrole, N-methylpyrroline, N-ethylpyrroline, N-butylpyrroline, purine, quinoline, isoquinoline, N-methylcarbazole, N-ethylcarbazole and N-butylcarbazole.

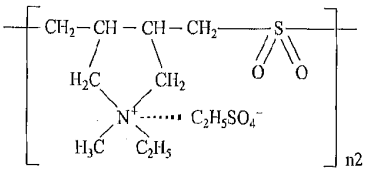
18. The method according to claim 10, wherein the leveling agent has a concentration of 1 to 20 ppm.

19. The method according to claim 10, wherein the roughness regulator comprises at least one of compounds represented by the following Formulae 1 to 5:

[Formula 1]

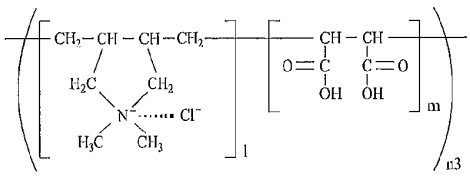


[Formula 2]

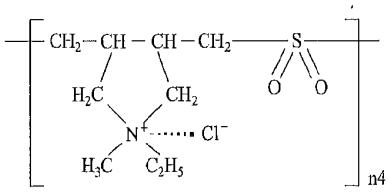


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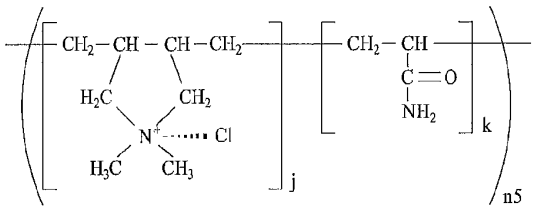
[Formula 3]



[Formula 4]



[Formula 5]



wherein j, k, 1, m and n1 to n5 each represent repeat units, are an integer of 1 or higher and are identical to or different from one another.

20. The method according to claim 19, wherein the compounds represented by Formulae 1 to 5 each have a number average molecular weight of 500 to 50,000.

21. The method according to claim 10, wherein the roughness regulator has a concentration of 1 to 30 ppm.

22. The method according to claim 10, wherein the electrolyte has a total organic carbon (TOC) concentration of 200 ppm or less.

23. The method according to claim 10, wherein the step of forming a copper layer comprises at least one of filtering the electrolyte through activated carbon, filtering the electrolyte through diatomite, or treating the electrolyte with ozone (O_3).

24. The method according to claim 10, wherein the step of preparing an electrolyte comprises:

heat-treating a copper wire;
cleaning the heat-treated copper wire with an acid;
cleaning the acid-cleaned copper wire with water; and
injecting the water-cleaned copper wire into sulfuric acid for an electrolyte.

25. The method according to claim 10, further comprising forming an anticorrosive layer on the copper layer.

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FIG. 1

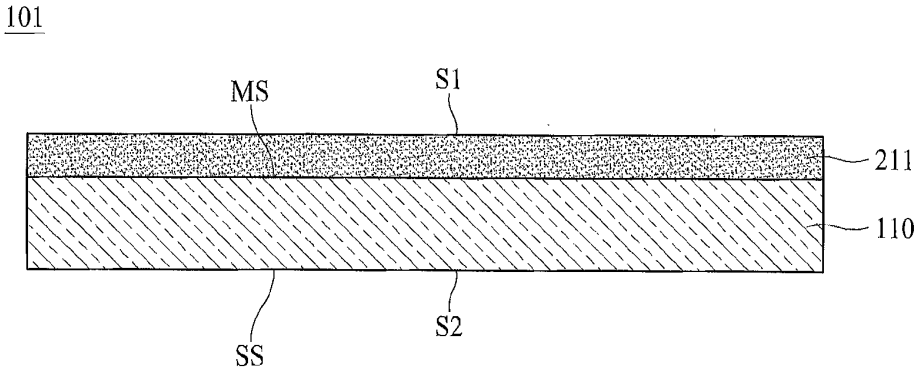
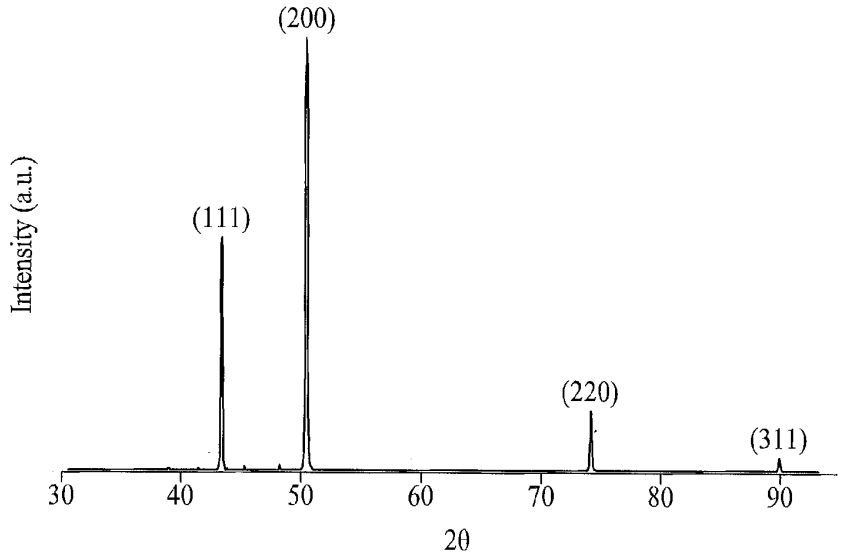


FIG. 2A



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FIG. 2B

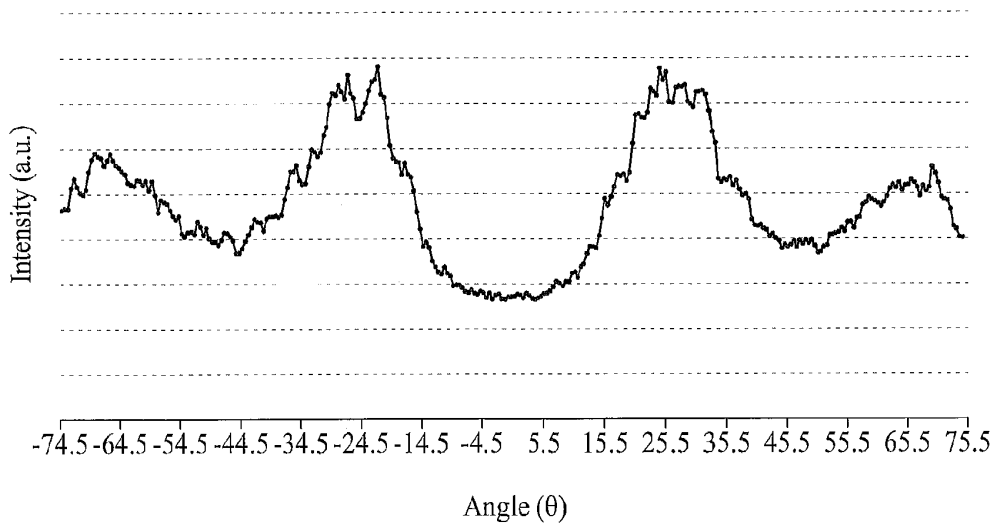
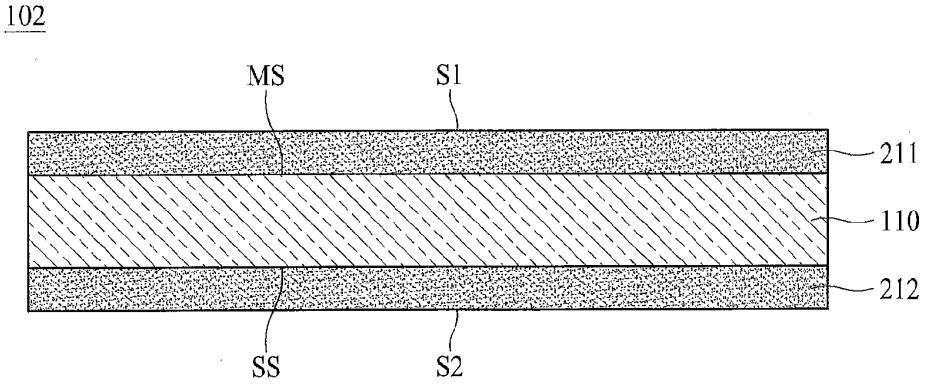


FIG. 3



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FIG. 4

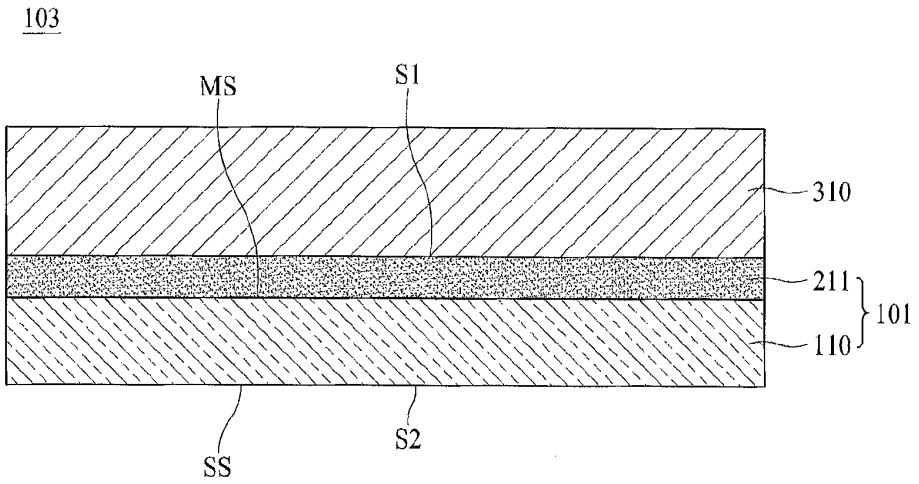
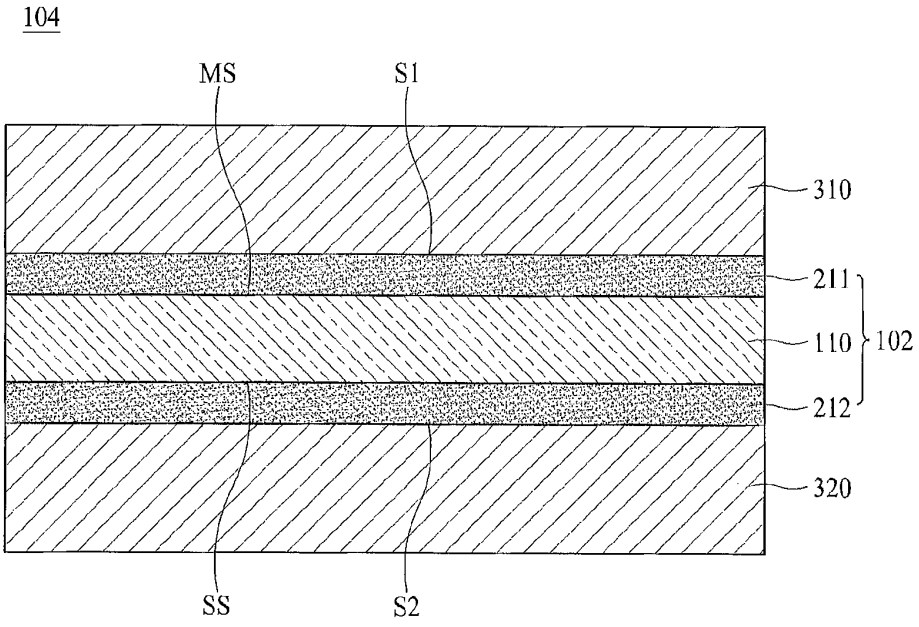


FIG. 5



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FIG. 6

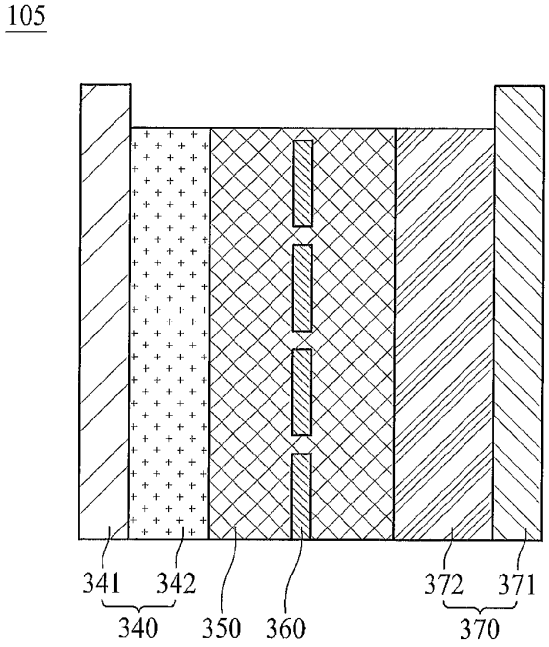
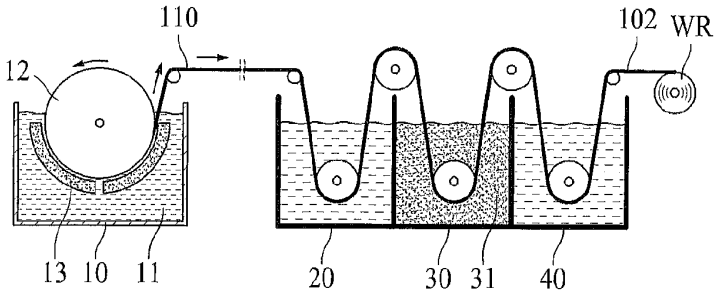


FIG. 7



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INTERNATIONAL SEARCH REPORT

International application No.
PCT/KR2018/008399

A. CLASSIFICATION OF SUBJECT MATTER
C25D 1/04(2006.01)i, C25D 3/38(2006.01)i, C25D 21/06(2006.01)i, C25D 5/34(2006.01)i, C25D 5/48(2006.01)i, H01M 4/66(2006.01)i, H01M 4/13(2010.01)i, H01M 10/052(2010.01)i
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
C25D 1/04; B32B 15/08; C22F 1/08; C25C 1/12; H01M 10/0525; H01M 10/36; H01M 4/64; H01M 4/66; C25D 3/38; C25D 21/06; C25D 5/34; C25D 5/48; H01M 4/13

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched
Korean Utility models and applications for Utility models: IPC as above
Japanese Utility models and applications for Utility models: IPC as above

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
eKOMPASS (KIPO internal), STN (Registry, Caplus) & Keywords: copper foil, electrode, secondary battery, curl, wrinkles, tear, copper layer, matte, shiny, residual stress, crystal surface, texture coefficient, rust resistance, elongation

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	KR 10-2015-0011751 A (CHANG CHUN PETROCHEMICAL CORPORATION) 02 February 2015 See claims 1, 9; paragraph [0022]; table 3, example 1.	1-9
Y	JP 2016-050325 A (JX NIPPON MINING & METALS CORP.) 11 April 2016 See claims 7, 13.	1-9
X	JP 2007-131909 A (MITSUI MINING & SMELTING CO., LTD.) 31 May 2007 See paragraphs [0026], [0034], [0036], [0041]-[0043], [0054], [0055]; table 1.	10-23,25
Y		24
Y	JP 2000-182623 A (NIPPON DENKAI K.K.) 30 June 2000 See paragraph [0031].	24
A	KR 10-2010-0125044 A (LS MTRON LTD.) 30 November 2010 See the entire document.	1-25

☐ Further documents are listed in the continuation of Box C. ☒ See patent family annex.

* Special categories of cited documents:
"A" document defining the general state of the art which is not considered to be of particular relevance
"E" earlier application or patent but published on or after the international filing date
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"P" document published prior to the international filing date but later than the priority date claimed
"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
24 DECEMBER 2018 (24.12.2018)	**24 DECEMBER 2018 (24.12.2018)**
Name and mailing address of the ISA/KR Korean Intellectual Property Office Government Complex Daejeon Building 4, 189, Cheongsa-ro, Seo-gu, Daejeon, 35208, Republic of Korea Facsimile No. +82-42-481-8578	Authorized officer Telephone No.

Form PCT/ISA/210 (second sheet) (January 2015)

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INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/KR2018/008399

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		KR 10-1660335 B1	29/09/2016
		TW 201505243 A	01/02/2015
		TW I533496 B	11/05/2016
		US 2015-0030873 A1	29/01/2015
		US 9209485 B2	08/12/2015
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METHOD FOR MANUFACTURING ELECTROLYTIC COPPER FOIL

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Priority number(s): JP20020331460 20021115

Abstract of JP2004162144 (A)

PROBLEM TO BE SOLVED: To manufacture an electrolytic copper foil having small surface roughness of a deposition surface and excellent elongation without using any gelatin or glue. ;SOLUTION: In a method for manufacturing the electrolytic copper foil by the electrolysis of sulfuric acid copper plating solution, the sulfuric acid copper plating solution contains polyethylene glycol, chlorine and 3-mercapto-1-sulphonic acid. The manufactured electrolytic copper foil has small surface roughness and excellent elongation, and is excellent for the electrolytic copper foil for a printed circuit board and a rechargeable lithium ion battery. ;COPYRIGHT: (C)2004,JPO

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(54)【発明の名称】電解銅箔の製造方法

(57)【要約】
【課題】ゼラチンや　などを用いなくても、析出面の表面粗さが小さく、伸び率に優れた電解銅箔を製造する。
【解決手段】硫酸酸性銅めっき液の電気分解による電解銅箔の製造方法において、ポリエチレングリコールと塩素と３－メルカプト－１－スルホン酸とを含有することを特徴とする硫酸酸性銅めっき液を用いる。製造した電解銅箔は表面粗さが小さく、伸び率に優れ、プリント配線板及びリチウムイオン二次電池用の電解銅箔として優れる。
【選択図】　なし

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【特許請求の範囲】
【請求項１】
硫酸酸性銅めっき液の電気分解による電解銅箔の製造方法において、硫酸酸性銅めっき液が、ポリエチレングリコールと塩素と３－メルカプト－１－スルホン酸とを含有することを特徴とする電解銅箔の製造方法。
【発明の詳細な説明】
【０００１】
【発明の属する技術分野】
本発明はプリント配線板及びリチウムイオン二次電池に用いられる電解銅箔の製造方法に関するものである。
【０００２】
【従来の技術】
プリント配線板及びリチウムイオン二次電池の製造に用いられる電解銅箔は、硫酸酸性銅めっき液から電気分解により回転陰極上に金属銅を析出させて製造されている。析出した金属銅の表面形状を制御する目的で、硫酸酸性銅めっき液には通常、ゼラチンや　などの生物由来の高分子化合物が添加されている。これらの高分子化合物は銅原子の局部的な析出を抑制し、均一な微小円錐からなる表面を形成する。この微小円錐による凹凸形状は、プリント配線板で必要とされる積層基材との強固な接着力に寄与する。凹凸形状が大きいと接着力は向上するが、エッチングによる配線回路の加工性が低下するため、プリント配線板に用いる電解銅箔においては凹凸形状の制御がきわめて重要である。生物由来の高分子化合物に加えて、塩素も添加剤として共に用いられている。これら添加剤の濃度を制御することにより、所定の特性を有する電解銅箔を製造している。
【０００３】
電子機器の小型化、高性能化に対応するため、プリント配線板においては微細な回路配線の形成が求められている。このため、凹凸形状の小さな、すなわち表面粗さの小さな電解銅箔が求められている。また、表面粗さの小さい電解銅箔は、表面の凹凸による高周波信号の乱れが少ないことから、高周波回路用プリント配線板に適している。
【０００４】
電気特性や機械特性、熱的特性に優れることから、従来のガラス布基材エポキシ樹脂よりも高耐熱性の積層基材が用いられるようになってきた。これらの積層基材では一般に従来よりも高温のプレス加工条件が要求されることから、回路配線の微細化とあいまって、プレス加工前後のストレスによる断線不良が深刻な問題となってきた。すなわち、電解銅箔から形成された回路配線が、プレス加工時の積層基材の寸法変化に追随できないために回路配線にクラックが発生し、最悪の場合には破断にいたるものである。そこで、高温時の伸び率が高いことが求められるようになってきた。
【０００５】
リチウムイオン二次電池においては負極活物質の支持体兼集電体として電解銅箔が使用されているが、充電時にリチウムイオンがインタカレーションされることにともなう負極活物質である炭素の寸法変化が大きく、電解銅箔が追随できずに破断する現象が問題となっている。このため、リチウムイオン二次電池においては常温での伸び率が大きく、かつ、引裂き伝播性が大きいことが求められている。引裂き伝播性は破断開始から完全破断にいたるまでの時間であり、破断に対する抵抗性の尺度である。また、活物質層の塗工性の点から、両面の表面粗さが小さいことが好ましいとされている。
【０００６】
したがって、プリント配線板分野及びリチウムイオン二次電池のいずれの分野においても、表面粗さが小さく、伸び率の大きい電解銅箔が求められている。
【０００７】
特開２００１－１１６８４号公報には、原材料の銅線を高度に洗浄してから調製した硫酸酸性銅めっき液を用いることにより、光沢面の表面粗さが中心線平均粗さで０．２０μｍ、析出面側で０．２１μｍと両面が平滑で同等の表面粗さを有し、伸び率に優れた電解銅

箔を製造することができることが述べられている。同公報には添加剤に関して明確には記載されていないが、実施例においては硫酸以外の薬品は記載されていないことから、ゼラチン、　、またはこれらに代わる何らかの添加剤は使用されていないものと解される。同公報によれば、確かに両面が平滑で加熱後の伸び率に優れる銅箔が得られるものの、加熱前の伸び率は充分なものではない。

【０００８】

一方、特開平９－１４３７８５号公報には、３－メルカプト－１－プロパンスルホン酸ナトリウムとヒドロキシエチルセルロースと低分子量　とを用いることにより、粗面側、すなわち、析出面側の表面粗さが中心線平均粗さで０．２～０．１４μｍであり、常温での伸び率が１９．８～１４．４％の電解銅箔が得られることが記載されている。

【０００９】

【発明が解決しようとする課題】

ゼラチンや　は生物由来の高分子化合物であり、主鎖がアミド結合により構成されていることから加水分解されやすい問題がある。このため、硫酸酸性銅めっき液中に加水分解性生物が蓄積しやすく、活性炭等により常時除去する必要がある。本発明はゼラチンや　など加水分解しやすい添加剤を含有しない硫酸酸性銅めっき液を用いて、析出面の表面粗さが小さく、伸び率に優れた電解銅箔を製造する方法を提供するものである。

【００１０】

【課題を解決するための手段】

本発明者らは、ポリエチレングリコールと塩素と３－メルカプト－１－プロパンスルホンとを添加剤として用いることにより、ゼラチンや　などを用いなくても、析出面の表面粗さが小さく、伸び率に優れた電解銅箔が得られることを見出し、本発明を完成するに至った。

【００１１】

すなわち、本発明は、硫酸酸性銅めっき液の電気分解による電解銅箔の製造方法において、ポリエチレングリコールと塩素と３－メルカプト－１－スルホン酸とを含有することを特徴とする電解銅箔の製造方法である。

【００１２】

【発明の実施の形態】

以下、本発明の実施の形態を詳細に説明する。

【００１３】

酸性硫酸銅めっき液の銅濃度及び有利硫酸濃度は、電解銅箔の製造に用いられる濃度範囲と同一であり、銅濃度が５０ｇ／ｌから１００ｇ／ｌ、遊離の硫酸濃度が５０ｇ／ｌから１００ｇ／ｌである。酸性硫酸銅めっき液の調製は、試薬硫酸銅と硫酸とを所定の割合で純水に溶解するほか、銅線くず、銅紛など金属銅を硫酸に溶解して用いることができる。金属銅を用いる場合には、電解銅箔の製造に用いて銅濃度が減少した酸性硫酸銅めっき液を金属銅の溶解に用いることで、硫酸酸性銅めっき液を再生使用することができる。

【００１４】

本発明に用いるポリエチレングリコールの分子量は特に制限されるものではないが、重量平均分子量で２００から１００００である。添加量は、硫酸酸性銅めっき液に対して０．１ＰＰｍから２０ＰＰｍである。添加量が０．１ＰＰｍよりも少ないと効果が伸び率が低下し、一方、１０ＰＰｍより多く添加しても効果は得られない。塩素の添加量は５ＰＰｍから５０ＰＰｍであり、添加量が５ＰＰｍよりも少ないと析出面の表面粗さが粗くなり、一方、５０ＰＰｍより多く添加しても効果は得られない。また、３－メルカプト－１－スルホン酸の添加量は０．１ＰＰｍから１０ＰＰｍである。添加量が０．１ＰＰｍよりも少ないと伸び率が低下し、一方、１０ＰＰｍより多く添加しても効果は得られない。

【００１５】

電解銅箔の製造装置は通常の電解銅箔の製造に用いる装置を使用することができる。一例をあげれば、半円筒状に　曲した鉛板からなる陽極と電解銅箔の析出されるチタン製回転陰極とを硫酸酸性銅めっき液に浸漬し、析出した電解銅箔を連続的に巻き取る。硫酸酸性

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銅めっき液の液温は３０℃から６０℃が好ましく、より好ましくは４０℃から５０℃である。液温が低いと伸び率が低下し、高温では電解銅箔の外観が不均一となる。また、電流密度は３０Ａ／ｄｍ^{2}から７０Ａ／ｄｍ^{2}で、より好ましくは４０Ａ／ｄｍ^{2}から６０Ａ／ｄｍ^{2}である。電流密度が低いと生産性が低下し、高いと析出面の表面粗さが大きくなり、平滑な面が得られない。

【００１６】

【実施例】

以下、本発明を実施例に基づいて詳細に説明するが、本発明はこれに限定されるものではない。

【００１７】

（実施例１～４）試薬硫酸銅と試薬硫酸とを純水に溶解し、ポリエチレングリコール（平均分子量１０００）と３－メルカプト－１－スルホン酸とを添加し、ついで塩化ナトリウムを用いて塩素濃度を調製して、硫酸酸性銅めっき液を調製した。組成を表１に示した。ついで、陰極として、径５ｃｍのチタン製円筒状電極を用い、表面を２０００番の研磨紙を用いて研磨を行った。表面粗さはＲαで０．２０μｍであった。陽極板には円筒状の鉛板を用い、上記の電解液を用いて液温４０℃、電流密度５０Ａ／ｄｍ^{2}で１分間電気分解を行い、銅箔を析出させた。ただし円筒状電極の回転数は３００ｒＰｍとした。銅箔は両面ともに光沢を有し、重量法により求めた厚さは１０μｍであった。表面粗さと機械特性の測定結果を表１に示す。表面粗さはＪＩＳ　Ｂ　０６５１に基づいて測定した。引張強度と伸び率は常態（２３℃）でＪＩＳ　Ｃ６５１５に基づいて測定した。また、破断開始から破断完了までの時間を測定し、引裂き伝播性として表示した。

【００１８】

（比較例１～４）

【００１９】

表１に示した組成の硫酸酸性銅めっき液を調製し、電解銅箔を製造して特性を評価した。結果を表１に示した。

【表１】

項目	実施例1	実施例2	実施例3	実施例4	比較例1	比較例2	比較例3	比較例4
銅濃度(g／l)	280	280	280	280	280	280	280	280
遊離硫酸濃度(g／l)	90	90	90	90	90	90	90	90
PEG(ppm)	10	10	2	10	0	10	10	50
MPS(ppm)	5	1	5	1	5	0	5	5
塩素(ppm)	20	20	20	10	20	20	1	20
ゼラチン(ppm)	0	0	0	0	4	0	0	0
析出面粗さ(μm)	1.8	1.9	1.5	1.0	0.8	2.0	1.3	1.5
引張り強さ(MPa)	330	340	320	330	350	450	380	340
伸び率(%)	10.0	11.0	9.0	9.0	5.0	9.0	10.0	9.0
引裂き伝播性(秒)	2.0	1.5	1.5	1.5	0.2	0.2	0.8	1.5

PEG:ポリエチレングリコール
MPS:3-メルカプト－１－プロパンスルホン酸
ゼラチン:分子量5000(加水分解品)
析出面粗さ:Rz－10点平均粗さ

【００２０】

【発明の効果】

以上、説明したように本発明の電解銅箔は表面粗さが小さく、伸び率に優れ、プリント配線板及びリチウムイオン二次電池用の電解銅箔として優れる。本発明の硫酸酸性銅めっき液は加水分解されやすいゼラチンや　を含まないので、液管理が容易である。

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Espacenet

JP2012140660A ELECTROLYTIC COPPER FOIL, AND METHOD FOR MANUFACTURING THE SAME

Applicants: NIPPON DENKAI KK

Inventors: KAWASAKI TOSHIO,OGUCHI HIROSHI,YAMAGUCHI TOMOHIRO

Classifications:
IPC ***C25D3/38; C25D1/04;***

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ELECTROLYTIC COPPER FOIL, AND METHOD FOR MANUFACTURING THE SAME

Abstract

PROBLEM TO BE SOLVED: To provide electrolytic copper foil which maintains high strength even after long-time storage and further even after heating, and is superior in electric conductivity.SOLUTION: The electrolytic copper foil is manufactured by electrolyzing an acidic copper plating solution in sulfuric acid which contains (A) a dithiocarbamic derivative or salt thereof; (B) thiourea; (C) a water-soluble sulfur compound having mercapto group or derivative thereof, or their salts; (D) polyalkylene glycol; and (E) chlorine ion as additives.

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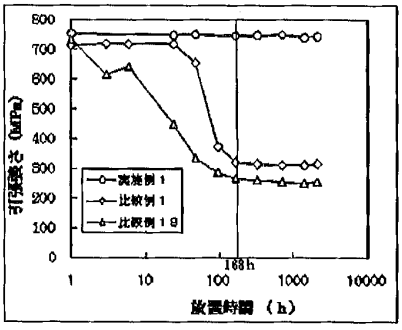
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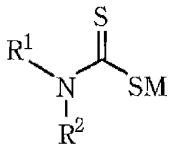
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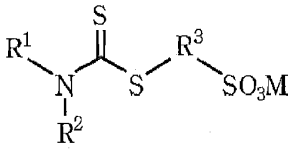
(54)【発明の名称】電解銅箔およびその製造方法

(57)【要約】
【課題】長時間保管後も高強度を維持し、加熱後も高強度で、かつ電気伝導性に優れた電解銅箔を提供する。
【解決手段】（A）ジチオカルバミン酸誘導体又はその塩、（B）チオ尿素、（C）メルカプト基を有する水溶性イオウ化合物又はその誘導体又はそれらの塩、（D）ポリアルキレングリコール及び（E）塩素イオンを添加剤として含有する硫酸酸性銅めっき液を電気分解することにより電解銅箔を製造する。
【選択図】図1



【特許請求の範囲】
【請求項１】
電着終了後１２０分以内に、２４０℃で１０分間加熱後、２０℃において引張り強さ及び電気伝導性を測定したとき、引張り強さが６５０ＭＰａ以上で、電気伝導性が８０％ＩＡＣＳ以上であり、電着終了から１６８時間後に測定した２０℃における引張り強さが、電着終了後１２０分以内に測定した２０℃における引張り強さの９０％以上であり、電着終了後１２０分以内に測定した２０℃における伸び率が３％以上である電解銅箔。
【請求項２】
電着終了から１６８時間後に測定した２０℃における引張り強さが７００ＭＰａ以上である請求項１に記載の電解銅箔。
【請求項３】
（Ａ）ジチオカルバミン酸誘導体又はその塩、（Ｂ）チオ尿素、（Ｃ）メルカプト基を有する水溶性イオウ化合物又はその誘導体又はそれらの塩、（Ｄ）ポリアルキレングリコール及び（Ｅ）塩素イオンを添加剤として含有する硫酸酸性銅めっき液を電気分解することを特徴とする請求項１又は請求項２に記載の電解銅箔の製造方法。
【請求項４】
添加剤（Ａ）であるジチオカルバミン酸誘導体又はその塩が、下記一般式（１）又は下記一般式（２）で表されるものである請求項３記載の電解銅箔の製造方法。
【化１】

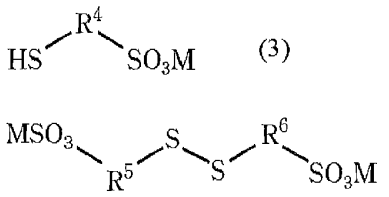

(1)


(2)

［一般式（１）及び（２）中、R^1及びR^2は、各々独立に、炭素数１～４のアルキル基又は炭素数６～１０のアリール基を表し、Ｍは水素原子又はアルカリ金属原子を表し、一般式（２）中、R^3は炭素数２～４のアルキレン基又は炭素数６～１０のアリーレン基を表す。］
【請求項５】
添加剤（Ａ）であるジチオカルバミン酸誘導体又はその塩が、Ｎ，Ｎ－ジメチルジチオカルバミン酸、Ｎ，Ｎ－ジエチルジチオカルバミン酸、Ｎ，Ｎ－ジプロピルジチオカルバミン酸、Ｎ，Ｎ－ジブチルジチオカルバミン酸、Ｎ，Ｎ－ジフェニルジチオカルバミン酸、Ｎ，Ｎ－ジメチルジチオカルバミルプロパンスルホン酸及びこれらのアルカリ金属塩からなる群から選ばれる少なくとも１種である請求項３又は請求項４に記載の電解銅箔の製造方法。
【請求項６】
添加剤（Ｃ）であるメルカプト基を有する水溶性イオウ化合物又はその誘導体又はそれらの塩が、下記一般式（３）又は下記一般式（４）で表されるものである請求項３～５いずれかに記載の電解銅箔の製造方法。

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【化２】



[一般式（３）及び（４）中、R^4、R^5及びR^6は、各々独立に、炭素数２～４のアルキレン基を表し、Ｍは水素原子又はアルカリ金属原子を表す。]

【請求項７】

添加剤（Ｃ）であるメルカプト基を有する水溶性イオウ化合物又はその誘導体又はそれらの塩が、３－メルカプト－１－プロパンスルホン酸、３，３′－ジチオビス（１－プロパンスルホン酸）及びそれらのアルカリ金属塩からなる群から選ばれる少なくとも１種である請求項３～６いずれかに記載の電解銅箔の製造方法。

【請求項８】

添加剤（Ｄ）であるポリアルキレングリコールの重量平均分子量が５００～１００，０００である請求項３～７いずれかに記載の電解銅箔の製造方法。

【請求項９】

硫酸酸性銅めっき液中の添加剤（Ａ）～（Ｅ）の濃度が、
（Ａ）ジチオカルバミン酸誘導体又はその塩の濃度が１０～６０ｍｇ／ｌ、
（Ｂ）チオ尿素の濃度が７．５～２５ｍｇ／ｌ、
（Ｃ）メルカプト基を有する水溶性イオウ化合物又はその誘導体又はそれらの塩の濃度が４０～３００ｍｇ／ｌ、
（Ｄ）ポリアルキレングリコールの濃度が４０～４００ｍｇ／ｌ、
（Ｅ）塩素イオンの濃度が３０～１００ｍｇ／ｌ
である請求項３～８いずれかに記載の電解銅箔の製造方法。

【請求項１０】

硫酸酸性銅めっき液が、銅の濃度が硫酸銅五水和物換算で１６０～３５０ｇ／ｌで、遊離硫酸の濃度が５０～１００ｇ／ｌである硫酸－硫酸銅水溶液に、添加剤（Ａ）～（Ｅ）を添加して調製されたものである請求項３～９いずれかに記載の電解銅箔の製造方法。

【発明の詳細な説明】

【技術分野】

【０００１】

本発明は、長時間保管後及び加熱後も高強度で、電気伝導性に優れた電解銅箔とその製造方法に関する。

【背景技術】

【０００２】

電解銅箔は、各種のプリント配線板やリチウム電池負極などに用いられてきたが、ＨＤＤの磁気ヘッドなど高強度を要求される用途には使用できず、ベリリウム銅やコルソン合金をはじめとする各種の高強度合金箔が使用されてきた。これは、電解銅箔が再結晶しやすく、初期特性として十分な高強度を示しても、加工時の熱履歴や経時変化により軟化してしまうためである。しかしながら、上記の合金箔には添加元素が障害となり、純銅に比べて電気伝導性が低い問題点がある。

【０００３】

電解銅箔は、硫酸銅水溶液を電気分解し、銅を析出させることによって製造される。硫酸銅水溶液に各種の有機イオウ系化合物を添加することによって、高強度の電解銅箔を製造できることが知られている。たとえば、添加剤として３－メルカプト－１－プロパンスルホン酸塩又は３，３′－ジチオビス（１－プロパンスルホン酸塩）、チオ尿素などを用いた場合、得られる電解銅箔は製造直後には７００ＭＰａを超える引張り強さを示す。し

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かしながら、これらの一般的な添加剤では銅の再結晶性を抑制することができず、常温で急速に再結晶して、引張り強さは４００ＭＰａ以下に低下する。

【０００４】

特殊な添加剤の組み合わせにより再結晶性を抑制することが提案されている。特許文献１には、分子量２５００００～１６０００００のヒドロキシエチルセルロース、ポリエチレンイミン、活性有機イオウ化合物のスルホン酸塩、アセチレングリコール及び塩素イオンを含有する硫酸銅水溶液を用いる電解銅箔の製造方法が開示されている。この特許文献１では、電着完了から２０分以内に測定した２５℃における抗張力と比較して、電着完了時点から３００分経過時に測定した２５℃における抗張力の低下率が１０％以下であるとしているが、一般的な銅箔の保障期間が３ヶ月から６ヶ月であることに対して、十分であるとは言い難い。一方、特許文献２には、添加剤Ａ：ベンゼン環とＮを含む複素環とを備え、該複素環にはメルカプト基が結合している構造を有する化合物又はチオ尿素系化合物、添加剤Ｂ：活性硫黄化合物のスルホン酸塩、添加剤Ｃ：環状構造を持つ４級アンモニウム塩重合体を用いて、初期の引張り強さが７０ｋｇｆ／ｍｍ^2、１８０℃－６０分間加熱後の引張り強さが初期の引張り強さに対して８５％以上の電解銅箔を製造すること記載されている。しかしながら、ポリイミド樹脂などの高耐熱性樹脂を用いる用途での耐熱温度が十分ではなく、さらに高い耐熱温度の電解銅箔が望まれている。

【先行技術文献】

【特許文献】

【０００５】

【特許文献１】特開２００４－３３９５５８号公報

【特許文献２】特開２００８－１０１２６７号公報

【発明の概要】

【発明が解決しようとする課題】

【０００６】

本発明は、長時間保管後も高強度を維持し、また、ポリイミド樹脂などの高耐熱性樹脂を用いる用途で要求される熱履歴によっても、十分な高強度を有し、かつ、電気伝導性が８０％ＩＡＣＳ以上の電解銅箔を提供するものである。

【課題を解決するための手段】

【０００７】

常温で再結晶することにより引張り強さが低下する銅箔について、引張り強さの経時変化を測定した結果を図１に示す。引張り強さは経時的に低下するが、次第に低下速度が減少し、電着終了後１６８時間以内に安定することを確認した。従って、電着終了から１６８時間後の引張り強さを評価することにより、３ヶ月程度の長期間保管後の引張り強さを保証できることが確認された。

【０００８】

本発明者らは鋭意検討を重ねた結果、硫酸酸性銅めっき液中に、添加剤として、（Ａ）ジチオカルバミン酸誘導体又はその塩、（Ｂ）チオ尿素、（Ｃ）メルカプト基を有する水溶性イオウ化合物又はその誘導体又はそれらの塩が、（Ｄ）ポリアルキレングリコール及び（Ｅ）塩素イオンの五つの添加剤を存在させることにより、電着完了から１６８時間後の引張り強さが高く（例えば７００ＭＰａ以上）、かつ、初期の引張り強さからの低下率が低く、２４０℃－１０分間加熱後（以下、加熱後と表記することがある）における引張り強さが高い（例えば６５０ＭＰａ以上）であると共に、電気伝導性が８０％ＩＡＣＳ以上である電解銅箔の製造が可能となることを見出し、電解銅箔の製造方法に係る本発明を完成するに至った。

【０００９】

即ち、本発明は、下記の電解銅箔及びその製造方法に関する。

（１）電着終了後１２０分以内に、２４０℃で１０分間加熱後、２０℃において引張り強さ及び電気伝導性を測定したとき、引張り強さが６５０ＭＰａ以上で、電気伝導性が８０％ＩＡＣＳ以上であり、電着終了から１６８時間後に測定した２０℃における引張り強

さが、電着終了後１２０分以内に測定した２０℃における引張り強さの９０％以上であり、電着終了後１２０分以内に測定した２０℃における伸び率が３％以上である電解銅箔。

【００１０】

（２）電着終了から１６８時間後に測定した２０℃における引張り強さが７００ＭＰａ以上である（１）に記載の電解銅箔。

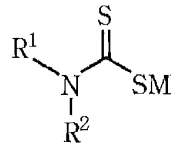
【００１１】

（３）（Ａ）ジチオカルバミン酸誘導体又はその塩、（Ｂ）チオ尿素、（Ｃ）メルカプト基を有する水溶性イオウ化合物又はその誘導体又はそれらの塩、（Ｄ）ポリアルキレングリコール及び（Ｅ）塩素イオンを添加剤として含有する硫酸酸性銅めっき液を電気分解することを特徴とする（１）又は（２）に記載の電解銅箔の製造方法。

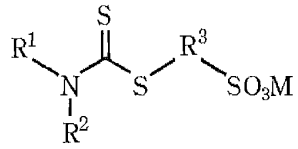
【００１２】

（４）添加剤（Ａ）であるジチオカルバミン酸誘導体又はその塩が、下記一般式（１）又は下記一般式（２）で表されるものである（３）に記載の電解銅箔の製造方法。

【化１】



(1)



(2)

［一般式（１）及び（２）中、R^1及びR^2は、各々独立に、炭素数１～４のアルキル基又は炭素数６～１０のアリール基を表し、Ｍは水素原子又はアルカリ金属原子を表し、一般式（２）中、R^3は炭素数２～４のアルキレン基又は炭素数６～１０のアリーレン基を表す。］

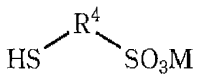
【００１３】

（５）添加剤（Ａ）であるジチオカルバミン酸誘導体又はその塩が、Ｎ，Ｎ－ジメチルジチオカルバミン酸、Ｎ，Ｎ－ジエチルジチオカルバミン酸、Ｎ，Ｎ－ジプロピルジチオカルバミン酸、Ｎ，Ｎ－ジブチルジチオカルバミン酸、Ｎ，Ｎ－ジフェニルジチオカルバミン酸、Ｎ，Ｎ－ジメチルジチオカルバミルプロパンスルホン酸及びこれらのアルカリ金属塩からなる群から選ばれる少なくとも１種である（３）又は（４）に記載の電解銅箔の製造方法。

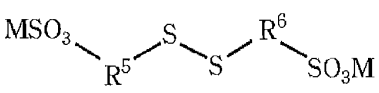
【００１４】

（６）添加剤（Ｃ）であるメルカプト基を有する水溶性イオウ化合物又はその誘導体又はそれらの塩が、下記一般式（３）又は下記一般式（４）で表されるものである（３）～（５）いずれかに記載の電解銅箔の製造方法。

【化２】



(3)



(4)

［一般式（３）及び（４）中、R^4、R^5及びR^6は、各々独立に、炭素数２～４のアルキレン基を表し、Ｍは水素原子又はアルカリ金属原子を表す。］

【００１５】

（７）添加剤（Ｃ）であるメルカプト基を有する水溶性イオウ化合物又はその誘導体又はそれらの塩が、３－メルカプト－１－プロパンスルホン酸、３，３′－ジチオビス（１－プロパンスルホン酸）及びそれらのアルカリ金属塩からなる群から選ばれる少なくとも１種である（３）～（６）いずれかに記載の電解銅箔の製造方法。

【００１６】

（８）添加剤（Ｄ）であるポリアルキレングリコールの重量平均分子量が５００～１００，０００である（３）～（７）いずれかに記載の電解銅箔の製造方法。

【００１７】

（９）硫酸酸性銅めっき液中の添加剤（Ａ）～（Ｅ）の濃度が、
（Ａ）ジチオカルバミン酸誘導体又はその塩の濃度が１０～６０ｍｇ／ｌ、
（Ｂ）チオ尿素の濃度が７．５～２５ｍｇ／ｌ、
（Ｃ）メルカプト基を有する水溶性イオウ化合物又はその誘導体又はそれらの塩の濃度が４０～３００ｍｇ／ｌ、
（Ｄ）ポリアルキレングリコールの濃度が４０～４００ｍｇ／ｌ、
（Ｅ）塩素イオンの濃度が３０～１００ｍｇ／ｌ
である（３）～（８）いずれかに記載の電解銅箔の製造方法。

【００１８】

（１０）硫酸酸性銅めっき液が、銅の濃度が硫酸銅五水和物換算で１６０～３５０ｇ／ｌで、遊離硫酸の濃度が５０～１００ｇ／ｌである硫酸－硫酸銅水溶液に、添加剤（Ａ）～（Ｅ）を添加して調製されたものである（３）～（９）いずれかに記載の電解銅箔の製造方法。

【発明の効果】

【００１９】

本発明の電解銅箔は、高強度で高導電率であることから、ＨＤＤの磁気ヘッドなどの高強度を必要とされる用途や小型化・薄肉化が進むその他の電子部品、さらにはリチウムイオン電池用負極の集電体などに好適に利用することができる。

【図面の簡単な説明】

【００２０】

【図１】電解銅箔の常温放置時間と引張り強さの関係を示すグラフ。

【発明を実施するための形態】

【００２１】

本発明において、電解銅箔とは、銅イオンを含有する銅めっき液を電気分解することにより電極面に銅を析出させて（電着）得られる銅箔を意味する。電解銅箔の厚みには特に制限はないが、通常、３～１７５μｍであることが好ましく、６～７０μｍであることがより好ましい。

【００２２】

本発明の電解銅箔は、電着終了後１２０分以内に、２４０℃で１０分間加熱後、２０℃において引張り強さ（以下、加熱後引張り強さと呼ぶことがある。）及び電気伝導性（以下、加熱後電気伝導性と呼ぶことがある。）を測定したとき、加熱後引張り強さが６５０ＭＰａ以上で、加熱後電気伝導性が８０％ＩＡＣＳ以上であり、電着終了から１６８時間後に測定した２０℃における引張り強さ（以下、放置後引張り強さと呼ぶことがある。）が、電着終了後１２０分以内に測定した２０℃における引張り強さ（以下、初期引張り強さと呼ぶことがある。）の９０％以上であり、電着終了後１２０分以内に測定した２０℃における伸び率が３％以上であることを特徴とする。

【００２３】

上記の加熱後引張り強さの測定においては、電解銅箔の２４０℃－１０分間の加熱と、２０℃における引張り強さの測定の両方を、電着終了後１２０分以内に行う。また、上記の加熱後電気伝導性の測定においても、電解銅箔の２４０℃－１０分間の加熱と、２０℃における電気伝導性の測定の両方を、電着終了後１２０分以内に行う。本発明における電気伝導性とは、IACS: International Annealed Copper Standard （国際焼きなまし銅線

標準）という名の"標準焼きなまし銅線"の電気伝導率（０．５８００×１０^{8} Ｓ／ｍ）を１００％とした場合の、それに対する電解銅箔の電気伝導率の％値としての比較値を意味し、％ＩＡＣＳで表記する。

【００２４】

上記の放置後引張り強さは、得られた電解銅箔を常温（１５～３０℃、以下同様。）で放置し、電着終了から１６８時間後に２０℃において測定する。また、上記の初期引張り強さは、電着終了後１２０分以内に、常温環境保管していた電解銅箔を２０℃において測定する。

【００２５】

本発明の電解銅箔の上記の放置後引張り強さは、上記初期引張り強さの９０％以上であるが、９２．５％以上であることが好ましい。

本発明の電解銅箔の上記加熱後電気伝導性は、８０％ＩＡＣＳ以上であるが、８１％ＩＡＣＳ以上であることが好ましい。

【００２６】

なお、本発明の電解銅箔の上記放置後引張り強さは、７００ＭＰａ以上であることが好ましく、７１０ＭＰａ以上であることがより好ましい。また、本発明の電解銅箔の上記初期引張り強さは、７００ＭＰａ以上であることが好ましく、７３０ＭＰａ以上であることがより好ましい。

【００２７】

本発明の電解銅箔は、電着終了後１２０分以内に測定した２０℃における伸び率が、３％以上である。この伸び率が３％未満であると、電解銅箔が破れやすく、取り扱いが困難である。なお、測定前の電解銅箔は、常温環境で保管されたものである。

【００２８】

本発明の電解銅箔は、その製造方法に特に制限はないが、例えば、下記に示す製造方法により好適に製造することができる。

本発明の電解銅箔の製造方法は、（Ａ）ジチオカルバミン酸誘導体又はその塩、（Ｂ）チオ尿素、（Ｃ）メルカプト基を有する水溶性イオウ化合物又はその誘導体又はそれらの塩、（Ｄ）ポリアルキレングリコール及び（Ｅ）塩素イオンの五つの添加剤を含有する硫酸酸性銅めっき液を電気分解することを特徴とする。

なお、本発明において、「硫酸酸性銅めっき液が添加剤（Ａ）～（Ｅ）を含有する」とは、硫酸酸性銅めっき液に添加剤（Ａ）～（Ｅ）が添加されていることを意味し、「硫酸酸性銅メッキ液中の添加剤（Ａ）～（Ｅ）の濃度」とは、硫酸酸性銅めっき液１リットルあたりの、添加された添加剤（Ａ）～（Ｅ）各々の重量（ｍｇ）を意味する。

【００２９】

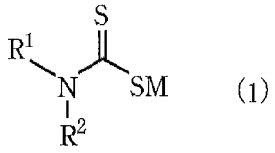
本発明の製造方法に用いられる硫酸酸性銅めっき液は、例えば、通常の電解銅箔の製造に用いられる硫酸－硫酸銅水溶液（添加剤を含まない硫酸－硫酸銅水溶液）に、添加剤（Ａ）～（Ｅ）を添加することにより調製することができる。硫酸－硫酸銅水溶液の銅濃度及び硫酸濃度は、通常の電解銅箔の製造に用いられる濃度範囲と同様であればよく、特に制限はない。好ましくは、銅濃度が硫酸銅五水和物として１６０～３５０ｇ／ｌ、より好ましくは２４０～３１０ｇ／ｌ、遊離硫酸濃度が５０～１００ｇ／ｌ、より好ましくは７０～９０ｇ／ｌである。硫酸－硫酸銅水溶液は、試薬硫酸銅と硫酸とを所定の割合で純水に溶解するか、又は、銅線くず、銅紛などの金属銅を硫酸水溶液に溶解して調製することができる。この硫酸－硫酸銅水溶液に所定の添加剤（Ａ）～（Ｅ）を添加することにより、硫酸酸性銅めっき液を調製する。銅の電解析出によって硫酸酸性銅めっき液中の銅濃度が減少した場合には、例えば、硫酸酸性銅めっき液に酸素の存在下で金属銅を溶解させることで、硫酸酸性銅めっき液を再生することができる。

【００３０】

本発明に用いる添加剤（Ａ）は、ジチオカルバミン酸誘導体又はその塩であり、例えば下記一般式（１）及び下記一般式（２）で表されるものが挙げられ、１種類を単独で用いてもよいし、２種以上を併用してもよい。

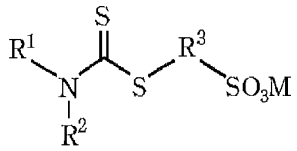
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【００３１】
ジチオカルバミン酸誘導体又はその塩の一般式（１）
【化１】



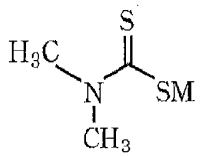
(1)

［一般式（１）中、R^1及びR^2は、各々独立に、炭素数１～４のアルキル基又は炭素数６～１０のアリール基を表し、Ｍは水素原子又はアルカリ金属原子を表す。］
【００３２】
ジチオカルバミン酸誘導体又はその塩の一般式（２）
【化２】

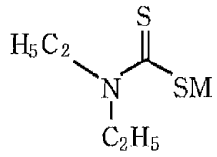


(2)

［一般式（２）中、R^1及びR^2は、各々独立に、炭素数１～４のアルキル基又は炭素数６～１０のアリール基を表し、R^3は炭素数２～４のアルキレン基又は炭素数６～１０のアリーレン基を表し、Ｍは水素原子又はアルカリ金属原子を表す。］
【００３３】
一般式（１）及び（２）で表される化合物としては、例えば、Ｎ，Ｎ－ジメチルジチオカルバミン酸、Ｎ，Ｎ－ジエチルジチオカルバミン酸、Ｎ，Ｎ－ジプロピルジチオカルバミン酸、Ｎ，Ｎ－ジブチルジチオカルバミン酸、Ｎ，Ｎ－ジフェニルジチオカルバミン酸、Ｎ，Ｎ－ジメチルジチオカルバミルプロパンスルホン酸及びこれらのアルカリ金属塩などがあるが、これらに限られるものではない。
【００３４】
Ｎ，Ｎ－ジメチルジチオカルバミン酸又はその塩
【化３】



［式中、Ｍは水素原子又はアルカリ金属原子を表す。］
【００３５】
Ｎ，Ｎ－ジエチルジチオカルバミン酸又はその塩
【化４】

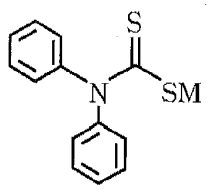


［式中、Ｍは水素原子又はアルカリ金属原子を表す。］
【００３６】

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Ｎ，Ｎ－ジフェニルジチオカルバミン酸又はその塩

【化５】

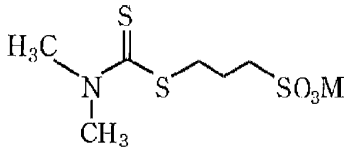


［式中、Ｍは水素原子又はアルカリ金属原子を表す。］

【００３７】

Ｎ，Ｎ－ジメチルジチオカルバミルプロパンスルホン酸又はその塩

【化６】



［式中、Ｍは水素原子又はアルカリ金属原子を表す。］

アルカリ金属原子としては、通常、ナトリウム又はカリウムが好ましい。

【００３８】

添加剤（Ａ）であるジチオカルバミン酸誘導体又はその塩の添加量は、硫酸酸性銅めっき液中の添加剤（Ａ）の濃度が１０～６０ｍｇ／ｌとなる量であることが好ましい。添加剤（Ａ）の濃度が１０ｍｇ／ｌ未満であると、本発明の電解銅箔に必要とされる所定の特性が得られず、６０ｍｇ／ｌを超えると、ポーラスなめっきとなり、やはり所定の特性が得られない。

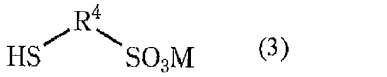
【００３９】

添加剤（Ｂ）は、チオ尿素である。添加剤（Ｂ）の添加量は、硫酸酸性銅めっき液中の添加剤（Ｂ）の濃度が７．５～２５ｍｇ／ｌとなる量であることが好ましい。添加剤（Ｂ）の濃度が７．５ｍｇ／ｌ未満であると、本発明の電解銅箔に必要とされる所定の特性が得られず、２５ｍｇ／ｌを超えると、ポーラスなめっきとなり、やはり所定の特性が得られない。

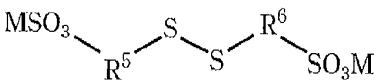
【００４０】

添加剤（Ｃ）は、メルカプト基を有する水溶性イオウ化合物又はその誘導体又はそれらの塩であり、例えば、下記一般式（３）及び（４）で表される化合物が挙げられ、１種類単独で用いてもよいし、２種以上を併用してもよい。

【化７】



(3)



(4)

［一般式（３）及び（４）中、Ｒ^{4}、Ｒ^{5}及びＲ^{6}は、各々独立に、炭素数２～４のアルキレン基を表し、Ｍは水素原子又はアルカリ金属原子を表す。］

【００４１】

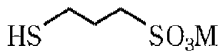
上記一般式（３）及び（４）で表される化合物としては、例えば、下記一般式で表される３－メルカプト－１－プロパンスルホン酸、３，３′－ジチオビス（１－プロパンスル

ホン酸）及びそれらのアルカリ金属塩などが挙げられるが、これらに限定されるものではない。

【００４２】

３－メルカプト－１－プロパンスルホン酸又はその塩

【化８】

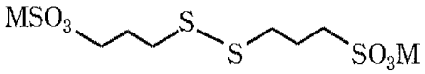


[式中、Ｍは水素原子又はアルカリ金属原子を表す。]

【００４３】

３，３′－ジチオビス（１－プロパンスルホン酸）又はその塩

【化９】



[式中、Ｍは水素原子又はアルカリ金属原子を表す。]

アルカリ金属原子としては、ナトリウム又はカリウムが好ましい。

【００４４】

添加剤（Ｃ）であるメルカプト基を有する水溶性イオウ化合物又はその誘導体又はそれらの塩の添加量は、硫酸酸性銅めっき液中の添加剤（Ｃ）の濃度が４０～３００ｍｇ／ｌとなる量であることが好ましい。添加剤（Ｃ）の濃度が４０ｍｇ／ｌ未満であると、ポーラスなめっきとなり、均一なメッキ被膜とならず、３００ｍｇ／ｌを超えると、本発明の電解銅箔に必要とされる所定の特性が得られない。

【００４５】

本発明に用いられる添加剤（Ｄ）はポリアルキレングリコールであり、例えば、ポリ（Ｃ^{1}～Ｃ^{4}－アルキレングリコール）が挙げられ、１種類を単独で用いてもよいし、２種以上を併用してもよい。ポリアルキレングリコールとしては、例えば、ポリエチレングリコールやポリプロピレングリコール、エチレングリコールとプロピレングリコールとの共重合体のいずれも好適に用いることができる。ポリアルキレングリコールの分子量は、重量平均分子量（ポリスチレンを基準としたゲルパーミエーションクロマトグラフィーにて測定した換算置）で５００～１０００００であることが好ましく、１０００～１００００であることがより好ましい。分子量が大き過ぎると、めっき表面にピットを生じやすく、分子量が小さすぎると、所望の特性が得られない。

【００４６】

添加剤（Ｄ）であるポリアルキレングリコールの添加量は、硫酸酸性銅めっき液中の添加剤（Ｄ）の濃度が４０～４００ｍｇ／ｌとなる量であることが好ましい。添加剤（Ｄ）の濃度が４０ｍｇ／ｌ未満である場合、及び、４００ｍｇ／ｌを超える場合には、本発明の電解銅箔に必要とされる所定の特性が得られない。

【００４７】

添加剤（Ｅ）は、塩素イオンである。塩素イオン供給源としては、例えば、塩酸、塩化ナトリウム等を用いることができる。添加剤（Ｅ）である塩素イオンの添加量は、硫酸酸性銅めっき液中の添加剤（Ｅ）の濃度が、塩素イオン濃度として３０～１００ｍｇ／ｌとなる量であることが好ましい。添加剤（Ｅ）の濃度が３０ｍｇ／ｌ未満であると、ポーラスなめっきとなり、１００ｍｇ／ｌを超えると、電解銅箔の加熱後引張り強さ及び放置後引張り強さが本発明の電解銅箔に必要とされる所定の値より低くなる。

【００４８】

次に、本発明の電解銅箔の製造方法に用いられる製造装置及びめっき条件について説明する。本発明では、通常の電解銅箔の製造に用いる製造装置を使用することができる。一例をあげれば、半円筒状に湾曲した酸化イリジウムコーティングを施したチタン板からなる陽極と、チタン製回転陰極とを、硫酸酸性銅めっき液に浸漬し、両極間に直流電流を通

電し、回転陰極上に析出した電解銅箔を連続的に巻き取る方法がある。酸性硫酸銅めっき液の液温は４０℃～６０℃が好ましい。液温が４０℃より低いと、得られる電解銅箔の加熱後引張り強さが所定の値とならなくなる傾向があり、６０℃より高いと、製造装置の樹脂部材が損傷を受けやすい。また、電流密度は３０Ａ／ｄｍ^2～５０Ａ／ｄｍ^{2}とすることが好ましい。電流密度が５０Ａ／ｄｍ^{2}より高いと、得られる電解銅箔の加熱後引張り強さが所定の値とならなくなる傾向があり、３０Ａ／ｄｍ^{2}より低いと生産性が悪く、実用的でない。

【実施例】

【００４９】

以下、実施例を挙げて本発明を具体的に説明するが、本発明は下記実施例に限定されるものではない。

【００５０】

［実施例１～１３、比較例１～１８、及び、参考例１～３］

実施例１～１３及び比較例１～１８においては、硫酸銅五水和物濃度２８０ｇ／ｌ、遊離硫酸濃度９０ｇ／ｌに調整した基本溶液（硫酸－硫酸銅水溶液）に、添加剤を添加し、得られた溶液を硫酸酸性銅めっき液として用いた。参考例１及び２は、特許文献１に記載された方法に従って電解銅箔を作製した例であり、参考例３は、特許文献２に記載された方法に従って電解銅箔を作製した例である。参考例１及び２（特許文献１）については、基本溶液中の硫酸銅五水和物濃度を２８０ｇ／ｌ、遊離硫酸濃度を１００ｇ／ｌとし、参考例３（特許文献２）については、基本溶液中の銅濃度を８０ｇ／ｌ、遊離硫酸濃度を１４０ｇ／ｌとした。また、添加剤の種類と添加量について、実施例及び比較例は表１に、参考例は表２に示した。

【００５１】

チタン製回転陰極（直径：４８ｍｍ、実効面積：１．０ｄｍ^2）の表面を＃２０００研磨紙で研磨した。陽極には酸化イリジウムコーティングしたチタン製の円筒状不溶性陽極（φ１４０ｍｍ、実効面積４．０ｄｍ^2）を用いた。めっき液の液温を５０℃とし、電流密度４０Ａ／ｄｍ^2、回転数３００ｒｐｍでめっきし、厚さ１５μｍの電解銅箔を製造した。実施例及び比較例では、電解処理を連続して行い、めっき２枚目の電解銅箔を評価サンプルとし、参考例は特許文献１及び２の記載に準じた。すなわち、特に記載がない参考例１及び参考例２はめっき１枚目、参考例３はめっき３枚目を電解銅箔の評価サンプルとして、その機械特性及び電気特性を評価し、結果を表３に示した。

また、実施例１、比較例１及び比較例１８で得られた電解銅箔を長時間常温で放置した時の２０℃における引張り強さの経時変化を測定し、図１に示した。

【００５２】

［評価方法］

初期引張り強さ：　常温環境におかれていた電解銅箔を、電着終了から１２０分以内に２０℃における引張り強さ測定に供した。

放置後引張り強さ：　電解銅箔を常温環境で保管し、電着終了から１６８時間後に、２０℃における引張り強さ測定に供した。

加熱後引張り強さ：　常温環境におかれていた電解銅箔を、電着終了から１２０分以内に、２４０℃で１０分間加熱し、２０℃における引張り強さ測定に供した。

加熱後電気伝導性：　常温環境におかれていた電解銅箔を、電着終了から１２０分以内に、２４０℃で１０分間加熱し、２０℃における電気伝導率測定に供し、％ＩＡＣＳ値を求めた。

伸び率：　常温環境におかれていた電解銅箔を、電着終了から１２０分以内に、２０℃における伸び率測定に供した。

【００５３】

上記の評価において、引張り強さと伸び率の測定は、ＪＩＳ　Ｃ６５１５に準じて万能引張り試験器を用いて行った。電気伝導性は、ＪＩＳ　Ｃ６５１５及びＩＥＣ６０２４９－１に準じて、デジタルマルチメータを用いた四端子法で測定した。

INSDOCID: <JP____2012140660A__I_>

【００５４】
【表１】

項目	液温(℃)	電流密度(A／dm^2)	添加剤濃度(mg／l)						
			添加剤(A)		添加剤(B)	添加剤(C)		添加剤(D)	添加剤(E)
			A1	A2		C1	C2		
実施例1	50	40	20		15	60		80	45
実施例2	50	40		20	15	60		80	45
実施例3	50	40	10		15	60		80	45
実施例4	50	40	60		15	60		80	45
実施例5	50	40	20		7.5	60		80	45
実施例6	50	40	20		25	60		80	45
実施例7	50	40	20		15		60	80	45
実施例8	50	40	20		15	40		80	45
実施例9	50	40	20		15	300		80	45
実施例10	50	40	20		15	60		40	45
実施例11	50	40	20		15	60		400	45
実施例12	50	40	20		15	60		80	30
実施例13	50	40	20		15	60		80	100
比較例1	50	40	0		0	60		80	45
比較例2	50	40	0		15	0		80	45
比較例3	50	40	0		15	60		80	45
比較例4	50	40	20		0	60		80	45
比較例5	50	40	20		15	0		80	45
比較例6	50	40	20		15	60		0	45
比較例7	50	40	20		15	60		80	2
比較例8	50	40	5		15	60		80	45
比較例9	50	40	80		15	60		80	45
比較例10	50	40	20		3	60		80	45
比較例11	50	40	20		30	60		80	45
比較例12	50	40	20		15	30		80	45
比較例13	50	40	20		15	450		80	45
比較例14	50	40	20		15	60		20	45
比較例15	50	40	20		15	60		600	45
比較例16	50	40	20		15	60		80	15
比較例17	50	40	20		15	60		80	200
比較例18	50	10	0		0		5	20	20

Ａ１：Ｎ，Ｎ－ジメチルジチオカルバミン酸ナトリウム
Ａ２：Ｎ，Ｎ－ジメチルジチオカルバミルプロパンスルホン酸ナトリウム
添加剤（Ｂ）：チオ尿素
Ｃ１：３－メルカプト－１－プロパンスルホン酸ナトリウム
Ｃ２：３，３′－ジチオビス（１－プロパンスルホン酸）二ナトリウム
添加剤（Ｄ）：ポリエチレングリコール　重量平均分子量１０００
【００５５】

【表２】

項目	液温(℃)	電流密度(A／dm^2)	添加剤濃度(mg／l)							
			添加剤B	添加剤C		ポリマーP				塩素
				C1	C2	P1	P2	P3	P4	
参考例1	40	40	0.5[1)]	18		70		20		70
参考例2	40	40	1.0[1)]	32			80	20		90
参考例3	50	51.5	25[2)]		60				70	45

1）　アセチレングリコール（エアープロダクツ社製、商品名：サーフィノール４６５）
2）　２－メルカプト－５－ベンズイミダゾールスルホン酸ナトリウム
Ｃ１：３－メルカプト－１－プロパンスルホン酸ナトリウム
Ｃ２：３，３′－ジチオビス（１－プロパンスルホン酸）二ナトリウム
Ｐ１：ヒドロキシエチルセルロース（ダイセル化学工業製、商品名：ＨＥＣダイセル　ＳＰ６００）
Ｐ２：ヒドロキシエチルセルロース（ダイセル化学工業製、商品名：ＨＥＣダイセル　ＳＰ４００）
Ｐ３：ポリエチレンイミン（日本触媒製エポミン　Ｐ－１０００）
Ｐ４：ジアリルジメチルアンモニウムクロライド重合体（センカ製，商品名：ユニセンス　ＦＰＡ１００Ｌ）

【００５６】

)NSDOCID: <JP_____2012140660A__I_>

【表３】

特性	引張り強さ(MPa)			伸び率(%)	電気伝導性(%IACS)
区分	初期	加熱後	放置後	初期	加熱後
実施例1	760	710	755	3.2	85
実施例2	810	660	750	3.6	87
実施例3	740	660	740	3.0	82
実施例4	730	720	735	3.2	81
実施例5	760	690	750	3.0	86
実施例6	770	730	740	3.2	85
実施例7	755	700	750	3.2	84
実施例8	750	650	730	3.8	83
実施例9	780	730	770	3.6	81
実施例10	740	650	740	3.0	88
実施例11	760	710	750	3.5	81
実施例12	760	660	710	3.4	88
実施例13	760	690	740	3.4	86
比較例1	640	320	440	4.2	100
比較例2	730	440	670	3.0	94
比較例3	805	650	660	2.8	81
比較例4	720	560	615	3.5	86
比較例5	ポーラスなめっき皮膜であり、測定不可能				
比較例6	ポーラスなめっき皮膜であり、測定不可能				
比較例7	ポーラスなめっき皮膜であり、測定不可能				
比較例8	730	600	720	3.2	86
比較例9	ポーラスなめっき皮膜であり、測定不可能				
比較例10	810	595	760	3.4	87
比較例11	ポーラスなめっき皮膜であり、測定不可能				
比較例12	ポーラスなめっき皮膜であり、測定不可能				
比較例13	815	600	740	3.2	86
比較例14	750	610	700	3.6	84
比較例15	760	610	700	3.4	86
比較例16	ポーラスなめっき皮膜であり、測定不可能				
比較例17	690	570	640	3.8	89
比較例18	735	280	265	9.8	98
参考例1	560	360	450	4.8	98
参考例2	610	410	490	4.6	96
参考例3	ポーラスなめっき皮膜であり、測定不可能				

【００５７】

実施例の電解銅箔は、加熱後引張り強さが６５０ＭＰａ～７３０ＭＰａであり、加熱後電気伝導性は８１％ＩＡＣＳ～８８％ＩＡＣＳであった。一方、比較例の電解銅箔は、ポーラスなめっきが多く、ほとんどがめっき皮膜として剥離できないため、測定不可能であった。測定可能なサンプルに関しては、加熱後引張り強さが３２０ＭＰａ～６５０ＭＰａであり、電気伝導性は８１％ＩＡＣＳ～９８％ＩＡＣＳであった。

【００５８】

また、実施例の電解銅箔は、初期、すなわち電着終了から６０分以内に測定した伸び率が３．０％～３．８％であり、電着終了から１６８時間後の引張り強さは７１０ＭＰａ～７７０ＭＰａであり、初期引張り強さに対する放置後引張り強さの維持率も９２．６％～

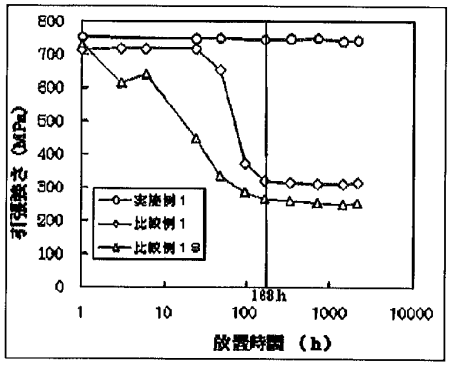
１０２．７％と高いものであった。

【産業上の利用可能性】

【００５９】

上記のようにして得られた電解銅箔は、高い引張り強さと耐熱性、さらには高い電気伝導性を併せ持ち、銅以外の金属成分を含まない。従って、プリント配線板用銅箔やリチウムイオン電池用負極の集電体として好適に用いることができる。

【図１】



Electronic Acknowledgement Receipt

EFS ID:	43909222
Application Number:	16959352
International Application Number:	
Confirmation Number:	1067
Title of Invention:	ELECTROLYTIC COPPER FOIL HAVING EXCELLENT HANDLING CHARACTERISTICS IN POSTPROCESSING, AND MANUFACTURING METHOD THEREFOR
First Named Inventor/Applicant Name:	Seung Min KIM
Customer Number:	24573
Filer:	Matthew S. Dicke/US Patent Mail
Filer Authorized By:	Matthew S. Dicke
Attorney Docket Number:	0313221.00022
Receipt Date:	30-SEP-2021
Filing Date:	30-JUN-2020
Time Stamp:	14:54:46
Application Type:	U.S. National Stage under 35 USC 371

Payment information:

Submitted with Payment	no

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1	Transmittal Letter	00022_IDS_Trans.pdf	90602 902fe0750ee2f9f6daea6de54a29731d178dc629	no	3

Warnings:

Information:					
2	Information Disclosure Statement (IDS) Form (SB08)	00022_PTOsb08.pdf	1035331 f103b2313dc9ff18cbb818746d6ecf11f41b32f8	no	4
Warnings:					
Information:					
3	Other Reference-Patent/App/Search documents	EESR.pdf	332381 7e5d84de2cf6098357ec6fa9ba0f0ebeb732df57	no	8
Warnings:					
Information:					
4	Foreign Reference	EP3663438.pdf	1978871 cc9988881be776726e042690c671da45a7a52df0	no	31
Warnings:					
Information:					
5	Foreign Reference	JP2004162144.pdf	367042 fe305c4daf58d164120d6e6a3cd9ecb7e6c167cd	no	5
Warnings:					
Information:					
6	Foreign Reference	JP2012140660A.pdf	985652 2aad85083b7c355c22b43a0cfd0af7d9328b053f	no	16
Warnings:					
Information:					
		Total Files Size (in bytes):	4789879		

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New Applications Under 35 U.S.C. 111

If a new application is being filed and the application includes the necessary components for a filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application.

National Stage of an International Application under 35 U.S.C. 371

If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course.

New International Application Filed with the USPTO as a Receiving Office

If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Applicant:	Seung Min KIM
Appl. No.:	16/959,352
Conf. No.:	1067
Filed:	June 30, 2020
Title:	ELECTROLYTIC COPPER FOIL HAVING EXCELLENT HANDLING CHARACTERISTICS IN POSTPROCESSING, AND MANUFACTURING METHOD THEREFOR
Art Unit:	1795
Examiner:	WITTENBERG, STEFANIE S
Docket No.:	0313221.00022

Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

INFORMATION DISCLOSURE STATEMENT TRANSMITTAL LETTER

Sir:

Submitted herewith is an Information Disclosure Statement for consideration in the above-identified application. In accordance with the provisions of 37 C.F.R. 1.56, 37 C.F.R. 1.97, and 37 C.F.R. 1.98, Applicants request that a citation and examination of the references cited on the enclosed SB08 form be made during the course of examination of the above-identified application for United States patent.

This Information Disclosure Statement is submitted as follows:

Submission without Certification

[X] Within three months of filing of a national application; within three months of the date of entry of the national stage as set forth in 37 C.F.R. §1.491 in an international application; before the mailing date of a first Office Action on the merits, or before the mailing of a first Office Action after the filing of a Request for Continued Examination.

[ ] After the period specified above, but before the mailing date of a Final Action under 37 CFR 1.113, a Notice of Allowance under 37 CFR 1.311, or an Action that otherwise closes prosecution in the application and is accompanied by payment of the fee set forth in 37 CFR 1.17(p).

Submission with Certification

[ ] Within three months of filing of a national application; within three months of the date of entry of the national stage as set forth in 37 C.F.R. §1.491 in an international application; before the mailing date of a first Office Action on the merits, or before the mailing of a first Office Action after the filing of a Request for Continued Examination.

[ ] After the period specified above, but before the mailing date of a Final Action under 37 CFR 1.113, a Notice of Allowance under 37 CFR 1.311, or an Action that otherwise closes prosecution in the application and is accompanied by the Certification specified in 37 CFR 1.97(e) which is set forth below.

[ ] After the mailing date of a Final Action under 37 CFR 1.113, a Notice of Allowance under 37 CFR 1.311, or an Action that otherwise closes prosecution in the application and is accompanied by the fee set forth in 37 CFR 1.17(p) and the Certification specified in 37 CFR 1.97(e) which is set forth below.

Certification under 37 CFR 1.97(e)

[ ] The undersigned counsel for applicant(s) hereby certifies that each item of information contained in the accompanying Information Disclosure Statement was first cited in any communication from a foreign patent office in a counterpart foreign application not more than **three months** prior to the filing of the Information Disclosure Statement.

[ ] The undersigned counsel for applicant(s) hereby certifies that no item of information contained in the accompanying Information Disclosure Statement was cited in a communication from a foreign patent office in a counterpart foreign application, and, to the knowledge of the undersigned, after making reasonable inquiry, no item of information contained in the accompanying Information Disclosure Statement was known to any individual designated in 37 CFR 1.56(c) more than **three months** prior to the filing of the Information Disclosure Statement.

Statement under 37 CFR 1.704(d)

[ ] The undersigned counsel for applicant(s) hereby states that each item of information contained in the accompanying Information Disclosure Statement was first cited in any communication from a patent office in a counterpart foreign or international application or from the Office, and/or is a communication that was issued by a patent office in a counterpart foreign or international application or by the Office, and this communication was not received by any individual designated in § 1.56(c) more than **thirty days** prior to the filing of the information disclosure statement.

[X] A copy of a Search Report from a corresponding foreign patent application is enclosed.

[ ] The Commissioner is hereby authorized to charge the amount of $ to cover the required fee to Deposit Account No. 02-1818.

[X] The Commissioner is hereby authorized to charge any additional fees which may be required, or credit any overpayment to Deposit Account No. 02-1818.

Respectfully submitted,

K&L GATES LLP

BY /Matthew S. Dicke/
Matthew S. Dicke
Reg. No. 58819
Customer No. 24573
Phone: (312) 578-5415

Dated: September 30, 2021

Electronic Acknowledgement Receipt	
EFS ID:	43884168
Application Number:	16959352
International Application Number:	
Confirmation Number:	1067
Title of Invention:	ELECTROLYTIC COPPER FOIL HAVING EXCELLENT HANDLING CHARACTERISTICS IN POSTPROCESSING, AND MANUFACTURING METHOD THEREFOR
First Named Inventor/Applicant Name:	Seung Min KIM
Customer Number:	24573
Filer:	Matthew S. Dicke/US Patent Mail
Filer Authorized By:	Matthew S. Dicke
Attorney Docket Number:	0313221.00022
Receipt Date:	28-SEP-2021
Filing Date:	30-JUN-2020
Time Stamp:	16:56:27
Application Type:	U.S. National Stage under 35 USC 371

Payment information:

Submitted with Payment	no

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1	Response to Election / Restriction Filed	0313221-00022_RespRestriction.pdf	121727 384d420dbd477d0cb90fe67370c81b1483878ad1	no	5

Warnings:

Information:	
Total Files Size (in bytes):	121727

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New Applications Under 35 U.S.C. 111
If a new application is being filed and the application includes the necessary components for a filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application.
National Stage of an International Application under 35 U.S.C. 371
If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course.
New International Application Filed with the USPTO as a Receiving Office
If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.

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Applicant:	Seung Min KIM
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Art Unit:	1795
Examiner:	WITTENBERG, STEFANIE S
Docket No.:	0313221.00022

Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

RESPONSE TO RESTRICTION REQUIREMENT

Examiner:

This Response is submitted in reply to the Restriction Requirement dated August 17, 2021.

A **Listing of Claims** begins on page 2 of this paper.

Remarks begin on page 5 of this paper.

Amendments to the Claims:

Please amend the claims as follows:

1. (Original) An electrolytic copper foil having a first surface and a second surface, wherein

a texture coefficient of (220) plane of the electrolytic copper foil defined by Equation 1 below is 0.4 to 1.32,

(Equation 1)

a difference ($|\Delta(Rz/Ra)|$) between Rz/Ra at the first surface of the electrolytic copper foil and Rz/Ra at the second surface of the electrolytic copper foil is less than 2.42, and

a difference ($|\Delta PD|$) between a peak density (PD) at the first surface of the electrolytic copper foil and a peak density (PD) at the second surface of the electrolytic copper foil is 96 ea or less.

2. (Original) The electrolytic copper foil according to claim 1, wherein

the second surface is an M surface, and

Rz/Ra at the second surface is 4.2 to 9.0.

3. (Original) The electrolytic copper foil according to claim 2, wherein

the first surface is an S surface, and

Rz/Ra at the S surface of the electrolytic copper foil is 5.1 to 6.8.

4. (Original) The electrolytic copper foil according to claim 1, wherein the electrolytic copper foil has a tensile strength, measured at room temperature, of 30 to 65 kgf/mm2.

5. (Original) The electrolytic copper foil according to claim 1, wherein the electrolytic copper foil has an elongation, measured at room temperature, of 3 % or more.

6. (Original) The electrolytic copper foil according to claim 1, wherein the electrolytic copper foil has a lateral weight deviation of 5 % or less.

7. (Original) The electrolytic copper foil according to claim 1, wherein an arithmetic mean of measured heights of corners of four protruding incision portions of the electrolytic copper foil, formed by incising electrolytic copper foil in a form of a cross having a size of 8 cm x 8 cm so as to be vertically divided into two parts, is less than 10 mm.

8. (Withdrawn – Currently Amended) A method of manufacturing ~~an electrolytic copper foil~~ the electrolytic copper foil according to claim 1 by applying electric current between a positive electrode plate and a rotary negative electrode drum, disposed in an electrolytic solution in an electrolytic bath so as to be spaced apart from each other, in order to electroplate a copper film on the rotary negative electrode drum, the method comprising:

buffing a surface of the rotary negative electrode drum using a brush having a grit of 500# to 3000#;

electrodepositing a copper film on the buffed rotary negative electrode drum; and

winding the electrodeposited copper film, wherein

the electrolytic solution comprises 70 to 90 g/L of copper ions, 80 to 120 g/L of sulfuric acid, 10 to 20 ppm of chlorine ions, 3 to 12 ppm of a sulfide-based compound, 25 to 50 ppm of molybdenum (Mo), and 5 to 25 ppm of polyethylene glycol (PEG).

9. (Withdrawn) The method according to claim 8, wherein the sulfide-based compound is selected from a group consisting of bis-(sodium sulfopropyl) disulfide (SPS), 3-mercapto 1-propane sulfonate (MPS), and 3-(benzothiazolyl-2-mercapto)-propyl-sulfonate (ZPS).

10. (Withdrawn) The method according to claim 8, wherein the sulfide-based compound is SPS.

REMARKS

This Response is submitted in reply to the Restriction Requirement dated August 17, 2021. The Examiner is requiring the Applicant to elect one of the following inventions:

I. Claims 1-7, drawn to a product.

II. Claims 8-10, drawn to a method.

Applicant hereby elects Group I, including claims 1-7, without traverse for examination on the merits. Claims 8-10 has been withdrawn. Favorable consideration is respectfully requested.

Respectfully submitted,

K&L Gates LLP

BY /Matthew S. Dicke/
Matthew S. Dicke
Reg. No. 58,819
Customer No. 29178
312-578-5415

Dated: September 28, 2021

UNITED STATES PATENT AND TRADEMARK OFFICE

UNITED STATES DEPARTMENT OF COMMERCE
United States Patent and Trademark Office
Address: COMMISSIONER FOR PATENTS
P.O. Box 1450
Alexandria, Virginia 22313-1450
www.uspto.gov

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
16/959,352	06/30/2020	Seung Min KIM	0313221.00022	1067

24573 7590 08/17/2021

K&L Gates LLP-Chicago
P.O. Box 1135
Chicago, IL 60690

EXAMINER	
WITTENBERG, STEFANIE S	

ART UNIT	PAPER NUMBER
1795	

NOTIFICATION DATE	DELIVERY MODE
08/17/2021	ELECTRONIC

Please find below and/or attached an Office communication concerning this application or proceeding.

The time period for reply, if any, is set in the attached communication.

Notice of the Office communication was sent electronically on above-indicated "Notification Date" to the following e-mail address(es):

USpatentmail@klgates.com

Office Action Summary	Application No. 16/959,352	Applicant(s) KIM et al.	
	Examiner STEFANIE S WITTENBERG	Art Unit 1795	AIA (FITF) Status Yes

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 2 MONTHS FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1)☐ Responsive to communication(s) filed on _____.

☐ A declaration(s)/affidavit(s) under **37 CFR 1.130(b)** was/were filed on _____.

2a)☐ This action is **FINAL.** 2b) ☐ This action is non-final.

3)☐ An election was made by the applicant in response to a restriction requirement set forth during the interview on _____; the restriction requirement and election have been incorporated into this action.

4)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims*

5) ☑ Claim(s) 1-10 is/are pending in the application.

5a) Of the above claim(s) _____ is/are withdrawn from consideration.

6) ☐ Claim(s) _____ is/are allowed.

7) ☐ Claim(s) _____ is/are rejected.

8) ☐ Claim(s) _____ is/are objected to.

9) ☑ Claim(s) 1-10 are subject to restriction and/or election requirement

* If any claims have been determined allowable, you may be eligible to benefit from the **Patent Prosecution Highway** program at a participating intellectual property office for the corresponding application. For more information, please see http://www.uspto.gov/patents/init_events/pph/index.jsp or send an inquiry to **PPHfeedback@uspto.gov.**

Application Papers

10)☐ The specification is objected to by the Examiner.

11)☐ The drawing(s) filed on _____ is/are: a)☐ accepted or b)☐ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).

Priority under 35 U.S.C. § 119

12)☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

Certified copies:

a)☐ All b)☐ Some** c)☐ None of the:

1.☐ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. _____.

3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

** See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

1) ☐ Notice of References Cited (PTO-892)

2) ☐ Information Disclosure Statement(s) (PTO/SB/08a and/or PTO/SB/08b) Paper No(s)/Mail Date _____.

3) ☐ Interview Summary (PTO-413) Paper No(s)/Mail Date _____.

4) ☐ Other: _____.

DETAILED ACTION

Status of Claims

Claims 1-10 are pending.

Notice of Pre-AIA or AIA Status

The present application, filed on or after March 16, 2013, is being examined under the first inventor to file provisions of the AIA.

Election/Restriction

REQUIREMENT FOR UNITY OF INVENTION

As provided in 37 CFR 1.475(a), a national stage application shall relate to one invention only or to a group of inventions so linked as to form a single general inventive concept ("requirement of unity of invention"). Where a group of inventions is claimed in a national stage application, the requirement of unity of invention shall be fulfilled only when there is a technical relationship among those inventions involving one or more of the same or corresponding special technical features. The expression "special technical features" shall mean those technical features that define a contribution which each of the claimed inventions, considered as a whole, makes over the prior art.

The determination whether a group of inventions is so linked as to form a single general inventive concept shall be made without regard to whether the inventions are claimed in separate claims or as alternatives within a single claim. See 37 CFR 1.475(e).

When Claims Are Directed to Multiple Categories of Inventions:

As provided in 37 CFR 1.475 (b), a national stage application containing claims to different categories of invention will be considered to have unity of invention if the claims are drawn only to one of the following combinations of categories:

(1) A product and a process specially adapted for the manufacture of said product; or

(2) A product and a process of use of said product; or

(3) A product, a process specially adapted for the manufacture of the said product, and a use of the said product; or

(4) A process and an apparatus or means specifically designed for carrying out the said process; or

(5) A product, a process specially adapted for the manufacture of the said product, and an apparatus or means specifically designed for carrying out the said process.

Otherwise, unity of invention might not be present. See 37 CFR 1.475 (c).

Restriction is required under 35 U.S.C. 121 and 372.

This application contains the following inventions or groups of inventions which are not so linked as to form a single general inventive concept under PCT Rule 13.1.

In accordance with 37 CFR 1.499, applicant is required, in reply to this action, to elect a single invention to which the claims must be restricted.

Group I, claim(s) 1-7, drawn to a product.

Group II, claim(s) 8-10, drawn to a method.

The groups of inventions listed above do not relate to a single general inventive concept under PCT Rule 13.1 because, under PCT Rule 13.2, they lack the same or corresponding special technical features for the following reasons:

Groups I and II lack unity of invention because even though the inventions of these groups require the technical feature of electrolytic copper foil with low surface roughness, this technical feature is not a special technical feature as it does not make a contribution over the prior art in view of Chae et al. (KR 2017-0126775). Chae et al. disclose a method of producing electrolytic copper foil having low surface roughness having fine nodules located on at least one matte surface (abstract).

Applicant is reminded that upon the cancellation of claims to a non-elected invention, the inventorship must be corrected in compliance with 37 CFR 1.48(a) if one or more of the currently named inventors is no longer an inventor of at least one claim remaining in the application. A request to correct inventorship under 37 CFR 1.48(a) must be accompanied by an application data sheet in accordance with 37 CFR 1.76 that identifies each inventor by his or her legal name and by the processing fee required under 37 CFR 1.17(i).

The examiner has required restriction between product or apparatus claims and process claims. Where applicant elects claims directed to the product/apparatus, and all product/apparatus claims are subsequently found allowable, withdrawn process claims that include all the limitations of the allowable product/apparatus claims should be considered for rejoinder. All claims directed to a nonelected process invention must include all the limitations of an allowable product/apparatus claim for that process invention to be rejoined.

In the event of rejoinder, the requirement for restriction between the product/apparatus claims and the rejoined process claims will be withdrawn, and the rejoined process claims will be fully examined for patentability in accordance with 37 CFR 1.104. Thus, to be allowable, the rejoined claims must meet all criteria for patentability including the requirements of 35 U.S.C. 101, 102, 103 and 112. Until all claims to the elected product/apparatus are found allowable, an

otherwise proper restriction requirement between product/apparatus claims and process claims may be maintained. Withdrawn process claims that are not commensurate in scope with an allowable product/apparatus claim will not be rejoined. See MPEP § 821.04. Additionally, in order for rejoinder to occur, applicant is advised that the process claims should be amended during prosecution to require the limitations of the product/apparatus claims. **Failure to do so may result in no rejoinder.** Further, note that the prohibition against double patenting rejections of 35 U.S.C. 121 does not apply where the restriction requirement is withdrawn by the examiner before the patent issues. See MPEP § 804.01.

Any inquiry concerning this communication or earlier communications from the examiner should be directed to STEFANIE S WITTENBERG whose telephone number is (571)270-7594. The examiner can normally be reached on Monday - Friday, 7:00 am -4:00 pm EST.

Examiner interviews are available via telephone, in-person, and video conferencing using a USPTO supplied web-based collaboration tool. To schedule an interview, applicant is encouraged to use the USPTO Automated Interview Request (AIR) at http://www.uspto.gov/interviewpractice.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Luan Van can be reached on (571) 272-8521. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR

system, see https://ppair-my.uspto.gov/pair/PrivatePair. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free). If you would like assistance from a USPTO Customer Service Representative or access to the automated information system, call 800-786-9199 (IN USA OR CANADA) or 571-272-1000.

/Stefanie S Wittenberg/
Primary Examiner, Art Unit 1795

Index of Claims	Application/Control No.	Applicant(s)/Patent Under Reexamination
	16/959,352	KIM et al.
	Examiner	Art Unit
	STEFANIE S WITTENBERG	1795

✓	Rejected	-	Cancelled	N	Non-Elected	A	Appeal
=	Allowed	÷	Restricted	I	Interference	O	Objected

CLAIMS

☐ Claims renumbered in the same order as presented by applicant ☐ CPA ☐ T.D. ☐ R.1.47

CLAIM		DATE								
Final	Original	08/12/2021								
	1	÷								
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	10	÷								

UNITED STATES PATENT AND TRADEMARK OFFICE

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United States Patent and Trademark Office
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Alexandria, Virginia 22313-1450
www.uspto.gov

APPLICATION NUMBER	FILING OR 371(C) DATE	FIRST NAMED APPLICANT	ATTY. DOCKET NO./TITLE
16/959,352	06/30/2020	Seung Min KIM	0313221.00022

CONFIRMATION NO. 1067

24573
K&L Gates LLP-Chicago
P.O. Box 1135
Chicago, IL 60690

PUBLICATION NOTICE

OC00000122977722

Title:ELECTROLYTIC COPPER FOIL HAVING EXCELLENT HANDLING CHARACTERISTICS IN POSTPROCESSING, AND MANUFACTURING METHOD THEREFOR

Publication No.US-2021-0025066-A1
Publication Date:01/28/2021

NOTICE OF PUBLICATION OF APPLICATION

The above-identified application will be electronically published as a patent application publication pursuant to 37 CFR 1.211, et seq. The patent application publication number and publication date are set forth above.

The publication may be accessed through the USPTO's publically available Searchable Databases via the Internet at www.uspto.gov. The direct link to access the publication is currently http://www.uspto.gov/patft/.

The publication process established by the Office does not provide for mailing a copy of the publication to applicant. A copy of the publication may be obtained from the Office upon payment of the appropriate fee set forth in 37 CFR 1.19(a)(1). Orders for copies of patent application publications are handled by the USPTO's Public Records Division. The Public Records Division can be reached by telephone at (571) 272-3150 or (800) 972-6382, by facsimile at (571) 273-3250, by mail addressed to the United States Patent and Trademark Office, Public Records Division, Alexandria, VA 22313-1450 or via the Internet.

In addition, information on the status of the application, including the mailing date of Office actions and the dates of receipt of correspondence filed in the Office, may also be accessed via the Internet through the Patent Electronic Business Center at www.uspto.gov using the public side of the Patent Application Information and Retrieval (PAIR) system. The direct link to access this status information is currently https://portal.uspto.gov/pair/PublicPair. Prior to publication, such status information is confidential and may only be obtained by applicant using the private side of PAIR.

Further assistance in electronically accessing the publication, or about PAIR, is available by calling the Patent Electronic Business Center at 1-866-217-9197.

Office of Data Managment, Application Assistance Unit (571) 272-4000, or (571) 272-4200, or 1-888-786-0101

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U.S. APPLICATION NO.	FIRST NAMED INVENTOR	ATTY. DOCKET NO.
16/959,352	Seung Min KIM	0313221.00022

24573
K&L Gates LLP-Chicago
P.O. Box 1135
Chicago, IL 60690

INTERNATIONAL APPLICATION NO.	
PCT/KR2019/001069	
I.A. FILING DATE	PRIORITY DATE
01/25/2019	01/31/2018

CONFIRMATION NO. 1067
371 ACCEPTANCE LETTER

OC000000120789304

Date Mailed: 10/22/2020

NOTICE OF ACCEPTANCE OF APPLICATION UNDER 35 U.S.C 371 AND 37 CFR 1.495

The applicant is hereby advised that the United States Patent and Trademark Office, in its capacity as a Designated / Elected Office (37 CFR 1.495), has ACCEPTED the above identified international application for national patentability examination in the United States Patent and Trademark Office.

The United States Application Number assigned to the application is shown above. A Filing Receipt will be issued for the present application in due course. **THE DATE APPEARING ON THE FILING RECEIPT AS THE "FILING DATE or 371(c) DATE" IS THE DATE ON WHICH THE LAST OF THE 35 U.S.C. 371 (c)(1) and (c)(2) REQUIREMENTS HAS BEEN RECEIVED IN THE OFFICE. THIS DATE IS SHOWN BELOW.** The filing date of the above identified application is the international filing date of the international application (Article 11(3) and 35 U.S.C. 363)

06/30/2020
DATE OF RECEIPT OF 35 U.S.C.
371(c)(1) and (c)(2) REQUIREMENTS

The following items have been received:

- Copy of the International Application filed on 06/30/2020
- English Translation of the IA filed on 06/30/2020
- Copy of the International Search Report filed on 06/30/2020
- Preliminary Amendments filed on 06/30/2020
- Information Disclosure Statements filed on 06/30/2020
- Inventor's Oath or Declaration filed on 06/30/2020
- Request for Immediate Examination filed on 06/30/2020
- U.S. Basic National Fees filed on 06/30/2020
- Assignment filed on 06/30/2020
- Authorize Access to Search Results filed on 06/30/2020
- Priority Documents filed on 06/30/2020
- Power of Attorney filed on 06/30/2020
- Authorization to Permit Access filed on 06/30/2020
- Application Data Sheet (37 CFR 1.76) filed on 06/30/2020

FORM PCT/DO/EO/903 (371 Acceptance Notice)

Applicant is reminded that any communications to the United States Patent and Trademark Office must be mailed to the address given in the heading and include the U.S. application no. shown above (37 CFR 1.5)

TONI M HOOD

Telephone: (571) 272-3654

FORM PCT/DO/EO/903 (371 Acceptance Notice)

UNITED STATES PATENT AND TRADEMARK OFFICE

UNITED STATES DEPARTMENT OF COMMERCE
United States Patent and Trademark Office
Address: COMMISSIONER FOR PATENTS
P.O. Box 1450
Alexandria, Virginia 22313-1450
www.uspto.gov

APPLICATION NUMBER	FILING or 371(c) DATE	GRP ART UNIT	FIL FEE REC'D	ATTY.DOCKET.NO	TOT CLAIMS	IND CLAIMS
16/959,352	06/30/2020		1580	0313221.00022	10	2

CONFIRMATION NO. 1067

24573
K&L Gates LLP-Chicago
P.O. Box 1135
Chicago, IL 60690

FILING RECEIPT

OC000000120789303

Date Mailed: 10/22/2020

Receipt is acknowledged of this non-provisional utility patent application. The application will be taken up for examination in due course. Applicant will be notified as to the results of the examination. Any correspondence concerning the application must include the following identification information: the U.S. APPLICATION NUMBER, FILING DATE, NAME OF FIRST INVENTOR, and TITLE OF INVENTION. Fees transmitted by check or draft are subject to collection.

Please verify the accuracy of the data presented on this receipt. If an error is noted on this Filing Receipt, please submit a written request for a corrected Filing Receipt, including a properly marked-up ADS showing the changes with strike-through for deletions and underlining for additions. If you received a "Notice to File Missing Parts" or other Notice requiring a response for this application, please submit any request for correction to this Filing Receipt with your reply to the Notice. When the USPTO processes the reply to the Notice, the USPTO will generate another Filing Receipt incorporating the requested corrections provided that the request is grantable.

Inventor(s)

Seung Min KIM, Anyang-si, Gyeonggi-do, KOREA, REPUBLIC OF;
Shan Hua JIN, Anyang-si, Gyeonggi-do, KOREA, REPUBLIC OF;

Applicant(s)

KCF Technologies Co., Ltd., Anyang-si, Gyeonggi-do, KOREA, REPUBLIC OF;

Power of Attorney: The patent practitioners associated with Customer Number 24573

Domestic Priority data as claimed by applicant

This application is a 371 of PCT/KR2019/001069 01/25/2019

Foreign Applications (You may be eligible to benefit from the **Patent Prosecution Highway** program at the USPTO. Please see http://www.uspto.gov for more information.)
REPUBLIC OF KOREA 10-2018-0012179 01/31/2018

Permission to Access Application via Priority Document Exchange: Yes

Permission to Access Search Results: Yes

Applicant may provide or rescind an authorization for access using Form PTO/SB/39 or Form PTO/SB/69 as appropriate.

If Required, Foreign Filing License Granted: 10/20/2020

The country code and number of your priority application, to be used for filing abroad under the Paris Convention, is **US 16/959,352**

Projected Publication Date: 01/28/2021

Non-Publication Request: No

Early Publication Request: No
Title

ELECTROLYTIC COPPER FOIL HAVING EXCELLENT HANDLING CHARACTERISTICS IN POSTPROCESSING, AND MANUFACTURING METHOD THEREFOR

Preliminary Class

Statement under 37 CFR 1.55 or 1.78 for AIA (First Inventor to File) Transition Applications: No

PROTECTING YOUR INVENTION OUTSIDE THE UNITED STATES

Since the rights granted by a U.S. patent extend only throughout the territory of the United States and have no effect in a foreign country, an inventor who wishes patent protection in another country must apply for a patent in a specific country or in regional patent offices. Applicants may wish to consider the filing of an international application under the Patent Cooperation Treaty (PCT). An international (PCT) application generally has the same effect as a regular national patent application in each PCT-member country. The PCT process **simplifies** the filing of patent applications on the same invention in member countries, but **does not result** in a grant of "an international patent" and does not eliminate the need of applicants to file additional documents and fees in countries where patent protection is desired.

Almost every country has its own patent law, and a person desiring a patent in a particular country must make an application for patent in that country in accordance with its particular laws. Since the laws of many countries differ in various respects from the patent law of the United States, applicants are advised to seek guidance from specific foreign countries to ensure that patent rights are not lost prematurely.

Applicants also are advised that in the case of inventions made in the United States, the Director of the USPTO must issue a license before applicants can apply for a patent in a foreign country. The filing of a U.S. patent application serves as a request for a foreign filing license. The application's filing receipt contains further information and guidance as to the status of applicant's license for foreign filing.

Applicants may wish to consult the USPTO booklet, "General Information Concerning Patents" (specifically, the section entitled "Treaties and Foreign Patents") for more information on timeframes and deadlines for filing foreign patent applications. The guide is available either by contacting the USPTO Contact Center at 800-786-9199, or it can be viewed on the USPTO website at http://www.uspto.gov/web/offices/pac/doc/general/index.html.

For information on preventing theft of your intellectual property (patents, trademarks and copyrights), you may wish to consult the U.S. Government website, http://www.stopfakes.gov. Part of a Department of Commerce initiative, this website includes self-help "toolkits" giving innovators guidance on how to protect intellectual property in specific countries such as China, Korea and Mexico. For questions regarding patent enforcement issues, applicants may call the U.S. Government hotline at 1-866-999-HALT (1-866-999-4258).

LICENSE FOR FOREIGN FILING UNDER

Title 35, United States Code, Section 184

Title 37, Code of Federal Regulations, 5.11 & 5.15

GRANTED

The applicant has been granted a license under 35 U.S.C. 184, if the phrase "IF REQUIRED, FOREIGN FILING LICENSE GRANTED" followed by a date appears on this form. Such licenses are issued in all applications where the conditions for issuance of a license have been met, regardless of whether or not a license may be required as set forth in 37 CFR 5.15. The scope and limitations of this license are set forth in 37 CFR 5.15(a) unless an earlier license has been issued under 37 CFR 5.15(b). The license is subject to revocation upon written notification. The date indicated is the effective date of the license, unless an earlier license of similar scope has been granted under 37 CFR 5.13 or 5.14.

This license is to be retained by the licensee and may be used at any time on or after the effective date thereof unless it is revoked. This license is automatically transferred to any related applications(s) filed under 37 CFR 1.53(d). This license is not retroactive.

The grant of a license does not in any way lessen the responsibility of a licensee for the security of the subject matter as imposed by any Government contract or the provisions of existing laws relating to espionage and the national security or the export of technical data. Licensees should apprise themselves of current regulations especially with respect to certain countries, of other agencies, particularly the Office of Defense Trade Controls, Department of State (with respect to Arms, Munitions and Implements of War (22 CFR 121-128)); the Bureau of Industry and Security, Department of Commerce (15 CFR parts 730-774); the Office of Foreign AssetsControl, Department of Treasury (31 CFR Parts 500+) and the Department of Energy.

NOT GRANTED

No license under 35 U.S.C. 184 has been granted at this time, if the phrase "IF REQUIRED, FOREIGN FILING LICENSE GRANTED" DOES NOT appear on this form. Applicant may still petition for a license under 37 CFR 5.12, if a license is desired before the expiration of 6 months from the filing date of the application. If 6 months has lapsed from the filing date of this application and the licensee has not received any indication of a secrecy order under 35 U.S.C. 181, the licensee may foreign file the application pursuant to 37 CFR 5.15(b).

SelectUSA

The United States represents the largest, most dynamic marketplace in the world and is an unparalleled location for business investment, innovation, and commercialization of new technologies. The U.S. offers tremendous resources and advantages for those who invest and manufacture goods here. Through SelectUSA, our nation works to promote and facilitate business investment. SelectUSA provides information assistance to the international investor community; serves as an ombudsman for existing and potential investors; advocates on behalf of U.S. cities, states, and regions competing for global investment; and counsels U.S. economic development organizations on investment attraction best practices. To learn more about why the United States is the best country in the world to develop technology, manufacture products, deliver services, and grow your business, visit http://www.SelectUSA.gov or call +1-202-482-6800.

MULTIPLE DEPENDENT CLAIM FEE CALCULATION SHEET Substitute for Form PTO-1360 (For use with Form PTO/SB/06)	Application Number 16959352	Filing Date
	Applicant(s) Seung KIM	
	* May be used for additional claims or amendments	

CLAIMS	AS FILED		AFTER FIRST AMENDMENT		AFTER SECOND AMENDMENT	
	Indep	Depend	Indep	Depend	Indep	Depend
1			1			
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Total Indep	0		2		0	
Total Depend	0		8		0	
Total Claims	0		10		0	

	*		*		*	
	Indep	Depend	Indep	Depend	Indep	Depend
51						
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PATENT APPLICATION FEE DETERMINATION RECORD

Substitute for Form PTO-875

Application or Docket Number: 16/959,352

APPLICATION AS FILED - PART I

FOR	(Column 1) NUMBER FILED	(Column 2) NUMBER EXTRA	SMALL ENTITY RATE($)	SMALL ENTITY FEE($)	OR	OTHER THAN SMALL ENTITY RATE($)	OTHER THAN SMALL ENTITY FEE($)
BASIC FEE (37 CFR 1.16(a), (b), or (c))	N/A	N/A	N/A			N/A	320
SEARCH FEE (37 CFR 1.16(k), (i), or (m))	N/A	N/A	N/A			N/A	540
EXAMINATION FEE (37 CFR 1.16(o), (p), or (q))	N/A	N/A	N/A			N/A	800
TOTAL CLAIMS (37 CFR 1.16(i))	10 minus 20 =	*			OR	x 100 =	0.00
INDEPENDENT CLAIMS (37 CFR 1.16(h))	2 minus 3 =	*				x 480 =	0.00
APPLICATION SIZE FEE (37 CFR 1.16(s))	If the specification and drawings exceed 100 sheets of paper, the application size fee due is $310 ($155 for small entity) for each additional 50 sheets or fraction thereof. See 35 U.S.C. 41(a)(1)(G) and 37 CFR 1.16(s).						0.00
MULTIPLE DEPENDENT CLAIM PRESENT (37 CFR 1.16(j))							0.00
* If the difference in column 1 is less than zero, enter "0" in column 2.			TOTAL			TOTAL	1660

APPLICATION AS AMENDED - PART II

AMENDMENT A

	(Column 1) CLAIMS REMAINING AFTER AMENDMENT		(Column 2) HIGHEST NUMBER PREVIOUSLY PAID FOR	(Column 3) PRESENT EXTRA	SMALL ENTITY RATE($)	SMALL ENTITY ADDITIONAL FEE($)	OR	OTHER THAN SMALL ENTITY RATE($)	OTHER THAN SMALL ENTITY ADDITIONAL FEE($)
Total (37 CFR 1.16(i))	*	Minus	**	=	x =		OR	x =	
Independent (37 CFR 1.16(h))	*	Minus	***	=	x =		OR	x =	
Application Size Fee (37 CFR 1.16(s))									
FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j))							OR		
					TOTAL ADD'L FEE		OR	TOTAL ADD'L FEE	

AMENDMENT B

	(Column 1) CLAIMS REMAINING AFTER AMENDMENT		(Column 2) HIGHEST NUMBER PREVIOUSLY PAID FOR	(Column 3) PRESENT EXTRA	RATE($)	ADDITIONAL FEE($)		RATE($)	ADDITIONAL FEE($)
Total (37 CFR 1.16(i))	*	Minus	**	=	x =		OR	x =	
Independent (37 CFR 1.16(h))	*	Minus	***	=	x =		OR	x =	
Application Size Fee (37 CFR 1.16(s))									
FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j))							OR		
					TOTAL ADD'L FEE		OR	TOTAL ADD'L FEE	

* If the entry in column 1 is less than the entry in column 2, write "0" in column 3.
** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 20, enter "20".
*** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 3, enter "3".
The "Highest Number Previously Paid For" (Total or Independent) is the highest found in the appropriate box in column 1.

PATENT ASSIGNMENT COVER SHEET

Electronic Version v1.1
Stylesheet Version v1.2

EPAS ID: PAT6266693

SUBMISSION TYPE:	NEW ASSIGNMENT
NATURE OF CONVEYANCE:	ASSIGNMENT

CONVEYING PARTY DATA

Name	Execution Date
SEUNG MIN KIM	06/18/2020
SHAN HUA JIN	06/17/2020

RECEIVING PARTY DATA

Name:	KCF TECHNOLOGIES CO., LTD.
Street Address:	4F., 39, LS-RO 116BEON-GIL, DONGAN-GU
City:	ANYANG-SI, GYEONGGI-DO
State/Country:	KOREA, REPUBLIC OF
Postal Code:	14118

PROPERTY NUMBERS Total: 1

Property Type	Number
Application Number:	16959352

CORRESPONDENCE DATA

Fax Number: (312)827-8185

Correspondence will be sent to the e-mail address first; if that is unsuccessful, it will be sent using a fax number, if provided; if that is unsuccessful, it will be sent via US Mail.

Phone: 3123721121
Email: chicago.patents@klgates.com
Correspondent Name: K&L GATES LLP
Address Line 1: PO BOX 1135
Address Line 4: CHICAGO, ILLINOIS 60690

ATTORNEY DOCKET NUMBER:	0313221.00022
NAME OF SUBMITTER:	MATTHEW S. DICKE
SIGNATURE:	/Matthew S. Dicke/
DATE SIGNED:	08/25/2020
	This document serves as an Oath/Declaration (37 CFR 1.63).

Total Attachments: 2
source=0313221.00022_Assignment#page1.tif
source=0313221.00022_Assignment#page2.tif

COMBINED ASSIGNMENT AND DECLARATION (37 CFR 1.63) FOR UTILITY OR DESIGN APPLICATION USING AN APPLICATION DATA SHEET (37 CFR 1.76)

Title of Invention	ELECTROLYTIC COPPER FOIL HAVING EXCELLENT HANDLING CHARACTERISTICS IN POSTPROCESSING, AND MANUFACTURING METHOD THEREFOR	Attorney Docket No. 0313221.00022

As the below named inventor, I hereby declare that:

This declaration is directed to: ☒ The attached application, or

☐ United States application or PCT international application number _____

filed on _____

The above-identified application was made or authorized to be made by me.

I believe that I am the original inventor or an original joint inventor of a claimed invention in the application.

AND WHEREAS, KCF TECHNOLOGIES CO., LTD. (hereinafter "ASSIGNEE"), a corporation duly organized and existing under the laws of Republic of Korea and having its principal office and place of business at 4F., 39, LS-ro 116beon-gil, Dongan-gu, Anyang-si, Gyeonggi-do, 14118, desires to acquire the entire right, title, and interest therein;

NOW, THEREFORE, in consideration of One Dollar ($1.00) and other good and valuable consideration, the receipt and sufficiency of which are hereby acknowledged, I do hereby sell, assign, and transfer, and hereby set over unto ASSIGNEE, its successors, assigns and legal representatives, the full and exclusive right, title and interest to said invention in the United States of America and all foreign countries, including, without limitation, said invention as described in the aforesaid application, to be held and enjoyed by me, its successors and assigns, as fully and entirely as the same would have been held and enjoyed by me had this assignment and sale not been made, including, without limitation, all rights to the aforesaid application and to any United States Letters Patent therefor, when issued together with all improvements thereon and betterments thereof, all related applications including, but not limited to, divisions, continuations, continuations-in-part, reissues and reexaminations thereof and substitutions of or for said application, and all foreign rights including the right to make application for Letters Patent for said inventions in any and all foreign countries and the right to claim priority as to the filing date under the International Convention on the basis for the aforesaid application for United States Letters Patent; and I hereby authorizes and requests the Commissioner of Patents to issue all Letters Patent issuing therefrom to ASSIGNEE, for its interest as ASSIGNEE, its successors, assigns and legal representatives.

I hereby agree to execute any papers, provide any information and testify in any interference or litigation at the request of ASSIGNEE, its successors, assigns and legal representatives, when deemed essential to ASSIGNEE's, its successors', assigns' and legal representatives' full enjoyment, protection, enforcement and title in and to such invention and rights hereby transferred.

I furthermore agree upon request of said ASSIGNEE, its successors, assigns and legal representatives, and without further remuneration, to execute any and all papers desired by said ASSIGNEE, its successors, assigns and legal representatives, for the filing and granting of foreign applications and the perfecting of title thereto in said ASSIGNEE, its successors, assigns and legal representatives.

I hereby acknowledge that any willful false statement made in this declaration is punishable under 18 U.S.C. 1001 by fine or imprisonment of not more than five (5) years, or both.

LEGAL NAME OF INVENTOR

Inventor: Seung Min KIM Date: June / 18 / 2020

Signature: 

COMBINED ASSIGNMENT AND DECLARATION (37 CFR 1.63) FOR UTILITY OR DESIGN APPLICATION USING AN APPLICATION DATA SHEET (37 CFR 1.76)

20061376 /김승민 / 정수기술연구소 /2020-06-18 08:57/ 본인 문서로서 무단 복사 및 외부 유출을 금합니다.

COMBINED ASSIGNMENT AND DECLARATION (37 CFR 1.63) FOR UTILITY OR DESIGN APPLICATION USING AN APPLICATION DATA SHEET (37 CFR 1.76)

Title of Invention	ELECTROLYTIC COPPER FOIL HAVING EXCELLENT HANDLING CHARACTERISTICS IN POSTPROCESSING, AND MANUFACTURING METHOD THEREFOR	Attorney Docket No. 0313221.00022

As the below named inventor, I hereby declare that:

This declaration is directed to:

☒ The attached application, or

☐ United States application or PCT international application number _____

filed on _____

The above-identified application was made or authorized to be made by me.

I believe that I am the original inventor or an original joint inventor of a claimed invention in the application.

AND WHEREAS, KCF TECHNOLOGIES CO., LTD. (hereinafter "ASSIGNEE"), a corporation duly organized and existing under the laws of Republic of Korea and having its principal office and place of business at 4F., 39, LS-ro 116beon-gil, Dongan-gu, Anyang-si, Gyeonggi-do, 14118, desires to acquire the entire right, title, and interest therein;

NOW, THEREFORE, in consideration of One Dollar ($1.00) and other good and valuable consideration, the receipt and sufficiency of which are hereby acknowledged, I do hereby sell, assign, and transfer, and hereby set over unto ASSIGNEE, its successors, assigns and legal representatives, the full and exclusive right, title and interest to said invention in the United States of America and all foreign countries, including, without limitation, said invention as described in the aforesaid application, to be held and enjoyed by me, its successors and assigns, as fully and entirely as the same would have been held and enjoyed by me had this assignment and sale not been made, including, without limitation, all rights to the aforesaid application and to any United States Letters Patent therefor, when issued together with all improvements thereon and betterments thereof, all related applications including, but not limited to, divisions, continuations, continuations-in-part, reissues and reexaminations thereof and substitutions of or for said application, and all foreign rights including the right to make application for Letters Patent for said inventions in any and all foreign countries and the right to claim priority as to the filing date under the International Convention on the basis for the aforesaid application for United States Letters Patent; and I hereby authorizes and requests the Commissioner of Patents to issue all Letters Patent issuing therefrom to ASSIGNEE, for its interest as ASSIGNEE, its successors, assigns and legal representatives.

I hereby agree to execute any papers, provide any information and testify in any interference or litigation at the request of ASSIGNEE, its successors, assigns and legal representatives, when deemed essential to ASSIGNEE's, its successors', assigns' and legal representatives' full enjoyment, protection, enforcement and title in and to such invention and rights hereby transferred.

I furthermore agree upon request of said ASSIGNEE, its successors, assigns and legal representatives, and without further remuneration, to execute any and all papers desired by said ASSIGNEE, its successors, assigns and legal representatives, for the filing and granting of foreign applications and the perfecting of title thereto in said ASSIGNEE, its successors, assigns and legal representatives.

I hereby acknowledge that any willful false statement made in this declaration is punishable under 18 U.S.C. 1001 by fine or imprisonment of not more than five (5) years, or both.

LEGAL NAME OF INVENTOR

Inventor: Shan Hua JIN Date: 2020.06.17

Signature: Jin Shan Hua

(12) 특허협력조약에 의하여 공개된 국제출원

(19) 세계지식재산권기구
국제사무국

(43) 국제공개일
2019 년 8 월 8 일 (08.08.2019)

WIPO | PCT

(10) 국제공개번호
WO 2019/151718 A1

(51) 국제특허분류:
C25D 1/04 (2006.01) *H01M 4/13* (2010.01)
C25D 3/38 (2006.01) *H01M 10/052* (2010.01)
H01M 4/66 (2006.01)

(21) 국제출원번호: PCT/KR2019/001069

(22) 국제출원일: 2019 년 1 월 25 일 (25.01.2019)

(25) 출원언어: 한국어

(26) 공개언어: 한국어

(30) 우선권정보:
10-2018-0012179 2018 년 1 월 31 일 (31.01.2018) KR

(71) 출원인: 케이씨에프테크놀로지스 주식회사 (**KCF TECHNOLOGIES CO., LTD.**) [KR/KR]; 14118 경기도 안양시 동안구 엘에스로116번길 39, 4층, Gyeonggi-do (KR).

(72) 발명자: 김승민 (**KIM, Seung Min**); 14118 경기도 안양시 동안구 엘에스로116번길 39, 4층, Gyeonggi-do (KR). 김선화 (**JIN, Shan Hua**); 14118 경기도 안양시 동안구 엘에스로116번길 39, 4층, Gyeonggi-do (KR).

(74) 대리인: 특허법인 천문 (**ASTRAN INT'L IP GROUP**); 06225 서울시 강남구 역삼로 233, 5층 (역삼동, 신성빌딩), Seoul (KR).

(81) 지정국 (별도의 표시가 없는 한, 가능한 모든 종류의 국내 권리의 보호를 위하여): AE, AG, AL, AM, AO, AT, AU, AZ, BA, BB, BG, BH, BN, BR, BW, BY, BZ, CA, CH, CL, CN, CO, CR, CU, CZ, DE, DJ, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IR, IS, JO, JP, KE, KG, KH, KN, KP, KW, KZ, LA, LC, LK, LR, LS, LU, LY, MA, MD, ME, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PA, PE, PG, PH, PL, PT, QA, RO, RS, RU, RW, SA, SC, SD, SE, SG, SK, SL, SM, ST, SV, SY, TH, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW.

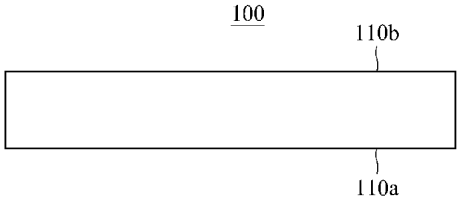
(84) 지정국 (별도의 표시가 없는 한, 가능한 모든 종류의 역내 권리의 보호를 위하여): ARIPO (BW, GH, GM, KE, LR, LS, MW, MZ, NA, RW, SD, SL, ST, SZ, TZ, UG, ZM, ZW), 유라시아 (AM, AZ, BY, KG, KZ, RU, TJ, TM), 유럽 (AL, AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV, MC, MK, MT, NL, NO, PL, PT, RO, RS, SE, SI, SK, SM, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, KM, ML, MR, NE, SN, TD, TG).

공개:
— 국제조사보고서와 함께 (조약 제21조(3))

WO 2019/151718 A1

(54) Title: ELECTROLYTIC COPPER FOIL HAVING EXCELLENT HANDLING CHARACTERISTICS IN POST-PROCESSING, AND MANUFACTURING METHOD THEREFOR

(54) 발명의 명칭: 후속 공정에서 핸들링 특성이 우수한 전해동박 및 그 제조방법



(57) Abstract: The present invention relates to an electrolytic copper foil having excellent handling characteristics in the manufacture of copper foil and in post-processing for manufacturing a secondary battery. The present invention provides an electrolytic copper foil having a first surface and a second surface, wherein the texture coefficient of the (220) plane of the electrolytic copper foil is 0.4-1.32, the difference (|Δ(Rz/Ra)|) between Rz/Ra on the first surface and Rz/Ra on the second surface, of the electrolytic copper foil, is less than 2.42, and the difference (|ΔPD|) in peak density (PD) between the first surface and the second surface, of the electrolytic copper foil, is 96 ea or less.

(57) 요약서: 본 발명은 동박 제조 및 후속 이차전지의 제조 공정에서 우수한 핸들링 특성을 갖는 전해동박에 관한 것이다. 본 발명은 제1 표면 및 상기 제2 표면을 갖는 전해동박에 있어서, 상기 전해동박은 (220) 면의 집합조직 계수가 0.4~1.32 이고, 상기 전해동박의 제1 표면에서의 Rz/Ra 와 제2 표면에서의 Rz/Ra 차이(|Δ(Rz/Ra)|)가 2.42 미만이며, 상기 전해동박의 제1 표면 및 제2 표면에서의 피크 밀도(PD) 차이(|ΔPD|) 가 96ea 이하인 것을 특징으로 하는 전해동박을 제공한다.

명세서

발명의 명칭: 후속 공정에서 핸들링 특성이 우수한 전해동박 및 그 제조방법

기술분야

[1] 본 발명은 전해동박에 관한 것으로, 보다 상세하게는 동박 제조 및 후속 이차전지의 제조 공정에서 우수한 핸들링 특성을 갖는 전해동박에 관한 것이다.

배경기술

[2] 휴대폰, 노트북 등 휴대용 가전의 사용 증가와 하이브리드 자동차의 보급과 더불어 Li 이차전지의 수요는 급격히 증가하고 있다.

[3] 리튬 이차전지에 있어서 음극 집전체의 소재로는 주로 전해동박이 사용된다. 전해동박은 전기 도금법에 의한 제박공정을 통해 제조되는데, 전해동박 제조시 생산 조건을 정밀하게 제어하지 않으며, 얇은 박막을 제조할 때 생길 수 있는 컬(Curl), 주름 또는 찢김 불량이 다량 발생하게 된다. 이러한 동박 제품의 불량은 동박 생산시 제조 원가를 상승시키는 주요한 원인이 되며, 컬 및 주름은 Li 이차전지의 품질을 저하시키는 주 요인으로 전체적인 품질 비용을 높이는 원인이 되기도 한다.

[4] 종래에는 이러한 동박 제품의 불량을 저감할 수 있는 방법으로 동박의 조도 범위를 일정하게 제어하는 것이 알려져 있다. 그러나, Li 이차전지의 용량 증대를 위해 10㎛ 이하의 동박을 Li 이차전지용 음극 집전체로 사용하는 비율이 증가함에 따라 동박의 조도를 정밀하게 제어를 함에도 불구하고 여전히 컬, 찢김 및 주름 불량이 발생하고 있는 실정이다.

[5] [선행기술문헌]

[6] 1. 한국특허공개 제10-2015-62228호

발명의 상세한 설명

기술적 과제

[7] 따라서, 본 발명은 위와 같은 관련 기술의 제한 및 단점들에 기인한 문제점들을 방지할 수 있는 전해동박 및 그 제조방법에 관한 것이다.

[8] 본 발명의 일 관점은, 전해동박의 제조 중 및/또는 후속 이차전지 제조 공정에서 컬, 주름 및/또는 찢김 발생 가능성을 감소시키는 전해동박을 제공하는 것이다.

[9] 본 발명의 다른 관점은, 전해동박의 제조 중 및/또는 후속 이차전지 제조 공정에서 컬, 주름 및/또는 찢김 발생 가능성을 감소시키는 전해동박을 제조하는 방법을 제공하는 것이다.

과제 해결 수단

[10] 위와 같은 본 발명의 일 관점에 따라, 제1 표면 및 상기 제2 표면을 갖는 전해동박에 있어서, 상기 전해동박은 다음의 수학식 1에 의해 정의되는

(220)면의 집합조직 계수가 0.4~1.32이고,

[11] (수학식 1)

[12]

$$TC(220) = \frac{\frac{I(220)}{I_0(220)}}{\frac{1}{n}\sum\frac{I(hkl)}{I_0(hkl)}}$$

[13] 상기 전해동박의 제1 표면에서의 Rz/Ra와 제2 표면에서의 Rz/Ra 차이(|Δ(Rz/Ra)|)가 2.42 미만이며, 상기 전해동박의 제1 표면 및 제2 표면에서의 피크 밀도(PD) 차이(|ΔPD|)가 96ea 이하인 것을 특징으로 하는 전해동박을 제공한다.

[14] 상기 제2 표면은 M면이고, 상기 제2 표면에서의 Rz/Ra가 4.2 ~ 9.0 인 것이 바람직하다. 또한, 상기 제1 표면은 S면이고, 상기 전해동박은 S면의 Rz/Ra가 5.1 ~ 6.8인 것이 바람직하다.

[15] 본 발명의 다른 관점에 따라, 전해조의 전해액 내에 서로 이격되게 배치된 양극판 및 회전 음극드럼 사이에 전류를 인가하여 상기 회전 음극드럼 상에 구리막을 전기 도금하여 전해동박을 제조하는 방법에 있어서, 상기 회전 음극드럼의 표면을 500# 내지 3000# 입도를 가지는 브러쉬로 버핑하는 단계; 상기 버핑된 회전 음극드럼 상에 구리막을 전착하는 단계; 및 도금된 상기 구리막을 권취하는 단계를 포함하되, 상기 전해액은 70 내지 90 g/L의 구리 이온, 80 내지 120 g/L의 황산, 10 내지 20 ppm의 염소 이온, 3 내지 12 ppm의 황화물계 화합물, 25 내지 50 ppm의 Mo, 및 5 내지 25 ppm의 PEG를 포함하는 것을 특징으로 하는 전해동박의 제조 방법을 제공한다.

[16] 상기 황화물계 화합물은 SPS, MPS 및 ZPS로 이루어진 그룹 중에서 선택될 수 있다. 바람직하게는 상기 황화물계 화합물은 SPS일 수 있다.

발명의 효과

[17] 본 발명에 따르면, 회전 음극드럼의 표면 프로파일, 동박 표면의 표면 조직 구조 및 표면 프로파일을 제어하여 전해동박 제조 공정 및/또는 후속 이차전지 제조 공정에서 컬, 주름 및/또는 찢김 발생 가능성을 감소시키는 전해동박을 제공할 수 있게 된다.

도면의 간단한 설명

[18] 도 1은 본 발명의 실시예에 따른 전해동박의 단면을 나타낸 모식도이다.

[19] 도 2는 본 발명의 전해동박 제박장치를 모식적으로 도시한 도면이다.

[20] 도 3은 본 발명의 일실시예에서 컬 값의 측정 방법을 보여주는 사진이다.

[21] 도 4의 (a) 및 (b)는 각각 찢김 및 주름 발생 상태를 예시하는 사진이다.

발명의 실시를 위한 형태

[22] 이하 도면을 참조하여 본 발명의 바람직한 실시예를 설명한다.

[23] 도 1은 본 발명의 실시예에 따른 전해동박의 단면을 나타낸 모식도이다.

[24] 도 1을 참조하면, 전해동박(100)은 제1 표면(110a) 및 제2 표면(110b)을 구비한다.

[25] 본 발명에서 상기 전해동박(100)은 소정 두께 예컨대 4 내지 30 ㎛의 두께를 갖는다. 동박 두께가 4㎛ 미만인 경우 전지 제조공정에서의 작업성 저하를 초래하고, 30㎛ 이상인 경우 Li 이차전지 제조시 동박의 두꺼운 두께로 인해 고용량 구현이 어렵게 된다.

[26] 상기 전해동박(100)은 회전 음극드럼에서 전기도금에 의해 형성되는데, 전기도금 과정에서 상기 회전 음극 드럼과 직접 접촉하는 표면은 샤이니 면(S면)과 그 반대 편의 매트 면(M면)을 갖는다. 예컨대, 본 발명에서 상기 제1 표면은 S면이고, 상기 제2 표면을 M면일 수 있다.

[27] 주름, 컬 및 찢김의 발생을 억제하기 위하여, 본 발명의 상기 전해동박(100)은 제어된 표면조직 인자 및 표면형상 인자를 갖는다.

[28] 표면조직 인자로서, 상기 전해동박은 (220)면의 집합조직 계수가 특정 범위에 있도록 제어된 결정 구조를 갖는 것이 바람직하다. 본 발명에서 (220)면의 집합조직 계수(Texture Coefficient; TC)는 다음의 수학식 1에 의해 표현된다.

[29] (수학식 1)

[30]
$$TC(220) = \frac{\frac{I(220)}{I_0(220)}}{\frac{1}{n}\Sigma\frac{I(hkl)}{I_0(hkl)}}$$

[31] 위 수학식 1에서 I(hkl)은 시편의 (hkl) 결정면의 XRD 회절 강도를 의미하고, I_0(hkl)은 JCPDS(Joint Committee on Powder Diffraction Standards)에 규정된 표준 구리 분말의 (hkl) 결정면의 회절 강도를 의미한다(X선 광원 : Cu $K_{\alpha 1}$) . 또한, 수학식 1에서 n은 특정 범위의 회절각(2θ) 내에서 회절 피크의 수를 나타낸다. 본 발명에서 집합조직 계수는 회절각(2θ) 30°에서 95° 범위에서 X선 회절 패턴으로부터 구하는데, 고려되는 현저한 결정면은 (111), (200), (220) 및 (311)면이다(즉, n=4). 따라서, (220)면의 집합조직계수는 시편의 X선 회절 패턴에서 (111), (200), (220) 및 (311)면에 대하여 표준 Cu의 피크 강도로 정규화 된 평균 피크 강도에 대하여 (220)면의 정규화 된 피크 강도의 비율을 나타낸다.

[32] 본 발명에서 상기 전해동박(100)은 제1 표면(110a) 및 제2 표면(110b) 모두에서 0.40 내지 1.32의 (220) 집합조직계수를 갖는 것이 바람직하다. 후술하는 바와 같이, (220) 집합조직 계수가 0.40 미만이면 동박의 결정 조직이 치밀하지 못하여 전지 제조 공정에서 겪는 응력 및 열에 의해 조직이 변형되어 주름을 발생시킨다. 또한, (220) 집합조직 계수가 1.32를 초과하면 동박의 조직이 너무 치밀하여 취성을 가지며 전지 제조 공정에서 찢김이 발생한다.

[33] 본 발명에서 상기 표면 형상 인자로서, 상기 전해동박(100)의 제1 표면에서의 Rz/Ra와 제2 표면에서의 Rz/Ra 차이, 즉 |Δ(Rz/Ra)|이 2.42 미만인 것이

바람직하다. 여기서, Rz는 십점평균조도, Ra는 산술평균조도이다. 또한, 본 발명에서 상기 전해동박은 제1 표면 및 제2 표면에서의 피크 밀도(Peak density, PD) 차이, 즉 |ΔPD|가 96ea 이하인 것이 바람직하다.

[34] 본 발명에서 전술한 Rz 및 Ra 는 JIS B 0601(2001) 규격에 따라 측정될 수 있고, PD는 ASME B46.1 규격에 따라 측정될 수 있다.

[35] 본 발명에서 전해동박 양면에서의 |Δ(Rz/Ra)| 및 |ΔPD|가 전술한 수치 범위를 벗어나면 전해동박 양면에서의 표면 특성 차이로 인해 컬이 발생하게 된다.

[36] 또한, 전해동박의 M면에서의 Rz/Ra는 4.2 내지 9.0 범위에 있는 것이 바람직하다. Rz/Ra가 4.2 미만인 경우 음극활물질과 접촉할 수 있는 동박의 비표면적이 작아 음극재와 충분한 결합력을 형성하기가 어렵고, 9.0을 초과하는 경우 전해동박의 표면이 불균일하여 음극활물질이 동박 표면에 균일하게 접착될 수 없다.

[37] 본 발명에서 상기 전해동박은 상온(25±15℃)에서 측정한 인장강도가 30 ~ 65kgf/mm^{2}인 전해동박인 것이 바람직하다. 인장강도가 30 미만인 경우 제조 공정 중에 가해 지는 힘에 의해 변형이 발생되기 쉽다. 또한, 인장강도가 65를 초과하는 경우 높은 취성을 가져 후속 Li 이차전지 제조 공정에서 가해지는 국부적인 압력에 의해 찢김이 발생될 수 있어, 작업성이 저하된다. 본 발명에서 시편의 인장강도는 IPC-TM-650 Test Method Manual의 규정에 준하여, 만능시험기(UTM)에 의해 측정될 수 있다. 본 발명의 일 실시예에 따르면, 인스트론사(Instron)의 만능시험기에 의해 인장강도가 측정되는데, 측정용 샘플의 폭은 12.7 mm이고, 그립(grip)간 거리는 50 mm이며, 측정 속도는 50 mm/min에서 측정된다. 평가를 위해 샘플의 인장강도는 3회에 걸쳐 반복 측정하여, 그 평균값을 전해동박의 인장강도로 할 수 있다.

[38] 또한, 본 발명에서 전해동박은 상온(25±15℃)에서 측정한 연신율이 3% 이상인 것이 바람직하다. 연신율이 3% 미만인 경우 원통형 전지에 적용될 경우 충방전시 가해지는 부피 팽창에 의해 동박이 신장되지 못하고 파단이 발생할 수 있다. 여기서 상온 연신율은 전술한 인장강도 측정 조건에서 시험 샘플의 파단시의 연신율로 한다.

[39] 또한, 본 발명의 전해동박은 폭방향 중량 편차가 5% 이하인 것이 바람직하다. 폭방향 중량 편차가 5%를 초과하는 경우 전해동박을 보빈에 권취할 때 동박과의 중량 중첩으로 국부적으로 늘어나는 현상이 발생되어 울음 불량이 발생할 수 있다. 본 발명에서 전해동박의 폭방향 중량 편차는 동박을 5㎝ x 5㎝의 면적으로 절개하여 시편을 만든 후 그 중량을 측정하여 단위면적당 동박 중량값을 환산하고, 동박의 폭 방향을 따라 상기 시편을 절개하는 과정을 반복적으로 수행하여 각 시편에 대한 동박 중량값들을 측정한 후 표준편차를 계산함으로써 산출된다.

[40] 도 2는 본 발명의 전해동박 제박장치를 모식적으로 도시한 도면이다.

[41] 도 2에 도시된 바와 같이, 전해조(10) 내의 전해액(20) 내에 서로 이격되게

배치된 양극판(30) 및 회전 음극드럼(40)이 구비된다. 회전 음극드럼(40)을 소정 방향으로 회전시키면서 상기 회전 음극드럼(40)과 양극판(30) 사이에 전원을 인가하면 전해액(20)을 매개로 하여 통전에 의해 도금이 수행된다. 회전 음극드럼(40) 표면에 도금된 구리막(100)은 가이드 롤(50)에 의해 권취된다.

[42] 상기 전해동박을 석출시키는 전해액(20)으로서는 황산 구리 전해액, 피로린산 구리 전해액 또는 슬파민산 구리 전해액 등이 사용될 수 있다. 바람직하게는 본 발명에서 전해액으로는 황산 구리 전해액이 매우 적합하다.

[43] 이 때, 상기 양극판(30)은 서로 전기적으로 절연된 제1 양극판(31) 및 제2 양극판(32)을 포함할 수 있다. 이 때, 상기 양극판(30), 즉 상기 제1 및 제2 양극판들(31, 32)에 의해 각각 제공되는 전류밀도는 40 내지 80 A/dm^2 일 수 있다.

[44] 본 발명의 일 실시예에서, 상기 전해액(20)은 70 내지 90 g/L의 구리 이온, 80 내지 120 g/L의 황산, 10 내지 30 ppm의 염소 이온을 포함할 수 있다.

[45] 또한, 상기 전해액(20)은 광택제나 평활제와 같은 첨가제를 더 포함할 수 있다. 본 발명에서 상기 첨가제는 SPS(비스-(소듐 술포프로필) 디설파이드), MPS(3-메르캅토 1-프로판 술폰산 나트륨) 및 ZPS(3-(벤조티아졸릴-2-메르캅톤)-프로필-술폰산 나트륨)로 이루어지는 그룹 중에서 선택되는 최소한 1종의 황화물계 화합물을 포함할 수 있다. 이 때, 바람직하게는 SPS가 사용되는 것이 좋다. 본 발명에서 상기 황화물계 화합물의 농도가 12ppm을 초과하면 도금이 미세하게 되고, (220) 집합조직 계수가 바람직한 상한을 초과하게 된다. 이와 달리, 전해액 내의 황화물계 화합물의 농도가 3ppm 미만이면 도금된 결정립의 사이즈가 크고 (111) 집합조직이 발달하여, 상대적으로 (220) 집합조직은 덜 발달하게 되어 집합조직계수가 바람직한 하한을 이탈하게 된다.

[46] 본 발명에서 상기 회전 음극드럼(40)은 전해동박의 S면의 표면 프로파일의 제어에 적합한 표면 프로파일을 가진다. 전해동박의 S면은 동박의 드럼과 접촉하며 그 프로파일은 드럼의 표면 구조에 영향을 받는다. 구체적으로 본 발명에서 드럼의 표면 구조는 드럼 표면의 버핑에 의해 제어될 수 있다. 예컨대, 500# 내지 3000# 입도를 가지는 브러쉬를 사용하여 드럼 표면을 버핑하게 되면 전착된 전해동박 S면의 Rz/Ra의 범위는 5.1~6.8 수준으로 변동성이 작은 값을 나타낸다. 이와 달리, 3000#이 넘는 브러쉬에 의한 드럼 표면 버핑은 드럼에 낮은 표면 프로파일을 초래하고, 구리의 균일한 전착을 유발한다. 이에 따라, S면의 Rz 값이 Ra 값에 수렴하게 되며, 결과적으로 M면과 S면의 Rz/Ra 차이가 큰 값을 나타내게 된다.

[47] 또한, 드럼 표면의 버핑은 피크밀도(PD)에 영향을 미칠 수 있다. 다만, 500# 내지 3000# 입도를 가지는 브러쉬를 사용하여 드럼 표면을 버핑하게 되면 전착된 전해동박 S면의 피크밀도는 10~20ea 수준의 비교적 균일한 값을 갖는 전해동박이 얻어질 수 있다.

[48] 본 발명에서 전해동박 M면의 표면 프로파일은 다음의 방식으로 추가적으로

제어될 수 있다.

[49] 먼저, 본 발명에서 전해액 내의 Mo 농도는 25 내지 50ppm으로 유지된다. 전해액 내의 Mo 농도가 50ppm을 초과하면 구리가 불균일하게 도금되어 동박 M면의 Rz가 급격하게 증가하게 된다. 이에 따라 Rz/Ra 값이 S면 대비 매우 높아지며, 동박 양면의 Rz/Ra 값의 차이는 바람직한 상한을 이탈하게 된다. 또한, Mo 농도가 25ppm 미만이면 Mo가 드럼의 전체 표면에 걸쳐 균일한 첨가제로서의 역할을 하지 못하여 국부적으로 불균일한 도금을 야기한다. 그 결과 동박의 M면에 얼룩 혹은 불균일 전착을 발생시키는데, 이러한 얼룩이나 불균일 도금은 후속 Li 이차전지 제조공정에서 음극재가 불균일하게 도포되게 되어 Li 이차전지 용량을 저하시키는 원인이 된다.

[50] 또한, 본 발명에서는 평활제로 사용되는 PEG의 농도를 제어함으로써 M면의 표면 프로파일을 바람직한 범위 내에서 유지되도록 할 수 있다. 본 발명에서 전해액 내의 폴리에틸렌글리콜(Polyethyleneglycol)의 농도는 5 내지 25 ppm 범위 내로 조정된다. PEG의 농도가 5ppm 미만이면 도금시 구리가 평활하게 전착되지 못하고 미세 요철이 발달된 표면 구조를 갖는다. 이로 인해 동박 M면의 PD 값이 높아지게 되고, M면과 S면의 PD 값 차이는 커지게 된다. 한편, PEG의 농도가 25ppm을 넘으면 전해액 내에 구리 도금이 평활하게 전착되어 Rz/Ra가 4.2 미만의 값을 가진다.

[51] 본 발명에서 상기 전해액(60)은 45 내지 65 ℃로 유지되고, 상기 전해조(10) 내로 공급되는 상기 전해액(20)의 유량은 35 내지 46 m^3/hour 범위로 유지되는 것이 바람직하다. 상기 전해액(20)의 유량이 35 m^3/hour 이하인 경우 회전 음극드럼(40) 표면에 구리 이온이 원활히 공급되지 못해 도금 박막이 불균일하게 형성되며, 상기 전해액(20)의 유량이 46 m^3/hour를 초과할 경우 필터를 통과하는 전해액(20)의 유속이 너무 빨라서 필터의 수명이 급격히 단축되는 원인이 된다.

[52]

[53] 이하 본 발명의 바람직한 실시예를 상술한다.

[54] <전해동박의 제조>

[55] 도 2에 도시된 것과 같은 장치를 사용하여 전해조 내의 전해액 내에 서로 이격되게 배치된 양극판 및 회전 음극드럼을 통전시킴으로써 상기 회전 음극드럼상에 구리막을 형성하였다.

[56] 전해액은 75g/L의 구리 이온, 100 g/L의 황산, 및 20 ppm의 염소 이온을 포함하는 용액에 SPS, Mo 및 PEG를 첨가함으로써 준비되었다. 전해액의 SPS, Mo 및 PEG 함량을 달리하여 상이한 함량 조건에서 구리막을 전착하였다. 이 때, 전해액의 온도는 약 55℃로 유지하고, 전류밀도는 60 A/dm^2, 유량은 40m^3/hr로 하였다. 또한, 동박 제조 전 동박 S면에서 상이한 표면 프로파일을 얻기 위하여 회전 음극드럼의 표면을 상이한 입도(거칠기)의 브러쉬로 버핑하여 실험을 수행하였다.

[57] 제조된 동박의 제박 조건을 아래 표 1에 나타내었다.

[58] [표1]

	SPS (ppm)	Mo (ppm)	PEG (ppm)	Brush (#)
실시예1	3	25	15	2000
실시예2	12	25	15	2000
실시예3	7	49	15	2000
실시예4	7	25	5	2000
비교예1	2	25	15	2000
비교예2	13	25	26	2000
비교예3	7	51	15	2000
비교예4	7	25	4	2000
비교예5	7	25	15	4000

[59] 이어서, 제조된 전해동박 시편(실시예 1 내지 4 및 비교예 1 내지 5)의 특성을 측정하였다. 각 특성에 대한 측정 방법은 다음과 같이 하였다.

[60] **집합조직 계수**

[61] 제작된 전해동박 시편의 M면에 대하여 회절각(2θ) 30°에서 95° 범위에서 X선 회절 패턴을 구하고, 결정면 (111), (200), (220) 및 (311)면을 기준으로 표준 Cu의 피크 강도로 정규화 된 평균 피크 강도에 대하여 (220)면의 정규화 된 피크 강도의 비율을 구하여 (220)면의 집합조직 계수로 하였다.

[62] **동박 표면 프로파일**

[63] 미투토요사 SJ-310 모델, 반경 2㎛인 스타일러스 팁을 사용하고, 측정 압력을 0.75mN으로 하여, JIS B 0601 (2001) 규격에 따라 Rz 및 Ra를 측정하였다. 이 때 컷 오프(Cut off) 길이를 제외한 측정 길이는 4mm이며, 컷 오프 길이는 초기와 말기 각각 0.8mm로 하였고, 각각 3회 측정값의 평균을 취하였다.

[64] 피크밀도(PD)는 ASME B46.1 규격에 따라 측정하며, 마흐(Mahr)사의 조도계(Marsurf M300 모델)와 반경 2㎛인 스타일러스 팁을 이용하여 피크 밀도를 측정하였다. 피크 카운트 레벨(Peak Count Level)은 프로파일의 중심선을 기준으로 ±0.5㎛로 하였고, 컷 오프 길이를 제외한 측정 길이는 4mm, 컷 오프 길이는 초기와 말기 각각 0.8mm로 하였다. 측정 압력은 0.7mN으로 하였다. 피크 밀도는 3회 측정값의 평균을 취하였다.

[65] **컬(curl)**

[66] 도 3과 같이, 실시예 및 비교예에서 제조된 전해동박의 M면 상의 임의의 지점에서 8cm X 8cm로 열십자 형태로 수직 이등분하도록 절개하여 4개의 절개부를 형성하였다. 절개 후 뾰족하게 튀어나온 4개의 절개부 모서리 높이를 측정하여 그 높이 측정값의 산술 평균값을 컬로 정의하였다.

[67] **주름 및 찢김**

[68] 롤투롤 공정에서 전해동박의 주름과 찢김이 발생하는지를 육안으로 관찰하였다. 도 4의 (a) 및 (b)는 각각 찢김 및 주름 발생 상태를 예시하는 사진이다.

[69] <음극의 제조>

[70] 전술한 실시예 및 비교예에서 제조된 전해동박으로 10cm 폭의 집전체를 준비하였다. 집전체 상에 음극활물질용으로 시판되는 인조 흑연 및 SiO_2 100 중량부에 대해 SBR(스티렌부타디엔고무) 2 중량부 및 CMC(카르복시메틸 셀룰로오스) 2 중량부를 혼합하고 증류수를 용제로 하여 슬러리를 제조하였다.

[71]

[72] 이어서, 표면이 깨끗한 유리판 위에 측정하고자 하는 전해동박 시편을 올려 놓은 후 주름, 구겨짐 등이 없도록 펼쳐 놓고, 동박 위에 바코터(Bar coater)를 사용하여 음극재 로딩(Loading)양이 9.0±0.5mg/㎠가 되도록 코팅하였다. 이 때, 바코터의 속도는 10~15mm/s의 속도로 실시하였다. 음극재가 코팅 된 동박을 100℃로 가열된 건조 오븐 에 넣어 15분 동안 건조하고, 건조된 동박 시편을 롤 프레스를 사용하여 전극 밀도 1.55±0.05g/㎤가 되도록 4단 프레스하여 음극을 제조하였다. 제조된 음극으로 다음의 방법으로 밀착력을 측정하였다.

[73] 제조된 전극을 절단하여 10mm(폭) x 100mm(길이)의 시료를 얻고, 이 시료의 활물질 부분과 보강판을 양면 테이프로로 접착하였다. 이때 제작 되는 모든 시료는 균일한 힘으로 부착 될 수 있도록 하였다. UTM 장치를 이용하여 제작된 시편의 접착력(밀착력)을 측정하였다.

[74] -. Crosshead speed : 50.0mm/min.

[75] -. 측정 길이 : 20~50mm

[76] -. 90° Peeling 테스트

[77]

[78] <Li 이차전지의 제조>

[79] 에틸렌카보네이트(EC) 및 에틸메틸카보네이트(EMC)를 1:2의 비율로 혼합한 비수성 유기용매에 용질로서 $LiPF_6$을 1M 용해시킨 것을 기본 전해액으로 하고, 이 기본 전해액 99.5중량%와 숙신산 무수물(Succinic anhydride) 0.5중량%를 혼합하여 비수전해액을 제조하였다.

[80] $Li_{1.1}Mn_{1.85}Al_{0.05}O_4$인 리튬 망간 산화물과 o-$LiMnO_2$인 사방정(orthorhombic) 결정구조의 리튬 망간 산화물을 중량비 90:10으로 혼합하여, 양극 활물질을 제조하였다. 상기 양극 활물질과 카본 블랙을 결착제인 PVDF[Poly(vinylidenefluoride)]와 85:10:5의 중량비로 유기 용매인 NMP와 혼합하여 슬러리를 제조하였다. 제조된 슬러리를 두께 20 ㎛인 Al 박(foil) 양면에 도포한 후 건조하여 양극을 제작하였다. 제조된 양극, 음극 및 전해액으로 Li 이차전지 셀을 제조하였다.

[81] 아래 표 2는 본 발명의 실시예에 따라 제조된 전해동박 시편의 물성 측정 결과 및 그 전해동박으로 제조된 음극의 밀착력 측정 결과를 나타낸 표이다.

[82] [표2]

	실시예1	실시예2	실시예3	실시예4	비교예1	비교예2	비교예3	비교예4	비교예5
집합조직계수	0.4	1.32	0.78	0.78	0.32	1.41	0.78	0.78	0.78
|Δ(Rz/Ra)|	0.85	0.85	2.42	0.85	0.85	0.85	2.43	0.85	2.43
Rz/Ra (M면)	4.22	4.21	9.00	4.21	4.21	4.08	9.13	4.22	4.22
Rz/Ra (S면)	3.37	3.36	6.58	3.36	3.36	3.23	6.70	3.37	1.79
|ΔPD|(ea/cm)	38	38	38	96	38	38	38	97	38
M면 PD(ea/cm)	48	48	48	105	48	48	48	107	48
S면 PD(ea/cm)	10	10	10	9	10	10	10	10	10
컬 (mm)	5.6	5.5	8.7	8.6	5.2	5.4	11.5	11.6	11.6
주름	no	no	no	no	yes	no	no	no	no
찢김	no	no	no	no	no	yes	no	no	no
밀착력 (N/m)	26.4	26.4	28.4	26.4	26.8	15.5	15.4	26.7	26.3

[83] 표 2를 참조하면, 실시예 1 내지 4에 따라 제조된 전해동박 샘플은 모두 10mm 이하의 양호한 컬 값을 나타내었다. 이와 같은 컬 값 범위를 갖는 전해동박 은 동박 제조공정이나 후속 전지 제조 공정에서 접힘을 발생하지 않게 된다. 한편, 비교예 1 및 비교예 2의 경우 실시예와 유사한 수준의 |Δ(Rz/Ra)| 및 |ΔPD|을 나타내고 있지만, 롤투롤 공정에서 주름 또는 찢김 현상이 관찰되었다. 이것은 각각 (220) 집합계수가 0.40 미만의 값을 가져 동박의 결정 조직이 치밀하지 못하여 전지 제조 공정에서 겪는 응력 및 열에 의해 조직이 변형되어 주름을 발생시키거나 (220) 집합조직 계수가 1.32를 초과하여 동박의 조직이 너무 치밀하여 취성을 가진 것에 기인한다.

[84] 한편, 비교예 3의 경우 M면의 Rz/Ra가 매우 높은 값(9.13)을 나타내며 그로 인해 |Δ(Rz/Ra)|가 2.42를 초과하여 높은 컬 값을 나타냄을 알 수 있다. 또한, 비교에 4의 경우 PEG의 함량이 작아 미세 요철이 발달된 표면 구조를 나타내어 동박 M면의 PD 값(97ea)이 높아지고 이로 인해 컬 값이 증가하게 됨을 알 수

있다. 한편, 비교예 5의 경우 S면의 Rz/Ra 값이 매우 낮은 값을 가지며 |Δ(Rz/Ra)|가 2.42를 초과하고 있는데, 이것은 회전 음극드럼의 표면 프로파일에 기인하는 것이다.

[85] 한편, 비교예 2 및 3의 경우, 제조된 음극이 낮은 밀착력 값을 나타내고 있다. 이와 같이 밀착력이 20 N/m 미만인 경우에는 Li 이차전지 제조후 충반전시 동박 표면에서 음극재가 탈리되어 충전 용량이 급격히 저하될 수 있다. 비교예 2 및 3은 각각 (220) 집합조직 계수가 낮거나 M면의 Rz/Ra가 낮은 값을 나타내어 음극재와 충분한 결합력을 형성할 수 없다. 그 이유는 동의 결정 조직이 치밀하지 못하거나 또는 비표면적이 낮은 것에 기인한다.

[86] 이상, 본 발명의 실시예를 통해 본 발명을 상술하였지만, 전술한 실시예는 본 발명의 기술 사상을 예시적으로 설명한 것에 불과한 것으로서, 본 발명이 속하는 기술 분야에서 통상의 지식을 가진 자라면 본 발명의 본질적인 특성에서 벗어나지 않는 범위에서 다양한 수정 및 변형이 가능함을 알 수 있을 것이다. 따라서, 본 발명에 개시된 실시 예는 본 발명의 기술 사상을 한정하기 위한 것이 아니라 설명하기 위한 것이고, 이러한 실시 예에 의하여 본 발명의 기술 사상의 범위가 한정되는 것은 아니다. 본 발명의 보호 범위는 아래의 청구범위에 의하여 해석되고, 그와 동등한 범위 내에 있는 모든 기술 사상은 본 발명의 권리범위에 포함되는 것으로 해석되어야 할 것이다.

청구범위

[청구항 1] 제1 표면 및 상기 제2 표면을 갖는 전해동박에 있어서,
상기 전해동박은 다음의 수학식 1에 의해 정의되는 (220)면의 집합조직 계수가 0.4~1.32이고,
(수학식 1)

$$TC(220) = \frac{\frac{I(220)}{I_0(220)}}{\frac{1}{n}\Sigma\frac{I(hkl)}{I_0(hkl)}}$$

상기 전해동박의 제1 표면에서의 Rz/Ra와 제2 표면에서의 Rz/Ra 차이(|Δ(Rz/Ra)|)가 2.42 미만이며,
상기 전해동박의 제1 표면 및 제2 표면에서의 피크 밀도(PD) 차이(|ΔPD|)가 96ea 이하인 것을 특징으로 하는 전해동박.

[청구항 2] 제1항에 있어서,
상기 제2 표면은 M면이고,
상기 제2 표면에서의 Rz/Ra가 4.2 ~ 9.0 인 것을 특징으로 하는 전해동박.

[청구항 3] 제2항에 있어서,
상기 제1 표면은 S면이고,
상기 전해동박은 S면의 Rz/Ra가 5.1 ~ 6.8인 것을 특징으로 하는 전해동박.

[청구항 4] 제1항에 있어서,
상기 전해동박은 상온에서의 인장강도가 30~65 kg/mm^{2}인 것을 특징으로 하는 전해동박.

[청구항 5] 제1항에 있어서,
상기 전해동박은 상온에서의 연신율이 3% 이상인 것을 특징으로 하는 전해동박.

[청구항 6] 제1항에 있어서,
상기 전해동박은 폭 방향 중량편차가 5% 이하인 것을 특징으로 하는 전해동박.

[청구항 7] 제1항에 있어서,
상기 전해동박은,
8cm X 8cm로 열십자 형태로 수직 이등분하도록 절개하여 4개의 절개부를 형성한 후 돌출된 4개의 절개부 모서리 높이를 측정한 평균값이 10 mm 미만인 것을 특징으로 하는 전해동박.

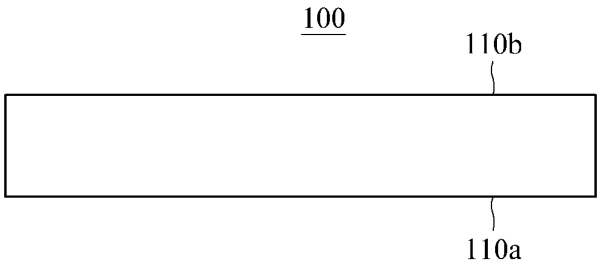
[청구항 8] 전해조의 전해액 내에 서로 이격되게 배치된 양극판 및 회전 음극드럼 사이에 전류를 인가하여 상기 회전 음극드럼 상에 구리막을 전기 도금하여 전해동박을 제조하는 방법에 있어서;
상기 회전 음극드럼의 표면을 500# 내지 3000# 입도를 가지는 브러쉬로

버핑하는 단계;
상기 버핑된 회전 음극드럼 상에 구리막을 전착하는 단계; 및
도금된 상기 구리막을 권취하는 단계를 포함하되,
상기 전해액은 70 내지 90 g/L의 구리 이온, 80 내지 120 g/L의 황산, 10 내지 20 ppm의 염소 이온, 3 내지 12 ppm의 황화물계 화합물, 25 내지 50 ppm의 Mo, 및 5 내지 25 ppm의 PEG를 포함하는 것을 특징으로 하는 전해동박의 제조 방법.

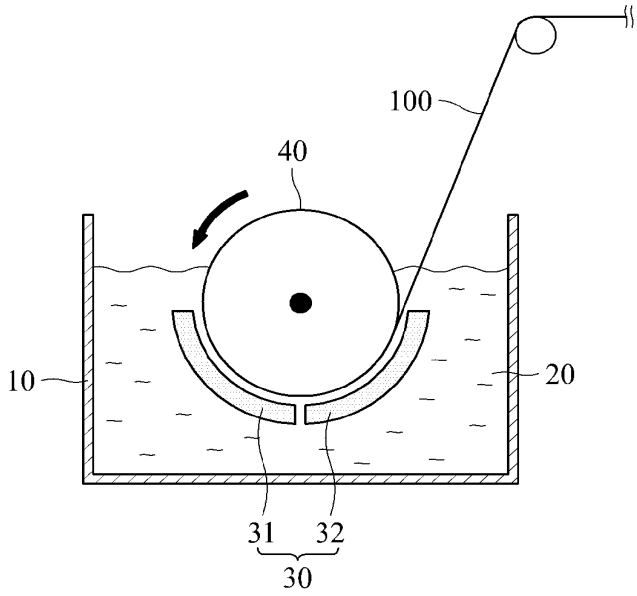
[청구항 9] 제8항에 있어서,
상기 황화물계 화합물은 SPS, MPS 및 ZPS로 이루어진 그룹 중에서 선택되는 것을 특징으로 하는 전해동박의 제조 방법.

[청구항 10] 제8항에 있어서,
상기 황화물계 화합물은 SPS인 것을 특징으로 하는 전해동박의 제조 방법.

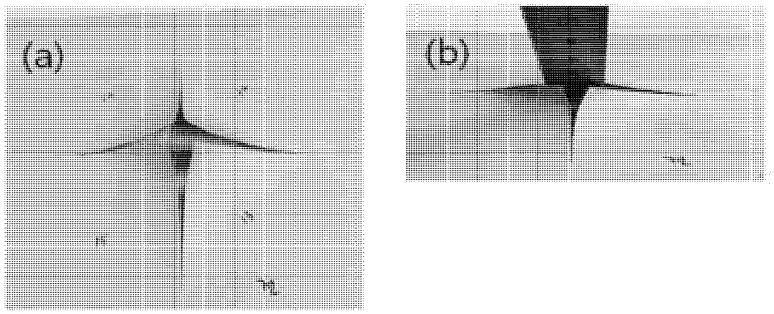
[도1]



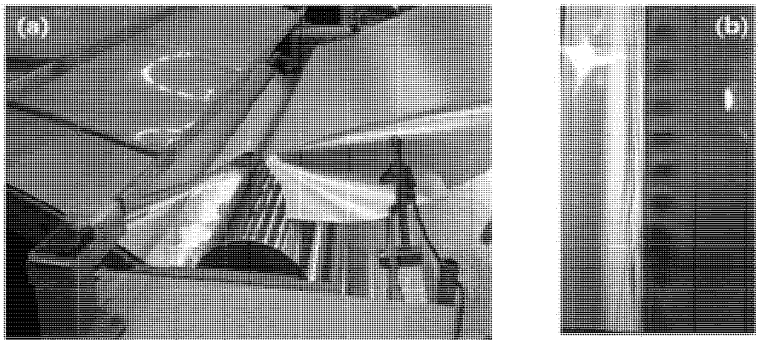
[도2]



[도3]



[도4]



INTERNATIONAL SEARCH REPORT

International application No.
PCT/KR2019/001069

A. CLASSIFICATION OF SUBJECT MATTER

C25D 1/04(2006.01)i, C25D 3/38(2006.01)i, H01M 4/66(2006.01)i, H01M 4/13(2010.01)i, H01M 10/052(2010.01)i

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

C25D 1/04; B32B 15/01; B32B 3/30; C25D 3/38; C25D 3/56; C25D 5/06; C25D 7/06; H01L 23/36; H01M 4/66; H01M 4/13; H01M 10/052

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched
Korean utility models and applications for utility models: IPC as above
Japanese utility models and applications for utility models: IPC as above

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

eKOMPASS (KIPO internal) & Keywords: secondary battery, electrolytic copper foil, copper plating, texture coefficient, peak density, buffing, polishing, electrolyte, Mo, SPS, PEG

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	KR 10-2017-0126775 A (LS MTRON LTD.) 20 November 2017 See paragraphs [0047], [0070]-[0072], [0075], [0094] and figures 1, 5.	1-10
Y	KR 10-2016-0102147 A (LS MTRON LTD.) 29 August 2016 See paragraphs [0050]-[0051].	1-10
A	KR 10-2015-0050266 A (KOREA INSTITUTE OF INDUSTRIAL TECHNOLOGY) 08 May 2015 See paragraphs [0003], [0010]-[0011], [0024], [0031] and figure 1.	1-10
A	JP 06-146066 A (NKK CORP.) 27 May 1994 See paragraphs [0039]-[0043] and figures 1-5.	1-10
A	JP 2017-063185 A (FUJI ELECTRIC CO., LTD.) 30 March 2017 See paragraphs [0055]-[0058].	1-10

☐ Further documents are listed in the continuation of Box C. ☒ See patent family annex.

* Special categories of cited documents:
"A" document defining the general state of the art which is not considered to be of particular relevance
"E" earlier application or patent but published on or after the international filing date
"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
"O" document referring to an oral disclosure, use, exhibition or other means
"P" document published prior to the international filing date but later than the priority date claimed
"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
07 MAY 2019 (07.05.2019)	**07 MAY 2019 (07.05.2019)**
Name and mailing address of the ISA/KR Korean Intellectual Property Office Government Complex Daejeon Building 4, 189, Cheongsa-ro, Seo-gu, Daejeon, 35208, Republic of Korea Facsimile No. +82-42-481-8578	Authorized officer Telephone No.

Form PCT/ISA/210 (second sheet) (January 2015)

INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/KR2019/001069

Patent document cited in search report	Publication date	Patent family member	Publication date
KR 10-2017-0126775 A	20/11/2017	None	
KR 10-2016-0102147 A	29/08/2016	None	
KR 10-2015-0050266 A	08/05/2015	KR 10-1535853 B1	13/07/2015
JP 06-146066 A	27/05/1994	None	
JP 2017-063185 A	30/03/2017	None	

Form PCT/ISA/210 (patent family annex) (January 2015)

국 제 조 사 보 고 서

국제출원번호
PCT/KR2019/001069

A. 발명이 속하는 기술분류(국제특허분류(IPC))

C25D 1/04(2006.01)i, C25D 3/38(2006.01)i, H01M 4/66(2006.01)i, H01M 4/13(2010.01)i, H01M 10/052(2010.01)i

B. 조사된 분야

조사된 최소문헌(국제특허분류를 기재)
C25D 1/04; B32B 15/01; B32B 3/30; C25D 3/38; C25D 3/56; C25D 5/06; C25D 7/06; H01L 23/36; H01M 4/66; H01M 4/13; H01M 10/052

조사된 기술분야에 속하는 최소문헌 이외의 문헌
한국등록실용신안공보 및 한국공개실용신안공보: 조사된 최소문헌란에 기재된 IPC
일본등록실용신안공보 및 일본공개실용신안공보: 조사된 최소문헌란에 기재된 IPC

국제조사에 이용된 전산 데이터베이스(데이터베이스의 명칭 및 검색어(해당하는 경우))
eKOMPASS(특허청 내부 검색시스템) & 키워드: 이차전지, 전해동박, 동도금, 집합조직 계수, 피크 밀도, 버핑, 연마, 전해액, Mo, SPS, PEG

C. 관련 문헌

카테고리*	인용문헌명 및 관련 구절(해당하는 경우)의 기재	관련 청구항
Y	KR 10-2017-0126775 A (엘에스엠트론 주식회사) 2017.11.20 단락 [0047], [0070]-[0072], [0075], [0094] 및 도면 1, 5 참조.	1-10
Y	KR 10-2016-0102147 A (엘에스엠트론 주식회사) 2016.08.29 단락 [0050]-[0051] 참조.	1-10
A	KR 10-2015-0050266 A (한국생산기술연구원) 2015.05.08 단락 [0003], [0010]-[0011], [0024], [0031] 및 도면 1 참조.	1-10
A	JP 06-146066 A (NKK CORP.) 1994.05.27 단락 [0039]-[0043] 및 도면 1-5 참조.	1-10
A	JP 2017-063185 A (FUJI ELECTRIC CO., LTD.) 2017.03.30 단락 [0055]-[0058] 참조.	1-10

☐ 추가 문헌이 C(계속)에 기재되어 있습니다.

☒ 대응특허에 관한 별지를 참조하십시오.

* 인용된 문헌의 특별 카테고리:

"A" 특별히 관련이 없는 것으로 보이는 일반적인 기술수준을 정의한 문헌

"E" 국제출원일보다 빠른 출원일 또는 우선일을 가지나 국제출원일 이후에 공개된 선출원 또는 특허 문헌

"L" 우선권 주장에 의문을 제기하는 문헌 또는 다른 인용문헌의 공개일 또는 다른 특별한 이유(이유를 명시)를 밝히기 위하여 인용된 문헌

"O" 구두 개시, 사용, 전시 또는 기타 수단을 언급하고 있는 문헌

"P" 우선일 이후에 공개되었으나 국제출원일 이전에 공개된 문헌

"T" 국제출원일 또는 우선일 후에 공개된 문헌으로, 출원과 상충하지 않으며 발명의 기초가 되는 원리나 이론을 이해하기 위해 인용된 문헌

"X" 특별한 관련이 있는 문헌. 해당 문헌 하나만으로 청구된 발명의 신규성 또는 진보성이 없는 것으로 본다.

"Y" 특별한 관련이 있는 문헌. 해당 문헌이 하나 이상의 다른 문헌과 조합하는 경우로 그 조합이 당업자에게 자명한 경우 청구된 발명은 진보성이 없는 것으로 본다.

"&" 동일한 대응특허문헌에 속하는 문헌

국제조사의 실제 완료일	국제조사보고서 발송일
2019년 05월 07일 (07.05.2019)	2019년 05월 07일 (07.05.2019)

ISA/KR의 명칭 및 우편주소
대한민국 특허청
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김진호
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서식 PCT/ISA/210 (두 번째 용지) (2015년 1월)

국 제 조 사 보 고 서
대응특허에 관한 정보

국제출원번호
PCT/KR2019/001069

국제조사보고서에서 인용된 특허문헌	공개일	대응특허문헌	공개일
KR 10-2017-0126775 A	2017/11/20	없음	
KR 10-2016-0102147 A	2016/08/29	없음	
KR 10-2015-0050266 A	2015/05/08	KR 10-1535853 B1	2015/07/13
JP 06-146066 A	1994/05/27	없음	
JP 2017-063185 A	2017/03/30	없음	

대 한 민 국 특 허 청
KOREAN INTELLECTUAL PROPERTY OFFICE

별첨 사본은 아래 출원의 원본과 동일함을 증명함.

This is to certify that the following application annexed hereto is a true copy from the records of the Korean Intellectual Property Office.

출 원 번 호 : 10-2018-0012179
Application Number

출 원 년 월 일 : 2018년 01월 31일
Filing Date JAN 31, 2018

출 원 인 : 케이씨에프테크놀로지스 주식회사
Applicant(s) KCF Technologies Co., Ltd.

2019 년 02 월 07 일

특 허 청
COMMISSIONER

2018-01-31

【서지사항】

【서류명】 특허출원서

【출원구분】 특허출원

【출원인】

【명칭】 엘에스엠트론 주식회사

【특허고객번호】 1-2008-029030-3

【대리인】

【명칭】 특허법인충정

【대리인번호】 9-2004-100021-1

【지정된변리사】 연충규, 김환석, 성정현

【포괄위임등록번호】 2015-046338-0

【발명의 국문명칭】 후속 공정에서 핸들링 특성이 우수한 전해동박 및 그 제조 방법

【발명의 영문명칭】 Copper Film With Enhanced Handling Properties At Subsequent Process, And Manufacturing Methods Thereof

【발명자】

【성명】 김승민

【성명의 영문표기】 Kim, Seung Min

【주민등록번호】 770119-1XXXXXX

【우편번호】 14119

【주소】 경기도 안양시 동안구 엘에스로 127 (호계동, LS타워 11층)

【국적】 KR

【발명자】

2018-01-31

【성명】 김선화

【성명의 영문표기】 Jin, Shan Hua

【주민등록번호】 810520-6XXXXXX

【우편번호】 14119

【주소】 경기도 안양시 동안구 엘에스로 127 (호계동, LS타워 11층)

【국적】 KR

【출원언어】 국어

【취지】 위와 같이 특허청장에게 제출합니다.

대리인 특허법인충정 (서명 또는 인)

【수수료】

【출원료】	0	면	46,000 원
【가산출원료】	26	면	0 원
【우선권주장료】	0	건	0 원
【심사청구료】	0	항	0 원
【합계】	46,000 원		

【발명의 설명】

【발명의 명칭】

후속 공정에서 핸들링 특성이 우수한 전해동박 및 그 제조방법{Copper Film With Enhanced Handling Properties At Subsequent Process, And Manufacturing Methods Thereof}

【기술분야】

【0001】 본 발명은 전해동박에 관한 것으로, 보다 상세하게는 동박 제조 및 후속 이차전지의 제조 공정에서 우수한 핸들링 특성을 갖는 전해동박에 관한 것이다.

【발명의 배경이 되는 기술】

【0002】 휴대폰, 노트북 등 휴대용 가전의 사용 증가와 하이브리드 자동차의 보급과 더불어 Li 이차전지의 수요는 급격히 증가하고 있다.

【0003】 리튬 이차전지에 있어서 음극 집전체의 소재로는 주로 전해동박이 사용된다. 전해동박은 전기 도금법에 의한 제박공정을 통해 제조되는데, 전해동박 제조시 생산 조건을 정밀하게 제어하지 않으며, 얇은 박막을 제조할 때 생길 수 있는 컬(Curl), 주름 또는 찢김 불량이 다량 발생하게 된다. 이러한 동박 제품의 불량은 동박 생산시 제조 원가를 상승시키는 주요한 원인이 되며, 컬 및 주름은 Li 이차전지의 품질을 저하시키는 주 요인으로 전체적인 품질 비용을 높이는 원인이 되기도 한다.

【0004】 종래에는 이러한 동박 제품의 불량을 저감할 수 있는 방법으로 동박의 조도 범위를 일정하게 제어하는 것이 알려져 있다. 그러나, Li 이차전지의 용량 증대를 위해 10㎛ 이하의 동박을 Li 이차전지용 음극 집전체로 사용하는 비율이 증가함에 따라 동박의 조도를 정밀하게 제어를 함에도 불구하고 여전히 컬, 찢김 및 주름 불량이 발생하고 있는 실정이다.

【선행기술문헌】

【특허문헌】

【0005】 **(특허문헌 0001)** 한국특허공개 제10-2015-62228호

【발명의 내용】

【해결하고자 하는 과제】

【0006】 상기 기술적 과제를 달성하기 위하여, 본 발명은 전해동박의 제조 중 및/또는 후속 이차전지 제조 공정에서 컬, 주름 및/또는 찢김 발생 가능성을 감소시키는 전해동박을 제공하는 것을 목적으로 한다.

【0007】 또한 본 발명은 전술한 전해동박의 제조 방법을 제공하는 것을 목적으로 한다.

【0008】 또한, 본 발명은 전술한 전해동박을 포함하는 Li 이차전지용 음극을 제공하는 것을 목적으로 한다.

【과제의 해결 수단】

【0009】상기 기술적 과제를 달성하기 위하여 본 발명은, 제1 표면 및 상기 제2 표면을 갖는 전해동박에 있어서, 상기 전해동박은 다음의 수학식 1에 의해 정의되는 (220)면의 집합조직 계수가 0.4~1.32이고,

【0010】(수학식 1)

【0011】
$$TC(220) = \frac{\frac{I(220)}{I_0(220)}}{\frac{1}{n}\sum\frac{I(hkl)}{I_0(hkl)}}$$

【0012】상기 전해동박의 제1 표면에서의 Rz/Ra와 제2 표면에서의 Rz/Ra 차이의 절대값(|Δ(Rz/Ra)|)이 2.42 미만이며, 상기 전해동박의 제1 표면 및 제2 표면에서의 피크 밀도(PD) 차이의 절대값(|ΔPD|)가 96ea 이하인 것을 특징으로 하는 전해동박을 제공한다.

【0013】이 때, 상기 제2 표면은 M면이고, 상기 제2 표면에서의 Rz/Ra가 4.2 ~ 9.0 인 것이 바람직하다. 또한, 상기 제1 표면은 S면이고, 상기 전해동박은 S면의 Rz/Ra가 5.1 ~ 6.8인 것이 바람직하다.

【0014】또한 상기 다른 기술적 과제를 달성하기 위하여 본 발명은 전해조의 전해액 내에 서로 이격되게 배치된 양극판 및 회전 음극드럼 사이에 전류를 인가하여 상기 회전 음극드럼 상에 구리막을 전기 도금하여 전해동박을 제조하는 방법에 있어서,

【0015】상기 음극드럼의 표면을 500~3000# 입도를 가지는 브러쉬로 버핑하는 단계; 상기 버핑된 회전 음극드럼 상에 구리막을 전착하는 단계; 및 도금된 상

기 구리막을 권취하는 단계를 포함하는 것을 특징으로 하는 전해동박의 제조 방법을 제공한다.

【0016】 이 때, 상기 전해액은 70 내지 90 g/L의 구리 이온, 80 내지 120 g/L의 황산, 10 내지 30 ppm의 염소 이온을 포함하고, 첨가제로 25 ~50ppm의 Mo를 포함하는 것이 바람직하다. 또한, 상기 전해액은 SPS, MPS 및 ZPS로 이루어진 그룹 중에서 선택된 최소한 1종의 황화물계 화합물을 더 포함할 수 있다. 바람직하게는 상기 황화물계 화합물은 SPS이고, 상기 SPS는 3~12 ppm 함유되는 것이 바람직하다.

【0017】 또한 본 발명에서 상기 전해액은 5~25 ppm의 PEG를 더 포함할 수 있다.

【0018】 상기 또 다른 기술적 과제를 달성하기 위하여 본 발명은, 전술한 전해동박으로 된 집전체; 및 상기 제1 표면 또는 상기 제2 표면 상의 음극 활물질층을 포함하는 Li 이차전지용 음극을 제공한다.

【발명의 효과】

【0019】 본 발명에 따르면, 드럼음극의 표면 프로파일, 동박 표면의 표면 조직 구조 및 표면 프로파일을 제어하여 전해동박 제조 공정 및/또는 후속 이차전지 제조 공정에서 컬, 주름 및/또는 찢김 발생 가능성을 감소시키는 전해동박을 제공할 수 있게 된다.

【도면의 간단한 설명】

【0020】도 1은 본 발명의 실시예에 따른 전해동박의 단면을 나타낸 모식도이다.

도 2는 본 발명의 전해동박 제박장치를 모식적으로 도시한 도면이다.

도 3은 본 발명의 일실시예에서 컬 값의 측정 방법을 보여주는 사진이다.

도 4의 (a) 및 (b)는 각각 찢김 및 주름 발생 상태를 예시하는 사진이다.

【발명을 실시하기 위한 구체적인 내용】

【0021】이하 도면을 참조하여 본 발명의 바람직한 실시예를 설명한다.

【0022】도 1은 본 발명의 실시예에 따른 전해동박의 단면을 나타낸 모식도이다.

【0023】도 1을 참조하면, 전해동박(100)은 제1 표면(110a) 및 제2 표면(110b)을 구비한다.

【0024】본 발명에서 상기 전해동박(100)은 소정 두께 예컨대 4 내지 30 ㎛의 두께를 갖는다. 동박 두께가 4㎛ 미만인 경우 전지 제조공정에서의 작업성 저하를 초래하고, 30㎛ 이상인 경우 Li 이차전지 제조시 동박의 두꺼운 두께로 인해 고용량 구현이 어렵게 된다.

【0025】상기 전해동박(100)은 회전 음극드럼에서 전기도금에 의해 형성되는데, 전기도금 과정에서 상기 회전 음극 드럼과 직접 접촉하는 표면은 샤이니 면(S면)과 그 반대 편의 매트 면(M면)을 갖는다. 예컨대, 본 발명에서 상기 제1 표면은 S면이고, 상기 제2 표면을 M면일 수 있다.

【0026】 주름, 컬 및 찢김의 발생을 억제하기 위하여, 본 발명의 상기 전해동박(100)은 제어된 표면조직 인자 및 표면형상 인자를 갖는다.

【0027】 표면조직 인자로서, 상기 전해동박은 (220)면의 집합조직 계수가 특정 범위에 있도록 제어된 결정 구조를 갖는 것이 바람직하다. 본 발명에서 (220)면의 집합조직 계수(Texture Coefficient; TC)는 다음의 수학식 1에 의해 표현된다.

【0028】 (수학식 1)

【0029】
$$TC(220) = \frac{\frac{I(220)}{I_0(220)}}{\frac{1}{n}\sum\frac{I(hkl)}{I_0(hkl)}}$$

【0031】 위 수학식 2에서 I(hkl)은 시편의 (hkl) 결정면의 XRD 회절 강도를 의미하고, I_0(hkl)은 JCPDS(Joint Committee on Powder Diffraction Standards)에 규정된 표준 구리 분말의 (hkl) 결정 표면의 회절 강도를 의미한다(X선 광원 : Cu $K_{\alpha 1}$) . 또한, 수학식 2에서 n은 특정 범위의 회절각(2Θ) 내에서 회절 피크의 수를 나타낸다. 본 발명에서 집합조직 계수는 회절각(2Θ) 30°에서 95° 범위에서 X선 회절 패턴으로부터 구하는데, 고려되는 현저한 결정면은 (111), (200), (220) 및 (311)면이다. 즉, (220)면의 집합조직계수는 시편의 X선 회절 패턴에서 (111), (200), (220) 및 (311)면에 대하여 표준 Cu의 피크 강도로 정규화 된 평균 피크 강도에 대하여 (220)면의 정규화 된 피크 강도의 비율을 나타낸다.

【0032】본 발명에서 상기 전해동박(100)은 (220) 집합조직계수가 0.40 내지 1.32 범위에 있는 것이 바람직하다. 후술하는 바와 같이, (220) 집합조직 계수가 0.40 미만이면 동박의 결정 조직이 치밀하지 못하여 전지 제조 공정에서 겪는 응력 및 열에 의해 조직이 변형되어 주름을 발생시킨다. 또한, (220) 집합조직 계수가 1.32를 초과하면 동박의 조직이 너무 치밀하여 취성을 가지며 전지 제조 공정에서 찢김이 발생한다.

【0033】본 발명에서 상기 표면 형상 인자로서, 상기 전해동박(100)의 제1 표면에서의 Rz/Ra와 제2 표면에서의 Rz/Ra 차이의 절대값 즉 |Δ(Rz/Ra)|이 2.42 미만인 것이 바람직하다. 여기서, Rz는 십점평균조도, Ra는 산술평균조도이다. 또한, 본 발명에서 상기 전해동박은 제1 표면 및 제2 표면에서의 피크 밀도(Peak density, PD) 차이의 절대값 |ΔPD|가 96ea 이하인 것이 바람직하다.

【0034】본 발명에서 전술한 Rz 및 Ra 는 JIS B 0601(2001) 규격에 따라 측정될 수 있고, PD는 ASME B46.1 규격에 따라 측정될 수 있다.

【0035】본 발명에서 전해동박 양면에서의 |Δ(Rz/Ra)| 및 |ΔPD|가 전술한 수치 범위를 벗어나면 전해동박 양면에서의 표면 특성 차이로 인해 컬이 발생하게 된다.

【0036】또한, 전해동박의 M면에서의 Rz/Ra는 4.2 내지 9.0 범위에 있는 것이 바람직하다. Rz/Ra가 4.2 미만인 경우 음극활물질과 접촉할 수 있는 동박의 비표면적이 작아 음극재와 충분한 결합력을 형성하기가 어렵고, 9.0을 초과하는 경우

전해동박의 표면이 불균일하여 음극활물질이 동박 표면에 균일하게 접착될 수 없다.

【0037】 본 발명에서 상기 전해동박은 상온(25±15℃)에서 측정한 인장강도가 30 ~ 65kgf/㎟인 전해동박인 것이 바람직하다. 인장강도가 30 미만인 경우 제조 공정 중에 가해 지는 힘에 의해 변형이 발생되기 쉽다. 또한, 인장강도가 65를 초과하는 경우 높은 취성을 가져 후속 Li 이차전지 제조 공정에서 가해지는 국부적인 압력에 의해 찢김이 발생될 수 있어, 작업성이 저하된다. 본 발명에서 시편의 인장강도는 IPC-TM-650 Test Method Manual의 규정에 준하여, 만능시험기(UTM)에 의해 측정될 수 있다. 본 발명의 일 실시예에 따르면, 인스트론사(Instron)의 만능시험기에 의해 인장강도가 측정되는데, 측정용 샘플의 폭은 12.7 ㎜이고, 그립(grip)간 거리는 50 ㎜이며, 측정 속도는 50 ㎜/min에서 측정된다. 평가를 위해 샘플의 인장강도는 3회에 걸쳐 반복 측정하여, 그 평균값을 전해동박의 인장강도로 할 수 있다.

【0038】 또한, 본 발명에서 전해동박은 상온(25±15℃)에서 측정한 연신율이 3% 이상인 것이 바람직하다. 연신율이 3% 미만인 경우 원통형 전지에 적용될 경우 충방전시 가해지는 부피 팽창에 의해 동박이 신장되지 못하고 파단이 발생할 수 있다. 여기서 상온 연신율은 전술한 인장강도 측정 조건에서 시험 샘플의 파단시의 연신율로 한다.

【0039】또한, 본 발명의 전해동박은 폭방향 중량 편차가 5% 이하인 것이 바람직하다. 폭방향 중량 편차가 5%를 초과하는 경우 전해동박을 보빈에 권취할 때 동박과의 중량 중첩으로 국부적으로 늘어나는 현상이 발생되어 울음 불량이 발생할 수 있다. 본 발명에서 전해동박의 폭방향 중량 편차는 동박을 5㎝ x 5㎝의 면적으로 절개하여 시편을 만든 후 그 중량을 측정하여 단위면적당 동박 중량값을 환산하고, 동박의 폭 방향을 따라 상기 시편을 절개하는 과정을 반복적으로 수행하여 각 시편에 대한 동박 중량값들을 측정한 후 표준편차를 계산함으로써 산출된다.

【0041】도 2는 본 발명의 전해동박 제박장치를 모식적으로 도시한 도면이다.

【0042】도 2에 도시된 바와 같이, 전해조(10) 내의 전해액(20) 내에 서로 이격되게 배치된 양극판(30) 및 회전 음극드럼(40)이 구비된다. 회전 음극드럼(40)은 소정 방향으로 회전하면서 음극 드럼(20)과 양극판(30) 사이에 전원을 인가하면 전해액(20)을 매개로 하여 통전에 의해 도금이 수행된다. 음극드럼(40) 표면에 도금된 구리막(100)은 가이드 롤(50)에 의해 권취된다.

【0043】상기 전해동박을 석출시키는 전해액(20)으로서는 황산 구리 전해액, 피로린산 구리 전해액 또는 슬파민산 구리 전해액 등이 사용될 수 있다. 바람직하게는 본 발명에서 전해액으로는 황산 구리 전해액이 매우 적합하다.

【0044】이 때, 상기 양극판(30)은 서로 전기적으로 절연된 제1 양극판(31) 및 제2 양극판(32)을 포함할 수 있다. 이 때, 상기 양극판(30), 즉 상기 제1 및 제2 양극판들(31, 32)에 의해 각각 제공되는 전류밀도는 40 내지 80 A/dm^2 일 수 있다.

【0045】본 발명의 일 실시예에서, 상기 전해액(20)은 70 내지 90 g/L의 구리 이온, 80 내지 120 g/L의 황산, 10 내지 30 ppm의 염소 이온을 포함할 수 있다.

【0046】또한, 상기 전해액(20)은 광택제나 평활제와 같은 첨가제를 더 포함할 수 있다. 본 발명에서 상기 첨가제는 SPS(비스-(소듐 술포프로필) 디설파이드), MPS(3-메르캅토 1-프로판 술폰산 나트륨) 및 ZPS(3-(벤조티아졸릴-2-메르캅톤)-프로필-술폰산 나트륨)로 이루어지는 그룹 중에서 선택되는 최소한 1종의 황화물계 화합물을 포함할 수 있다. 이 때, 바람직하게는 SPS가 사용되는 것이 좋다. 본 발명에서 상기 SPS의 농도가 12ppm을 초과하면 도금이 미세하게 되고, (220) 집합조직 계수가 바람직한 상한을 초과하게 된다. 이와 달리, 전해액 내의 황화물계 화합물의 농도가 3ppm 미만이면 도금된 결정립의 사이즈가 크고 (111) 집합조직이 발달하여, 상대적으로 (220) 집합조직은 덜 발달하게 되어 집합조직계수가 바람직한 하한을 이탈하게 된다.

【0047】본 발명에서 상기 음극드럼은 전해동박의 S면의 표면 프로파일의 제어를 위한 적합하도록 대응하는 표면 프로파일을 가진다. 전해동박의 S면은 동박의 드럼과 접촉하며 그 프로파일은 드럼의 표면 구조에 영향을 받는다. 구체적으로 본

발명에서 드럼의 표면 구조는 드럼 표면의 버핑에 의해 제어될 수 있다. 예컨대, 500~3000# 입도를 가지는 브러쉬를 사용하여 드럼 표면을 버핑하게 되면 전착된 전해동박 S면의 Rz/Ra의 범위는 5.1~6.8 수준으로 변동성이 작은 값을 나타낸다. 이와 달리, 4000#이 넘는 브러쉬에 의한 드럼 표면 버핑은 드럼에 낮은 표면 프로파일을 초래하고, 구리의 균일한 전착을 유발한다. 이에 따라, S면의 Rz 값이 Ra 값에 수렴하게 되며, 결과적으로 M면과 S면의 Rz/Ra 차이가 큰 값을 나타내게 된다.

【0048】 또한, 드럼 표면의 버핑은 피크밀도(PD)에 영향을 미칠 수 있다. 다만, 500~3000# 입도를 가지는 브러쉬를 사용하여 드럼 표면을 버핑하게 되면 전착된 전해동박 S면의 피크밀도는 10~20ea 수준의 비교적 균일한 값을 갖는 전해동박이 얻어질 수 있다.

【0049】 본 발명에서 전해동박 M면의 표면 프로파일은 다음의 방식으로 추가적으로 제어될 수 있다.

【0050】 먼저, 본 발명에서 전해액 내의 Mo 농도는 25 내지 50ppm으로 유지된다. 전해액 내의 Mo 농도가 50ppm을 초과하면 구리가 불균일하게 도금되어 동박 M면의 Rz가 급격하게 증가하게 된다. 이에 따라 Rz/Ra 값이 S면 대비 매우 높아지며, 동박 양면의 Rz/Ra 값의 차이는 바람직한 상한을 이탈하게 된다. 또한, Mo 농도가 25ppm 미만이면 Mo가 드럼의 전체 표면에 걸쳐 균일한 첨가제로서의 역할을 하지 못하여 국부적으로 불균일한 도금을 야기한다. 그 결과 동박의 M면에 얼룩 혹은 불균일 전착을 발생시키는데, 이러한 얼룩이나 불균일 도금은 후속 Li 이차전지

제조공정에서 음극재가 불균일하게 도포되게 되어 Li 이차전지 용량을 저하시키는 원인이 된다.

【0051】 또한, 본 발명에서는 평활제로 사용되는 PEG의 농도를 제어함으로써 M면의 표면 프로파일을 바람직한 범위 내에서 유지되도록 할 수 있다. 본 발명에서 전해액 내의 폴리에틸렌글리콜(Polyethyleneglycol)의 농도는 5 내지 25 ppm 범위 내로 조정된다. PEG의 농도가 5ppm 미만이면 도금시 구리가 평활하게 전착되지 못하고 미세 요철이 발달된 표면 구조를 갖는다. 이로 인해 동박 M면의 PD 값이 높아지게 되고, M면과 S면의 PD 값 차이는 커지게 된다. 한편, PEG의 농도가 25ppm을 넘으면 전해액 내에 구리 도금이 평활하게 전착되어 Rz/Ra가 4.2 미만의 값을 가진다.

【0052】 본 발명에서 상기 전해액(60)은 45 내지 65 ℃로 유지되고, 상기 전해조(10) 내로 공급되는 상기 전해액(20)의 유량은 35 내지 46 m^3/hour 범위로 유지되는 것이 바람직하다. 상기 전해액(20)의 유량이 35 m^3/hour 이하인 경우 회전 음극드럼(40) 표면에 구리 이온이 원활히 공급되지 못해 도금 박막이 불균일하게 형성되며, 상기 전해액(20)의 유량이 46 m^3/hour를 초과할 경우 필터를 통과하는 전해액(20)의 유속이 너무 빨라서 필터의 수명이 급격히 단축되는 원인이 된다.

【0054】이하 본 발명의 바람직한 실시예를 상술한다.

【0056】<전해동박의 제조>

【0057】도 2에 도시된 것과 같은 장치를 사용하여 전해조 내의 전해액 내에 서로 이격되게 배치된 양극판 및 회전 음극드럼을 통전시킴으로써 상기 회전 음극드럼상에 구리막을 형성하였다.

【0058】전해액은 75g/L의 구리 이온 및 100 g/L의 황산으로 이루어지고, 첨가제로 SPS, Mo 및 PEG를 포함한다. 전해액의 SPS, Mo 및 PEG 함량을 달리하여 상이한 함량 조건에서 구리막을 전착하였다. 이 때, 전해액의 온도는 약 55℃로 유지하고, 전류밀도는 60 A/dm^2, 유량은 40m^3/hr로 하였다. 또한, 동박 제조 전 동박 S면에서 상이한 표면 프로파일을 얻기 위하여 음극드럼의 표면을 상이한 입도(거칠기)의 브러쉬로 버핑하여 실험을 수행하였다.

【0059】

【0060】제조된 동박의 제박 조건을 아래 표 1에 나타내었다.

【0061】**【표 1】**

구분	SPS (pm)	Mo (Ppm)	PEG (Ppm)	Brush (#)
실시예1	3	25	15	2000
실시예2	12	25	15	2000
실시예3	7	49	15	2000
실시예4	7	25	5	2000
비교예1	2	25	15	2000
비교예2	13	25	26	2000
비교예3	7	51	15	2000
비교예4	7	25	4	2000
비교예5	7	25	15	4000

【0063】 이어서, 제조된 전해동박 시편(실시예 1 내지 4 및 비교에 1 내지 5)의 특성을 측정하였다. 각 특성에 대한 측정 방법은 다음과 같이 하였다.

【0065】 집합조직 계수

【0066】 제작된 전해동박 시편을 회절각(2Θ) 30°에서 95° 범위에서 X선 회절 패턴을 구하고, 결정면 (111), (200), (220) 및 (311)면을 기준으로 표준 Cu의 피크 강도로 정규화 된 평균 피크 강도에 대하여 (220)면의 정규화 된 피크 강도의 비율을 구하여 (220)면의 집합조직 계수로 하였다.

【0068】 동박 표면 프로파일

【0069】 미투토요사 SJ-310 모델, 반경 2㎛인 스타일러스 팁을 사용하고, 측정 압력을 0.75mN으로 하여, JIS B 0601 (2001) 규격에 따라 Rz 및 Ra를 측정하였다. 이 때 컷 오프(Cut off) 길이를 제외한 측정 길이는 4mm이며, 컷 오프 길이는 초기와 말기 각각 0.8mm로 하였고, 각각 3회 측정값의 평균을 취하였다.

【0070】 피크밀도(PD)는 ASME B46.1 규격에 따라 측정하며, 마흐(Mahr)사의 조도계(Marsurf M300 모델)와 반경 2㎛인 스타일러스 팁을 이용하여 피크 밀도를 측정하였다. 피크 카운트 레벨(Peak Count Level)은 프로파일의 중심선을 기준으로

±0.5㎛로 하였고, 컷 오프 길이를 제외한 측정 길이는 4㎜, 컷 오프 길이는 초기와 말기 각각 0.8㎜로 하였다. 측정 압력은 0.7mN으로 하였다. 피크 밀도는 3회 측정값의 평균을 취하였다.

【0072】 컬 발생 여부

【0073】 도 3과 같이, 실시예 및 비교예에서 제조된 전해동박의 M면 상의 임의의 지점에서 8cm X 8cm로 열십자 형태로 수직 이등분하도록 절개하여 4개의 절개부를 형성하였다. 절개 후 뾰족하게 튀어나온 4개의 절개부 모서리 높이를 측정하여 그 높이 측정값의 산술 평균값을 컬로 정의하였다.

【0075】 주름 및 찢김 발생 여부

【0076】 롤투롤 공정에서 전해동박의 주름과 찢김이 발생하는지를 육안으로 관찰하였다. 도 4의 (a) 및 (b)는 각각 찢김 및 주름 발생 상태를 예시하는 사진이다.

【0078】 <음극의 제조>

【0079】 전술한 실시예 및 비교예에서 제조된 전해동박으로 10cm 폭의 집전체를 준비하였다. 집전체 상에 음극활물질용으로 시판되는 인조 흑연 및 SiO_2 100 중량부에 대해 SBR(스티렌부타디엔고무) 2 중량부 및 CMC(카르복시메틸

셀룰로오스) 2 중량부를 혼합하고 증류수를 용제로 하여 슬러리를 제조하였다.

【0080】 이어서, 표면이 깨끗한 유리판 위에 측정하고자 하는 전해동박 시편을 올려 놓은 후 주름, 구겨짐 등이 없도록 펼쳐 놓고, 동박 위에 바코터(Bar coater)를 사용하여 음극재 로딩(Loading)양이 9.0±0.5mg/㎠가 되도록 코팅하였다. 이 때, 바코터의 속도는 10~15㎜/s의 속도로 실시하였다. 음극재가 코팅 된 동박을 100℃로 가열된 건조 오븐 에 넣어 15분 동안 건조하고, 건조된 동박 시편을 롤 프레스를 사용하여 전극 밀도 1.55±0.05g/cc가 되도록 4단 프레스하여 음극을 제조하였다. 제조된 음극으로 다음의 방법으로 밀착력을 측정하였다.

【0081】 제조된 전극을 폭 10㎜ x 길이 100㎜로 절단하고, 절단된 전극의 활물질 부분과 보강판을 양면 테이프로로 접착하였다. 이때 제작 되는 모든 시료는 균일한 힘으로 부착 될 수 있도록 하였다. UTM 장치를 이용하여 제작된 시편의 접착력(밀착력)을 측정하였다.

【0082】 -. Crosshead speed : 50.0㎜/min.

【0083】 -. 측정 길이 : 20~50㎜

【0084】 -. 90° Peeling 테스트

【0086】 <Li 이차전지의 제조>

【0087】 에틸렌카보네이트(EC) 및 에틸메틸카보네이트(EMC)를 1:2의 비율로 혼합한 비수성 유기용매에 용질로서 $LiPF_6$을 1M 용해시킨 것을 기본 전해액으로 하

고, 이 기본 전해액 99.5중량%와 숙신산 무수물(Succinic anhydride) 0.5중량%를 혼합하여 비수전해액을 제조하였다.

【0088】 $Li_{1.1}Mn_{1.8}5Al_{0.05}O_4$인 리튬 망간 산화물과 o-$LiMnO_2$인 사방정(orthorhombic) 결정구조의 리튬 망간 산화물을 중량비 90:10으로 혼합하여, 양극 활물질을 제조하였다. 상기 양극 활물질과 카본 블랙을 결착제인 PVDF[Poly(vinylidenefluoride)]와 85:10:5의 중량비로 유기 용매인 NMP와 혼합하여 슬러리를 제조하였다. 제조된 슬러리를 두께 20 ㎛인 Al 박(foil) 양면에 도포한 후 건조하여 양극을 제작하였다. 제조된 양극, 음극 및 전해액으로 Li 이차전지 셀을 제조하였다.

【0090】 아래 표 2는 본 발명의 실시예에 따라 제조된 전해동박 시편의 물성 측정 결과 및 그 전해동박으로 제조된 음극의 밀착력 측정 결과를 나타낸 표이다.

【0092】【표 2】

구분	집합조직 계수	| △(Rz/Ra) |	Rz/Ra (M면)	Rz/Ra (S면)	| △PD | (ea/cm)	M면 PD (ea/cm)	S면 PD (ea/cm)	컬	주름	찢김	밀착력 (N/m)
실시예1	0.4	0.85	4.22	3.37	38	48	10	5.6	양호	양호	26.4
실시예2	1.32	0.85	4.21	3.36	38	48	10	5.5	양호	양호	26.4
실시예3	0.78	2.42	9.00	6.58	38	48	10	8.7	양호	양호	28.4
실시예4	0.78	0.85	4.21	3.36	96	105	9	8.6	양호	양호	26.4
비교예1	0.32	0.85	4.21	3.36	38	48	10	5.2	주름	양호	26.8
비교예2	1.41	0.85	4.08	3.23	38	48	10	5.4	양호	찢김	15.5
비교예3	0.78	2.43	9.13	6.70	38	48	10	11.5	양호	양호	15.4
비교예4	0.78	0.85	4.22	3.37	97	107	10	11.6	양호	양호	26.7
비교예5	0.78	2.43	4.22	1.79	38	48	10	11.6	양호	양호	26.3

【0094】표 2를 참조하면, 실시예 1 내지 4에 따라 제조된 전해동박 샘플은 모두 10㎜ 이하의 양호한 컬 값을 나타내었다. 이와 같은 컬 값 범위를 갖는 전해동박 은 동박 제조공정이나 후속 전지 제조 공정에서 접힘을 발생하지 않게 된다. 한편, 비교예 1 및 비교예 2의 경우 실시예와 유사한 수준의 | Δ(Rz/Ra)| 및 | ΔPD | 을 나타내고 있지만, 롤투롤 공정에서 주름 또는 찢김 현상이 관찰되었다. 이것은 각각 (220) 집합계수가 0.40 미만의 값을 가져 동박의 결정 조직이 치밀하지 못하여 전지 제조 공정에서 겪는 응력 및 열에 의해 조직이 변형되어 주름을 발생시키거나 (220) 집합조직 계수가 1.32를 초과하여 동박의 조직이 너무 치밀하여

취성을 가진 것에 기인한다.

【0095】 한편, 비교예 3의 경우 M면의 Rz/Ra가 매우 높은 값(9.13)을 나타내며 그로 인해 |Δ(Rz/Ra)|가 2.42를 초과하여 높은 컬 값을 나타냄을 알 수 있다. 또한, 비교에 4의 경우 PEG의 함량이 작아 미세 요철이 발달된 표면 구조를 나타내어 동박 M면의 PD 값(97ea)이 높아지고 이로 인해 컬 값이 증가하게 됨을 알 수 있다. 한편, 비교예 5의 경우 S면의 Rz/Ra 값이 매우 낮은 값을 가지며 |Δ(Rz/Ra)|가 2.42를 초과하고 있는데, 이것은 드럼 음극의 표면 프로파일에 기인하는 것이다.

【0096】 한편, 비교예 2 및 3의 경우, 제조된 음극이 낮은 밀착력 값을 나타내고 있다. 이와 같이 밀착력이 20 N/m 미만인 경우에는 Li 이차전지 제조후 충반전시 동박 표면에서 음극재가 탈리되어 충전 용량이 급격히 저하될 수 있다. 비교예 2 및 3은 각각 (220) 집합조직 계수가 낮거나 M면의 Rz/Ra가 낮은 값을 나타내어 음극재와 충분한 결합력을 형성할 수 없다. 그 이유는 동의 결정 조직이 치밀하지 못하거나 또는 비표면적이 낮은 것에 기인한다.

【0097】 이상, 본 발명의 실시예를 통해 본 발명을 상술하였지만, 전술한 실시예는 본 발명의 기술 사상을 예시적으로 설명한 것에 불과한 것으로서, 본 발명이 속하는 기술 분야에서 통상의 지식을 가진 자라면 본 발명의 본질적인 특성에서 벗어나지 않는 범위에서 다양한 수정 및 변형이 가능함을 알 수 있을 것이다. 따라서, 본 발명에 개시된 실시 예는 본 발명의 기술 사상을 한정하기 위한 것이 아니라 설명하기 위한 것이고, 이러한 실시 예에 의하여 본 발명의 기술 사상의 범위가

한정되는 것은 아니다. 본 발명의 보호 범위는 아래의 청구범위에 의하여 해석되고, 그와 동등한 범위 내에 있는 모든 기술 사상은 본 발명의 권리범위에 포함되는 것으로 해석되어야 할 것이다.

【부호의 설명】

【0099】10 전해조

20 전해액

30 양극판

31 제1 양극판

32 제2 양극판

40 드럼 음극

100 전해동박

110a 제1 표면

110b 제2 표면

【청구범위】

【청구항 1】

제1 표면 및 상기 제2 표면을 갖는 전해동박에 있어서,

상기 전해동박은 다음의 수학식 1에 의해 정의되는 (220)면의 집합조직 계수가 0.4~1.32이고,

(수학식 1)

$$TC(220) = \frac{\frac{I(220)}{I_0(220)}}{\frac{1}{n}\sum\frac{I(hkl)}{I_0(hkl)}}$$

상기 전해동박의 제1 표면에서의 Rz/Ra와 제2 표면에서의 Rz/Ra 차이의 절대값(|Δ(Rz/Ra)|)이 2.42 미만이며,

상기 전해동박의 제1 표면 및 제2 표면에서의 피크 밀도(PD) 차이의 절대값(|ΔPD|)가 96ea 이하인 것을 특징으로 하는 전해동박.

【청구항 2】

제1항에 있어서,

상기 제2 표면은 M면이고,

상기 제2 표면에서의 Rz/Ra가 4.2 ~ 9.0 인 것을 특징으로 하는 전해동박.

【청구항 3】

제2항에 있어서,

상기 제1 표면은 S면이고,

상기 전해동박은 S면의 Rz/Ra가 5.1 ~ 6.8인 것을 특징으로 하는 전해동박.

【청구항 4】

제1항에 있어서,

상기 전해동박은 상온에서의 인장강도가 30~65 kg/mm^2인 것을 특징으로 하는 전해동박.

【청구항 5】

제1항에 있어서,

상기 전해동박은 상온에서의 연신율이 3% 이상인 것을 특징으로 하는 전해동박.

【청구항 6】

제1항에 있어서,

상기 전해동박은 폭 방향 중량편차가 5% 이하인 것을 특징으로 하는 전해동박.

【청구항 7】

제1항에 있어서,

상기 전해동박은,

8㎝ X 8㎝로 열십자 형태로 수직 이등분하도록 절개하여 4개의 절개부를 형

성한 후 돌출된 4개의 절개부 모서리 높이를 측정한 평균값이 10 ㎜ 미만인 것을 특징으로 하는 전해동박.

【청구항 8】

전해조의 전해액 내에 서로 이격되게 배치된 양극판 및 회전 음극드럼 사이에 전류를 인가하여 상기 회전 음극드럼 상에 구리막을 전기 도금하여 전해동박을 제조하는 방법에 있어서;

상기 음극드럼의 표면을 500~3000# 입도를 가지는 브러쉬로 버핑하는 단계;

상기 버핑된 회전 음극드럼 상에 구리막을 전착하는 단계; 및

도금된 상기 구리막을 권취하는 단계를 포함하는 것을 특징으로 하는 전해동박의 제조 방법.

【청구항 9】

제8항에 있어서,

상기 전해액은 70 내지 90 g/L의 구리 이온, 80 내지 120 g/L의 황산, 10 내지 30 ppm의 염소 이온을 포함하고, 첨가제로 25 ~50ppm의 Mo를 포함하는 것을 특징으로 하는 전해동박의 제조 방법.

【청구항 10】

제9항에 있어서,

상기 전해액은 SPS, MPS 및 ZPS로 이루어진 그룹 중에서 선택된 최소한 1종의 황화물계 화합물을 더 포함하는 것을 특징으로 하는 전해동박의 제조 방법.

【청구항 11】

제10항에 있어서,

상기 황화물계 화합물은 SPS이고,

상기 SPS는 3~12 ppm 함유되는 것을 특징으로 하는 전해동박의 제조 방법.

【청구항 12】

제11항에 있어서,

상기 전해액은 5~25 ppm의 PEG를 더 포함하는 것을 특징으로 하는 전해동박의 제조 방법.

【청구항 13】

제1항 내지 제7항 중 어느 한 항에 기재된 전해동박으로 된 집전체; 및

상기 제1 표면 또는 상기 제2 표면 상의 음극 활물질층을 포함하는 Li 이차전지용 음극.

【요약서】

【요약】

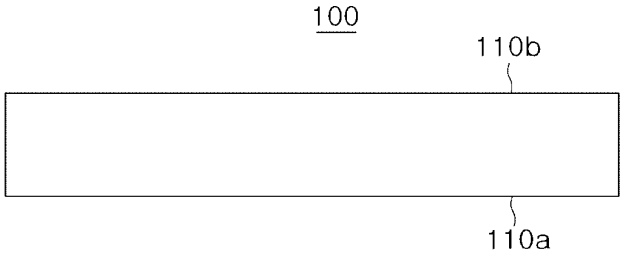
본 발명은 동박 제조 및 후속 이차전지의 제조 공정에서 우수한 핸들링 특성을 갖는 전해동박에 관한 것이다. 본 발명은 제1 표면 및 상기 제2 표면을 갖는 전해동박에 있어서, 상기 전해동박은 (220)면의 집합조직 계수가 0.4~1.32이고, 상기 전해동박의 제1 표면에서의 Rz/Ra와 제2 표면에서의 Rz/Ra 차이의 절대값(｜Δ(Rz/Ra)｜)이 2.42 미만이며, 상기 전해동박의 제1 표면 및 제2 표면에서의 피크 밀도(PD) 차이의 절대값(｜ΔPD｜)가 96ea 이하인 것을 특징으로 하는 전해동박을 제공한다. 본 발명에 따르면, 드럼음극의 표면 프로파일, 동박 표면의 표면 조직 구조 및 표면 프로파일을 제어하여 전해동박 제조 공정 및/또는 후속 이차전지 제조 공정에서 컬, 주름 및/또는 찢김 발생 가능성을 감소시키는 전해동박을 제공할 수 있게 된다.

【대표도】

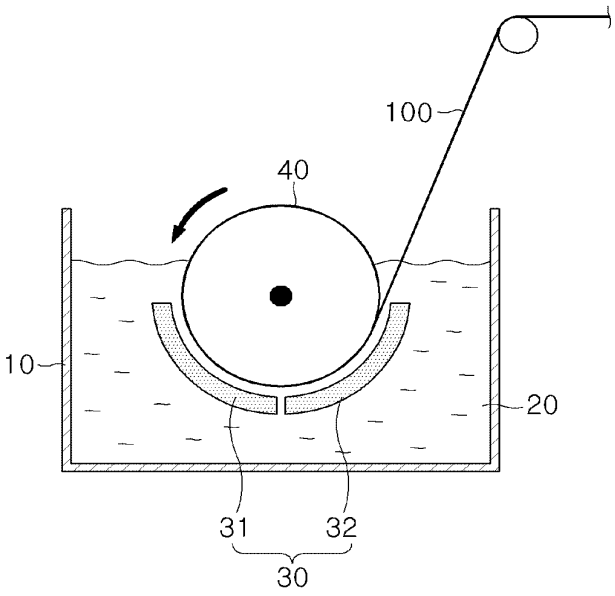
도 1

【도면】

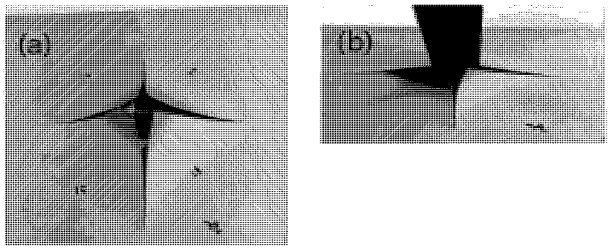
【도 1】



【도 2】



【도 3】



【도 4】



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0-1	국제출원번호	**PCT/KR2019/001069**
0-2	국제출원일자	**2019년 01월 25일 (25.01.2019)**
0-3	수리관청 명칭 및 "PCT 국제출원"	**RO/KR**

0-4	**서식 PCT/RO/101 - PCT 출원서**	
0-4-1	우측에 기재된 바와 같이 작성되었다.	**PCT-SAFE** **버전 3.51.074.250 MT/FOP 20160701/0.20.5.24**
0-5	**신청** 아래 서명인은 본 국제 출원서가 특허협력조약에 의해 처리될 것을 청구합니다.	
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0-7	**출원인 또는 대리인의 서류참조기호**	**OP19KF001WO**
I	**발명의 명칭**	**후속 공정에서 핸들링 특성이 우수한 전해동박 및 그 제조방법**
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II-1	이 사람은	**오직 출원인 (applicant only)**
II-2	우측 지정국에 관한 출원인	**모든 지정국 (all designated States)**
II-4ko	성명	**케이씨에프테크놀로지스 주식회사**
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III-1-1	이 사람은	**오직 발명자 (inventor only)**
III-1-3	우측 지정국에 관한 발명자	**모든 지정국 (all designated States)**
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III-2-1	이 사람은	**오직 발명자 (inventor only)**
III-2-3	우측 지정국에 관한 발명자	**모든 지정국 (all designated States)**
III-2-4ko	성명	**김선화**
III-2-4en	Name (LAST, First):	**JIN, Shan Hua**
III-2-5ko	주소	**대한민국** **14118** **경기도 안양시 동안구 엘에스로116번길 39, 4층**
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IV-1	**대리인 또는 대표자** 아래에 기재된 자는 관할 국제기관에 대하여 우측에 표시된 자격으로 출원인을 대리하는 것으로 선임되었다.	**대리인**
IV-1-1ko	성명	**특허법인 천문**
IV-1-1en	Name:	**ASTRAN INT'L IP GROUP**
IV-1-2ko	주소	**대한민국** **06225** **서울시 강남구 역삼로 233, 5층 (역삼동, 신성빌딩)**
IV-1-2en	Address:	**(ShinSung Building, Yeoksam-dong) 5th Floor, 233, Yeoksam-ro** **Gangnam-gu Seoul 06225** **Republic of Korea**
IV-1-3	전화번호	**82-2-3453-0635**
IV-1-4	팩스번호	**82-2-3453-0645**
IV-1-5	이메일 주소	**info@cheonmoon.com**
IV-1-5(a)	이메일 사용동의 수리관청, 국제조사기관, 국제사무국, 국제예비심사기관이 필요 시 이 이메일 주소를 사용하여 이 국제출원과 관련하여 발행된 통지서를 송부할 것에 동의한다.	**서면 통지서에 앞서 선람용 사본 송부**
IV-1-6	대리인 코드	**9-2009-100001-0**
V	**지정국**	
V-1	**본 출원서의 제출로, 규칙 4.9(a)에 따라, 부여될 수 있는 모든 종류의 권리 보호를 위하여, 그리고 해당하는 경우 지역특허 및 국내특허 모두를 위하여 당해 국제출원일에 PCT에 기속되는 모든 체약국이 지정된다.**	
V-2	**V-2란은 출원서 제출시 또는 규칙 26의2.1에 의해 그 이후 출원서 제6기재란에 위 특정 관련 체약국의 국내 선출원에 대한 우선권주장이 포함되어 있을 경우 당해 체약국의 국내법에 의해 해당 국내 선출원의 효력이 상실되는 것을 방지하기 위한 목적으로 당해 체약국의 지정을 제외하는 데에만 사용될 수 있다 (지정 제외시 이의 취소 불가능).**	**KR**
VI-1	**선국내출원에 대한 우선권 주장**	
VI-1-1	출원일	**2018년 01월 31일 (31.01.2018)**
VI-1-2	출원번호	**10-2018-0012179**
VI-1-3	파리협약 당사국명 또는 WTO 회원국명	**KR**

PCT 출원서

출력(전자적 형태가 원본)

VI-2	**우선권서류 신청** 수리관청에 대하여 위에 명시된 선출원의 인증등본을 준비하여 국제사무국에 송부하여 줄 것을 신청한다.	**VI-1**	
VI-3	**인용에 의한 보완** 조약 제11조(1)(iii)(d) 또는 (e)에서 규정하는 국제출원의 요소, 또는 규칙 20.5(a)에서 규정하는 명세서, 청구 범위 또는 도면의 일부가 본 국제출원에는 포함되어 있지 않지만 조약 제11조(1)(iii) 규정의 요소 중 하나 이상이 수리관청에 최초로 접수된 날에 우선권주장의 기초가 된 선출원에 완전히 포함되어 있는 경우, 그 요소 또는 부분은 규칙 20.6 규정에 의한 확인을 조건으로, 규칙 20.6의 규정과 관련하여 본 국제출원에 있어서 인용에 의해 보완된다.		
VII-1	국제조사기관(ISA) 선택	대한민국 특허청 (ISA/KR)	
VIII	**선언서**	선언서 개수	
VIII-1	발명자의 신원에 관한 선언	-	
VIII-2	국제출원일에 특허출원 및 특허를 받을 수 있는 출원인의 자격에 관한 선언	-	
VIII-3	국제출원일에 선출원의 우선권을 주장할 수 있는 출원인의 자격에 관한 선언	-	
VIII-4	발명자 선언(미국에 대한 지정의 경우에 한함)	-	
VIII-5	신규성을 해치지 아니하는 개시 또는 신규성 상실의 예외에 관한 선언	-	
IX	**체크 리스트**	용지 수	전자적 파일 첨부
IX-1	출원서(선언서 포함)	**4**	✓
IX-2	명세서	**10**	✓
IX-3	청구범위	**2**	✓
IX-4	요약서	**1**	✓
IX-5	도면	**2**	✓
IX-7	용지매수 소계	**19**	
	첨부 항목	서면 첨부	전자적 파일 첨부
IX-8	수수료 계산 용지	-	✓
IX-9	개별위임장 원본	-	✓
IX-20	**요약서에 수반되어야 할 도면 번호**	**1**	
IX-21	**국제출원의 출원 언어**	한국어	

PCT 출원서

출력(전자적 형태가 원본)

X-1	출원인, 대리인 또는 대표자의 서명 또는 날인	
X-1-1	성명	특허법인 천문
X-1-2	서명인의 성명	황광연
X-1-3	권한 (출원서를 통해 서명자의 자격이 명백하지 않은 경우에는 그 자격도 표시)	대표

수리관청 전용

10-1	국제출원으로 제출된 서류의 실제 접수일	**2019년 01월 25일 (25.01.2019)**
10-2	도면	
10-2-1	접수	
10-2-2	미접수	
10-3	국제출원으로 제출된 서류를 완성하는 서류 또는 도면의 추후 기간내 제출에 따른 정정된 실제 접수일	
10-4	**PCT** 제**11**조**(2)**에 따라 제출이 요구된 보완서로서 기간내 제출된 보완서의 접수일	
10-5	국제조사기관**(ISA)**	**ISA/KR**
10-6	조사료 납부시까지 지연된 조사용 사본의 송부	

국제 사무국 전용

11-1	국제 사무국의 기록원본 접수일	

Doc code: IDS
Doc description: Information Disclosure Statement (IDS) Filed

PTO/SB/08a (03-15)
Approved for use through 07/31/2016. OMB 0651-0031
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE
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INFORMATION DISCLOSURE STATEMENT BY APPLICANT (**Not for submission under 37 CFR 1.99)**		
	Application Number	
	Filing Date	
	First Named Inventor	Seung Min KIM
	Art Unit	
	Examiner Name	
	Attorney Docket Number	0313221.00022

U.S.PATENTS Remove

Examiner Initial*	Cite No	Patent Number	Kind Code[1]	Issue Date	Name of Patentee or Applicant of cited Document	Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear
	1					

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U.S.PATENT APPLICATION PUBLICATIONS Remove

Examiner Initial*	Cite No	Publication Number	Kind Code[1]	Publication Date	Name of Patentee or Applicant of cited Document	Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear
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FOREIGN PATENT DOCUMENTS Remove

Examiner Initial*	Cite No	Foreign Document Number[3]	Country Code[2]	Kind Code[4]	Publication Date	Name of Patentee or Applicant of cited Document	Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear	T[5]
	1	20170126775	KR	A	2017-11-20	LS MTRON LTD		
	2	20160102147	KR	A	2016-08-29	LS MTRON LTD.		
	3	20150050266	KR	A	2015-05-08	KOREA IND TECH INST		

EFS Web 2.1.17

INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)		
	Application Number	
	Filing Date	
	First Named Inventor	Seung Min KIM
	Art Unit	
	Examiner Name	
	Attorney Docket Number	0313221.00022

	4	H06146066	JP	A	1994-05-27	NIPPON KOKAN KK		
	5	2017063185	JP	A	2017-03-30	FUJI ELECTRIC CO LTD.		
	6	I533496	TW	B	2016-05-11	CHANG CHUN PETROCHEMICAL CO		

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NON-PATENT LITERATURE DOCUMENTS Remove

Examiner Initials*	Cite No	Include name of the author (in CAPITAL LETTERS), title of the article (when appropriate), title of the item (book, magazine, journal, serial, symposium, catalog, etc), date, pages(s), volume-issue number(s), publisher, city and/or country where published.	T[5]
	1	International Search Report for related International Application No. PCT/KR2019/001069; report dated August 8, 2019; (5 pages)	
	2	Written Opinion for related International Application No. PCT/KR2019/001069; report dated August 8, 2019; (5 pages)	

If you wish to add additional non-patent literature document citation information please click the Add button Add

EXAMINER SIGNATURE

Examiner Signature		Date Considered	

*EXAMINER: Initial if reference considered, whether or not citation is in conformance with MPEP 609. Draw line through a citation if not in conformance and not considered. Include copy of this form with next communication to applicant.

[1] See Kind Codes of USPTO Patent Documents at www.USPTO.GOV or MPEP 901.04. [2] Enter office that issued the document, by the two-letter code (WIPO Standard ST.3). [3] For Japanese patent documents, the indication of the year of the reign of the Emperor must precede the serial number of the patent document. [4] Kind of document by the appropriate symbols as indicated on the document under WIPO Standard ST.16 if possible. [5] Applicant is to place a check mark here if English language translation is attached.

INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)		
	Application Number	
	Filing Date	
	First Named Inventor	Seung Min KIM
	Art Unit	
	Examiner Name	
	Attorney Docket Number	0313221.00022

CERTIFICATION STATEMENT

Please see 37 CFR 1.97 and 1.98 to make the appropriate selection(s):

That each item of information contained in the information disclosure statement was first cited in any communication from a foreign patent office in a counterpart foreign application not more than three months prior to the filing of the information disclosure statement. See 37 CFR 1.97(e)(1).

OR

☐ That no item of information contained in the information disclosure statement was cited in a communication from a foreign patent office in a counterpart foreign application, and, to the knowledge of the person signing the certification after making reasonable inquiry, no item of information contained in the information disclosure statement was known to any individual designated in 37 CFR 1.56(c) more than three months prior to the filing of the information disclosure statement. See 37 CFR 1.97(e)(2).

See attached certification statement.

The fee set forth in 37 CFR 1.17 (p) has been submitted herewith.

☒ A certification statement is not submitted herewith.

SIGNATURE

A signature of the applicant or representative is required in accordance with CFR 1.33, 10.18. Please see CFR 1.4(d) for the form of the signature.

Signature	/Matthew S. Dicke/	Date (YYYY-MM-DD)	2020-06-30
Name/Print	Matthew S. Dicke	Registration Number	58819

This collection of information is required by 37 CFR 1.97 and 1.98. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.14. This collection is estimated to take 1 hour to complete, including gathering, preparing and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

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The Privacy Act of 1974 (P.L. 93-579) requires that you be given certain information in connection with your submission of the attached form related to a patent application or patent. Accordingly, pursuant to the requirements of the Act, please be advised that: (1) the general authority for the collection of this information is 35 U.S.C. 2(b)(2); (2) furnishing of the information solicited is voluntary; and (3) the principal purpose for which the information is used by the U.S. Patent and Trademark Office is to process and/or examine your submission related to a patent application or patent. If you do not furnish the requested information, the U.S. Patent and Trademark Office may not be able to process and/or examine your submission, which may result in termination of proceedings or abandonment of the application or expiration of the patent.

The information provided by you in this form will be subject to the following routine uses:

1. The information on this form will be treated confidentially to the extent allowed under the Freedom of Information Act (5 U.S.C. 552) and the Privacy Act (5 U.S.C. 552a). Records from this system of records may be disclosed to the Department of Justice to determine whether the Freedom of Information Act requires disclosure of these record s.

2. A record from this system of records may be disclosed, as a routine use, in the course of presenting evidence to a court, magistrate, or administrative tribunal, including disclosures to opposing counsel in the course of settlement negotiations.

3. A record in this system of records may be disclosed, as a routine use, to a Member of Congress submitting a request involving an individual, to whom the record pertains, when the individual has requested assistance from the Member with respect to the subject matter of the record.

4. A record in this system of records may be disclosed, as a routine use, to a contractor of the Agency having need for the information in order to perform a contract. Recipients of information shall be required to comply with the requirements of the Privacy Act of 1974, as amended, pursuant to 5 U.S.C. 552a(m).

5. A record related to an International Application filed under the Patent Cooperation Treaty in this system of records may be disclosed, as a routine use, to the International Bureau of the World Intellectual Property Organization, pursuant to the Patent Cooperation Treaty.

6. A record in this system of records may be disclosed, as a routine use, to another federal agency for purposes of National Security review (35 U.S.C. 181) and for review pursuant to the Atomic Energy Act (42 U.S.C. 218(c)).

7. A record from this system of records may be disclosed, as a routine use, to the Administrator, General Services, or his/her designee, during an inspection of records conducted by GSA as part of that agency's responsibility to recommend improvements in records management practices and programs, under authority of 44 U.S.C. 2904 and 2906. Such disclosure shall be made in accordance with the GSA regulations governing inspection of records for this purpose, and any other relevant (i.e., GSA or Commerce) directive. Such disclosure shall not be used to make determinations about individuals.

8. A record from this system of records may be disclosed, as a routine use, to the public after either publication of the application pursuant to 35 U.S.C. 122(b) or issuance of a patent pursuant to 35 U.S.C. 151. Further, a record may be disclosed, subject to the limitations of 37 CFR 1.14, as a routine use, to the public if the record was filed in an application which became abandoned or in which the proceedings were terminated and which application is referenced by either a published application, an application open to public inspections or an issued patent.

9. A record from this system of records may be disclosed, as a routine use, to a Federal, State, or local law enforcement agency, if the USPTO becomes aware of a violation or potential violation of law or regulation.

Electronic Patent Application Fee Transmittal

Application Number:	
Filing Date:	
Title of Invention:	ELECTROLYTIC COPPER FOIL HAVING EXCELLENT HANDLING CHARACTERISTICS IN POSTPROCESSING, AND MANUFACTURING METHOD THEREFOR
First Named Inventor/Applicant Name:	Seung Min KIM
Filer:	Matthew S. Dicke/Meg Boinski
Attorney Docket Number:	0313221.00022

Filed as Large Entity

Filing Fees for U.S. National Stage under 35 USC 371

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Basic Filing:				
NATIONAL STAGE FEE	1631	1	300	300
NATL STAGE SEARCH FEE - REPORT PROVIDED	1642	1	520	520
NATIONAL STAGE EXAM - ALL OTHER CASES	1633	1	760	760
Pages:				
Claims:				
Miscellaneous-Filing:				
Petition:				
Patent-Appeals-and-Interference:				

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Post-Allowance-and-Post-Issuance:				
Extension-of-Time:				
Miscellaneous:				
		Total in USD ($)		**1580**

Electronic Acknowledgement Receipt	
EFS ID:	39869568
Application Number:	16959352
International Application Number:	PCT/KR2019/001069
Confirmation Number:	1067
Title of Invention:	ELECTROLYTIC COPPER FOIL HAVING EXCELLENT HANDLING CHARACTERISTICS IN POSTPROCESSING, AND MANUFACTURING METHOD THEREFOR
First Named Inventor/Applicant Name:	Seung Min KIM
Customer Number:	24573
Filer:	Matthew S. Dicke/US Patent Mail
Filer Authorized By:	Matthew S. Dicke
Attorney Docket Number:	0313221.00022
Receipt Date:	30-JUN-2020
Filing Date:	
Time Stamp:	16:36:43
Application Type:	U.S. National Stage under 35 USC 371

Payment information:

Submitted with Payment	yes
Payment Type	DA
Payment was successfully received in RAM	$1580
RAM confirmation Number	E20206TG37564208
Deposit Account	021818
Authorized User	US Patent Mail
The Director of the USPTO is hereby authorized to charge indicated fees and credit any overpayment as follows: 37 CFR 1.17 (Patent application and reexamination processing fees) 37 CFR 1.492 (National application filing, search, and examination fees)	

37 CFR 1.492(a) (Basic national fee only)

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1	Transmittal of New Application	00022_371_Trans.pdf	252048 866f7cce597e35c2a033f6dd2896dd40f38619ac	no	4
Warnings:					
Information:					
2	Application Data Sheet	00022_ADS.pdf	1822589 84bb687ba3ec0e3769c1f038f1604834804ca141	no	8
Warnings:					
Information:					
3	Oath or Declaration filed	00022_Declaration.pdf	119866 ce44abca380c5f707b6af092764e2e0ab486ce94	no	2
Warnings:					
Information:					
4	Power of Attorney	00022_POA.pdf	734959 d72196a05d8b13e0349d03270806cd84c8995f80	no	4
Warnings:					
Information:					
5	Documents submitted with 371 Applications	00022_IntPublication.pdf	1276623 de3ce81f5cb5dd23acebc2e71b58a756ee7784e1	no	19
Warnings:					
Information:					
6	Transmittal Letter	00022_IDS_Trans.pdf	90725 488e447d820964b89b1584641b410302fff1d467	no	3
Warnings:					
Information:					

7	Documents submitted with 371 Applications	ISR.pdf	225130 432cc6a306bebcfd5c319d825282a00d9dd9e2ca	no	5
Warnings:					
Information:					
8	Documents submitted with 371 Applications	WrittenOpinion.pdf	165844 bc5a7a4b26fba05c9c5411455daeca1c77d7ec8f	no	5
Warnings:					
Information:					
9	Foreign Reference	JP2017063185A.pdf	3054622 26d66cbc72129ef8a0cbc441dc0ad64f45601276	no	14
Warnings:					
Information:					
10	Foreign Reference	JPH06146066a.pdf	2688380 1e4837b23c623a4a71d9f4958e44f11dca654ea3	no	14
Warnings:					
Information:					
11	Foreign Reference	KR20150050266A.pdf	1810235 d025693d9b70ca54d114d1556014c2d40259de26	no	12
Warnings:					
Information:					
12	Foreign Reference	KR20160102147A.pdf	2298465 b8ae74e8578eb35cc889fd7ace90581fde61b0ab	no	13
Warnings:					
Information:					
13	Foreign Reference	KR20170126775A.pdf	3616787 fcaab2f3ca50b7679d0acef00fc1596553e1f5bb	no	19
Warnings:					
Information:					

14	Foreign Reference	TWI533496B.pdf	1010779 dc0e622944f110695e5dc31bb605b974ff0b5ca5	no	21
Warnings:					
Information:					
15	Drawings-only black and white line drawings	00022_Drawings.pdf	106462 c03c5e5ce26604186782110bba94bbca20e4da0a	no	2
Warnings:					
Information:					
16		00022_Specification.pdf	175424 795db149602cffa29be866b2169d44716ae0c3ce	yes	32

Multipart Description/PDF files in .zip description

Document Description	Start	End
Specification	1	26
Claims	27	31
Abstract	32	32

Warnings:					
Information:					
17	Preliminary Amendment	00022_PreliminaryAmendment.pdf	137415 18394fce1f44b377865c6dfb80a5c4a154220934	no	6
Warnings:					
Information:					
18	Information Disclosure Statement (IDS) Form (SB08)	00022_PTOsb08.pdf	1035422 7e12998b0469a20188436ec02e230881b038364a	no	4
Warnings:					
Information:					

A U.S. Patent Number Citation or a U.S. Publication Number Citation is required in the Information Disclosure Statement (IDS) form for autoloading of data into USPTO systems. You may remove the form to add the required data in order to correct the Informational Message if you are citing U.S. References. If you chose not to include U.S. References, the image of the form will be processed and be made available within the Image File Wrapper (IFW) system. However, no data will be extracted from this form. Any additional data such as Foreign Patent Documents or Non Patent Literature will be manually reviewed and keyed into USPTO systems.

19	Fee Worksheet (SB06)	fee-info.pdf	35265 84a0ec2d9c72641223b785def3c02bfe7770a62e	no	2
Warnings:					
Information:					
			Total Files Size (in bytes):	20657040	

This Acknowledgement Receipt evidences receipt on the noted date by the USPTO of the indicated documents, characterized by the applicant, and including page counts, where applicable. It serves as evidence of receipt similar to a Post Card, as described in MPEP 503.

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If a new application is being filed and the application includes the necessary components for a filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application.

National Stage of an International Application under 35 U.S.C. 371

If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course.

New International Application Filed with the USPTO as a Receiving Office

If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.

Doc Code: PA..
Document Description: Power of Attorney

PTO/AIA/82A (07-13)
Approved for use through 01/31/2018. OMB 0651-0035
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NOTE: This form is to be submitted with the Power of Attorney by Applicant form (PTO/AIA/82B) to identify the application to which the Power of Attorney is directed, in accordance with 37 CFR 1.5, unless the application number and filing date are identified in the Power of Attorney by Applicant form. If neither form PTO/AIA/82A nor form PTO/AIA82B identifies the application to which the Power of Attorney is directed, the Power of Attorney will not be recognized in the application.

Application Number	To be assigned
Filing Date	Filed herewith
First Named Inventor	Seung Min KIM
Title	ELECTROLYTIC COPPER FOIL HAVING EXCELLENT HANDLING CHARACTERISTICS IN POSTPROCESSING, AND MANUFACTURING METHOD THEREFOR
Art Unit	To be assigned
Examiner Name	To be assigned
Attorney Docket Number	0313221.00022

SIGNATURE of Applicant or Patent Practitioner

Signature	/Matthew S. Dicke/	Date (Optional)	2020-06-30
Name	Matthew S. Dicke	Registration Number	58,819
Title (if Applicant is a juristic entity)			
Applicant Name (if Applicant is a juristic entity)			

NOTE: This form must be signed in accordance with 37 CFR 1.33. See 37 CFR 1.4(d) for signature requirements and certifications. If more than one applicant, use multiple forms.

☐ *Total of _____ forms are submitted.

This collection of information is required by 37 CFR 1.131, 1.32, and 1.33. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.11 and 1.14. This collection is estimated to take 3 minutes to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

If you need assistance in completing the form, call 1-800-PTO-9199 and select option 2.

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POWER OF ATTORNEY TO PROSECUTE APPLICATIONS BEFORE THE USPTO

I hereby revoke all previous powers of attorney given in the application identified in the attached statement under 37 CFR 3.73(c).

I hereby appoint:

[X] Practitioners associated with Customer Number: 24573

OR

[ ] Practitioner(s) named below (if more than ten patent practitioners are to be named, then a customer number must be used):

Name	Registration Number	Name	Registration Number

As attorney(s) or agent(s) to represent the undersigned before the United States Patent and Trademark Office (USPTO) in connection with any and all patent applications assigned only to the undersigned according to the USPTO assignment records or assignment documents attached to this form in accordance with 37 CFR 3.73(c).

Please change the correspondence address for the application identified in the attached statement under 37 CFR 3.73(c) to:

[X] The address associated with Customer Number: 24573

OR

[ ]

Firm or individual name		
Address		
City	State	Zip
Country		
Telephone	Email	

Assignee name and address: KCF Technologies Co., Ltd.
4F., 39, LS-ro 116beon-gil, Dongan-gu, Anyang-si, Gyeonggi-do 14118, Republic of Korea

A copy of this form, together with a statement under 37 CFR 3.73(c) (Form PTO/AIA/96 or equivalent) is required to be filed in each application in which this form is used. The statement under 37 CFR 3.73(c) may be completed by one of the practitioners appointed in this form, and must identify the application in which this Power of Attorney is to be filed.

SIGNATURE of Assignee of Record

The individual whose signature and title is supplied below is authorized to act on behalf of the assignee.

Signature [signature]	Date 2018. 4. 19
Name YOUNG-WOOK. CHAE	Telephone 82-10-2954-7380
Title Management of Technology Team KCF Technologies Co., Ltd.	

This collection of information is required by 37 CFR 1.31, 1.32, and 1.33. The information is required to obtain or retain a benefit by the public, which is to update (and by the USPTO to process) the file of a patent or reexamination proceeding. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.11 and 1.14. This collection is estimated to take 18 minutes to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

If you need assistance in completing the form, call 1-800-PTO-9199 and select option 2.

Privacy Act Statement

The **Privacy Act of 1974 (P.L. 93-579)** requires that you be given certain information in connection with your submission of the attached form related to a patent application or patent. Accordingly, pursuant to the requirements of the Act, please be advised that: (1) the general authority for the collection of this information is 35 U.S.C. 2(b)(2); (2) furnishing of the information solicited is voluntary; and (3) the principal purpose for which the information is used by the U.S. Patent and Trademark Office is to process and/or examine your submission related to a patent application or patent. If you do not furnish the requested information, the U.S. Patent and Trademark Office may not be able to process and/or examine your submission, which may result in termination of proceedings or abandonment of the application or expiration of the patent.

The information provided by you in this form will be subject to the following routine uses:

1. The information on this form will be treated confidentially to the extent allowed under the Freedom of Information Act (5 U.S.C. 552) and the Privacy Act (5 U.S.C 552a). Records from this system of records may be disclosed to the Department of Justice to determine whether disclosure of these records is required by the Freedom of Information Act.
2. A record from this system of records may be disclosed, as a routine use, in the course of presenting evidence to a court, magistrate, or administrative tribunal, including disclosures to opposing counsel in the course of settlement negotiations.
3. A record in this system of records may be disclosed, as a routine use, to a Member of Congress submitting a request involving an individual, to whom the record pertains, when the individual has requested assistance from the Member with respect to the subject matter of the record.
4. A record in this system of records may be disclosed, as a routine use, to a contractor of the Agency having need for the information in order to perform a contract. Recipients of information shall be required to comply with the requirements of the Privacy Act of 1974, as amended, pursuant to 5 U.S.C. 552a(m).
5. A record related to an International Application filed under the Patent Cooperation Treaty in this system of records may be disclosed, as a routine use, to the International Bureau of the World Intellectual Property Organization, pursuant to the Patent Cooperation Treaty.
6. A record in this system of records may be disclosed, as a routine use, to another federal agency for purposes of National Security review (35 U.S.C. 181) and for review pursuant to the Atomic Energy Act (42 U.S.C. 218(c)).
7. A record from this system of records may be disclosed, as a routine use, to the Administrator, General Services, or his/her designee, during an inspection of records conducted by GSA as part of that agency's responsibility to recommend improvements in records management practices and programs, under authority of 44 U.S.C. 2904 and 2906. Such disclosure shall be made in accordance with the GSA regulations governing inspection of records for this purpose, and any other relevant (*i.e.*, GSA or Commerce) directive. Such disclosure shall not be used to make determinations about individuals.
8. A record from this system of records may be disclosed, as a routine use, to the public after either publication of the application pursuant to 35 U.S.C. 122(b) or issuance of a patent pursuant to 35 U.S.C. 151. Further, a record may be disclosed, subject to the limitations of 37 CFR 1.14, as a routine use, to the public if the record was filed in an application which became abandoned or in which the proceedings were terminated and which application is referenced by either a published application, an application open to public inspection or an issued patent.
9. A record from this system of records may be disclosed, as a routine use, to a Federal, State, or local law enforcement agency, if the USPTO becomes aware of a violation or potential violation of law or regulation.

Doc Code: PA..
Document Description: Power of Attorney

PTO/AIA/82B (07-13)
Approved for use through 01/31/2018. OMB 0651-0035
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE
Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it displays a valid OMB control number

POWER OF ATTORNEY BY APPLICANT

I hereby revoke all previous powers of attorney given in the application identified in either the attached transmittal letter or the boxes below.

Application Number	Filing Date

(Note: The boxes above may be left blank if information is provided on form PTO/AIA/82A.)

☑ I hereby appoint the Patent Practitioner(s) associated with the following Customer Number as my/our attorney(s) or agent(s), and to transact all business in the United States Patent and Trademark Office connected therewith for the application referenced in the attached transmittal letter (form PTO/AIA/82A) or identified above: 24573

OR

☐ I hereby appoint Practitioner(s) named in the attached list (form PTO/AIA/82C) as my/our attorney(s) or agent(s), and to transact all business in the United States Patent and Trademark Office connected therewith for the patent application referenced in the attached transmittal letter (form PTO/AIA/82A) or identified above. (Note: Complete form PTO/AIA/82C.)

Please recognize or change the correspondence address for the application identified in the attached transmittal letter or the boxes above to:

☐ The address associated with the above-mentioned Customer Number

OR

☑ The address associated with Customer Number: 24573

OR

☐ Firm or Individual Name					
Address					
City		State		Zip	
Country					
Telephone		Email			

I am the Applicant (if the Applicant is a juristic entity, list the Applicant name in the box):

KCF Technologies Co., Ltd.

☐ Inventor or Joint Inventor (title not required below)

☐ Legal Representative of a Deceased or Legally Incapacitated Inventor (title not required below)

☑ Assignee or Person to Whom the Inventor is Under an Obligation to Assign (provide signer's title if applicant is a juristic entity)

☐ Person Who Otherwise Shows Sufficient Proprietary Interest (e.g., a petition under 37 CFR 1.46(b)(2) was granted in the application or is concurrently being filed with this document) (provide signer's title if applicant is a juristic entity)

SIGNATURE of Applicant for Patent

The undersigned (whose title is supplied below) is authorized to act on behalf of the applicant (e.g., where the applicant is a juristic entity).

Signature	[signature]	Date (Optional)	2018. 8. 17
Name	YOUNG-WOOK, CHAE		
Title	Management of Technology Team, KCF Technologies Co., Ltd.		

NOTE: Signature - This form must be signed by the applicant in accordance with 37 CFR 1.33. See 37 CFR 1.4 for signature requirements and certifications. If more than one applicant, use multiple forms.

☐ Total of forms are submitted.

This collection of information is required by 37 CFR 1.131, 1.32, and 1.33. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.11 and 1.14. This collection is estimated to take 3 minutes to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

If you need assistance in completing the form, call 1-800-PTO-9199 and select option 2.

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Applicant:	Seung Min KIM
Appl. No.:	To be assigned
Conf. No.:	To be assigned
Filed:	Filed herewith
Title:	ELECTROLYTIC COPPER FOIL HAVING EXCELLENT HANDLING CHARACTERISTICS IN POSTPROCESSING, AND MANUFACTURING METHOD THEREFOR
Art Unit:	To be assigned
Examiner:	To be assigned
Docket No.:	0313221.00022

Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

INFORMATION DISCLOSURE STATEMENT TRANSMITTAL LETTER

Sir:

Submitted herewith is an Information Disclosure Statement for consideration in the above-identified application. In accordance with the provisions of 37 C.F.R. 1.56, 37 C.F.R. 1.97, and 37 C.F.R. 1.98, Applicants request that a citation and examination of the references cited on the enclosed SB08 form be made during the course of examination of the above-identified application for United States patent.

This Information Disclosure Statement is submitted as follows:

Submission without Certification

[X] Within three months of filing of a national application; within three months of the date of entry of the national stage as set forth in 37 C.F.R. §1.491 in an international application; before the mailing date of a first Office Action on the merits, or before the mailing of a first Office Action after the filing of a Request for Continued Examination.

[ ] After the period specified above, but before the mailing date of a Final Action under 37 CFR 1.113, a Notice of Allowance under 37 CFR 1.311, or an Action that otherwise closes prosecution in the application and is accompanied by payment of the fee set forth in 37 CFR 1.17(p).

Submission with Certification

[ ] Within three months of filing of a national application; within three months of the date of entry of the national stage as set forth in 37 C.F.R. §1.491 in an international application; before the mailing date of a first Office Action on the merits, or before the mailing of a first Office Action after the filing of a Request for Continued Examination.

[ ] After the period specified above, but before the mailing date of a Final Action under 37 CFR 1.113, a Notice of Allowance under 37 CFR 1.311, or an Action that otherwise closes prosecution in the application and is accompanied by the Certification specified in 37 CFR 1.97(e) which is set forth below.

[ ] After the mailing date of a Final Action under 37 CFR 1.113, a Notice of Allowance under 37 CFR 1.311, or an Action that otherwise closes prosecution in the application and is accompanied by the fee set forth in 37 CFR 1.17(p) and the Certification specified in 37 CFR 1.97(e) which is set forth below.

Certification under 37 CFR 1.97(e)

[ ] The undersigned counsel for applicant(s) hereby certifies that each item of information contained in the accompanying Information Disclosure Statement was first cited in any communication from a foreign patent office in a counterpart foreign application not more than **three months** prior to the filing of the Information Disclosure Statement.

[ ] The undersigned counsel for applicant(s) hereby certifies that no item of information contained in the accompanying Information Disclosure Statement was cited in a communication from a foreign patent office in a counterpart foreign application, and, to the knowledge of the undersigned, after making reasonable inquiry, no item of information contained in the accompanying Information Disclosure Statement was known to any individual designated in 37 CFR 1.56(c) more than **three months** prior to the filing of the Information Disclosure Statement.

Statement under 37 CFR 1.704(d)

[ ] The undersigned counsel for applicant(s) hereby states that each item of information contained in the accompanying Information Disclosure Statement was first cited in any communication from a patent office in a counterpart foreign or international application or from the Office, and/or is a communication that was issued by a patent office in a counterpart foreign or international application or by the Office, and this communication was not received by any individual designated in § 1.56(c) more than **thirty days** prior to the filing of the information disclosure statement.

[X] A copy of a Search Report from a corresponding foreign patent application is enclosed.

[ ] The Commissioner is hereby authorized to charge the amount of $ to cover the required fee to Deposit Account No. 02-1818.

[X] The Commissioner is hereby authorized to charge any additional fees which may be required, or credit any overpayment to Deposit Account No. 02-1818.

Respectfully submitted,

K&L GATES LLP

BY /Matthew S. Dicke/
Matthew S. Dicke
Reg. No. 58819
Customer No. 24573
Phone: (312) 578-5415

Dated: June 30, 2020

특 허 협 력 조 약

PCT

국 제 조 사 보 고 서
(PCT 제 18 조 및 PCT규칙 43 및 44)

출원인 또는 대리인의 서류참조기호 OP19KF001WO	추가적인 조치	서식 PCT/ISA/220 및 아래 5.(해당하는경우) 참조
국제출원번호 **PCT/KR2019/001069**	국제출원일 *(일/월/년)* 2019년 01월 25일 (25.01.2019)	(최) 우선일 *(일/월/년)* 2018년 01월 31일 (31.01.2018)
출원인 케이씨에프테크놀로지스 주식회사		

본 국제조사보고서는 본 국제조사기관에 의하여 작성되었으며 PCT 제18조의 규정에 따라 출원인에게 송부됩니다. 이 국제조사보고서의 사본은 국제사무국에 송부됩니다.

본 국제조사보고서는 총 **3** 매로 구성되어 있습니다.

☒ 본 보고서에서 인용된 각 선행기술 문헌의 사본도 첨부되어 있습니다.

1. **보고서의 기초**
   a. **언어**와 관련하여, 국제조사는 아래에 기초하여 수행되었습니다.
      ☒ 출원시의 언어로 된 국제출원
      ☐ 국제조사를 위해 _____ 로 번역되어 제출된 국제출원의 번역문(PCT규칙 12.3(a) 및 23.1(b))
   b. ☐ 본 국제조사보고서는 PCT규칙 91의 규정에 따라 당해 기관이 허가하였거나 또는 당해 기관에 통보된 **명백한 잘못의 정정**을 고려하여 작성되었습니다(PCT규칙 43.6의2(a)).
   c. ☐ 국제출원에 개시된 **핵산염기 및/또는 아미노산 서열**에 관하여는 제1기재란을 참조하십시오.
2. ☐ **일부 청구항은 조사할 수 없습니다**(제2기재란 참조).
3. ☐ **발명의 단일성이 결여되어 있습니다**(제3기재란 참조).
4. **발명의 명칭**과 관련하여,
   ☒ 출원인이 제출한 대로 승인합니다.
   ☐ 본 국제조사기관이 다음과 같이 발명의 명칭을 작성하였습니다:
5. **요약서**와 관련하여,
   ☒ 출원인이 제출한 대로 승인합니다.
   ☐ PCT규칙 38.2의 규정에 따라 본 기관이 제4기재란에 표시된 대로 요약서를 작성하였습니다. 출원인은 본 국제조사보고서의 발송일부터 1월 이내에 본 기관에 의견을 제출할 수 있습니다.
6. **도면**과 관련하여,
   a. 요약서와 함께 공개될 **도면**은 제 1 도이며
      ☒ 출원인이 제안하였습니다.
      ☐ 출원인이 도면의 번호를 제안하지 않았기 때문에 본 기관이 선택하였습니다.
      ☐ 본 도면이 발명의 특징을 더 잘 나타내고 있기 때문에 본 기관이 선택하였습니다.
   b. ☐ 요약서와 함께 공개될 도면이 없습니다.

국 제 조 사 보 고 서

국제출원번호
PCT/KR2019/001069

A. 발명이 속하는 기술분류(국제특허분류(IPC))

C25D 1/04(2006.01)i, C25D 3/38(2006.01)i, H01M 4/66(2006.01)i, H01M 4/13(2010.01)i, H01M 10/052(2010.01)i

B. 조사된 분야

조사된 최소문헌(국제특허분류를 기재)
C25D 1/04; B32B 15/01; B32B 3/30; C25D 3/38; C25D 3/56; C25D 5/06; C25D 7/06; H01L 23/36; H01M 4/66; H01M 4/13; H01M 10/052

조사된 기술분야에 속하는 최소문헌 이외의 문헌
한국등록실용신안공보 및 한국공개실용신안공보: 조사된 최소문헌란에 기재된 IPC
일본등록실용신안공보 및 일본공개실용신안공보: 조사된 최소문헌란에 기재된 IPC

국제조사에 이용된 전산 데이터베이스(데이터베이스의 명칭 및 검색어(해당하는 경우))
eKOMPASS(특허청 내부 검색시스템) & 키워드: 이차전지, 전해동박, 동도금, 집합조직 계수, 피크 밀도, 버핑, 연마, 전해액, Mo, SPS, PEG

C. 관련 문헌

카테고리*	인용문헌명 및 관련 구절(해당하는 경우)의 기재	관련 청구항
Y	KR 10-2017-0126775 A (엘에스엠트론 주식회사) 2017.11.20 단락 [0047], [0070]-[0072], [0075], [0094] 및 도면 1, 5 참조.	1-10
Y	KR 10-2016-0102147 A (엘에스엠트론 주식회사) 2016.08.29 단락 [0050]-[0051] 참조.	1-10
A	KR 10-2015-0050266 A (한국생산기술연구원) 2015.05.08 단락 [0003], [0010]-[0011], [0024], [0031] 및 도면 1 참조.	1-10
A	JP 06-146066 A (NKK CORP.) 1994.05.27 단락 [0039]-[0043] 및 도면 1-5 참조.	1-10
A	JP 2017-063185 A (FUJI ELECTRIC CO., LTD.) 2017.03.30 단락 [0055]-[0058] 참조.	1-10

☐ 추가 문헌이 C(계속)에 기재되어 있습니다.

☒ 대응특허에 관한 별지를 참조하십시오.

* 인용된 문헌의 특별 카테고리:

"A" 특별히 관련이 없는 것으로 보이는 일반적인 기술수준을 정의한 문헌

"E" 국제출원일보다 빠른 출원일 또는 우선일을 가지나 국제출원일 이후에 공개된 선출원 또는 특허 문헌

"L" 우선권 주장에 의문을 제기하는 문헌 또는 다른 인용문헌의 공개일 또는 다른 특별한 이유(이유를 명시)를 밝히기 위하여 인용된 문헌

"O" 구두 개시, 사용, 전시 또는 기타 수단을 언급하고 있는 문헌

"P" 우선일 이후에 공개되었으나 국제출원일 이전에 공개된 문헌

"T" 국제출원일 또는 우선일 후에 공개된 문헌으로, 출원과 상충하지 않으며 발명의 기초가 되는 원리나 이론을 이해하기 위해 인용된 문헌

"X" 특별한 관련이 있는 문헌. 해당 문헌 하나만으로 청구된 발명의 신규성 또는 진보성이 없는 것으로 본다.

"Y" 특별한 관련이 있는 문헌. 해당 문헌이 하나 이상의 다른 문헌과 조합하는 경우로 그 조합이 당업자에게 자명한 경우 청구된 발명은 진보성이 없는 것으로 본다.

"&" 동일한 대응특허문헌에 속하는 문헌

국제조사의 실제 완료일	국제조사보고서 발송일
2019년 05월 07일 (07.05.2019)	2019년 05월 07일 (07.05.2019)

ISA/KR의 명칭 및 우편주소
대한민국 특허청
(35208) 대전광역시 서구 청사로 189,
4동 (둔산동, 정부대전청사)
팩스 번호 +82-42-481-8578

심사관
김진호
전화번호 +82-42-481-8699

서식 PCT/ISA/210 (두 번째 용지) (2015년 1월)

국 제 조 사 보 고 서
대응특허에 관한 정보

국제출원번호
PCT/KR2019/001069

국제조사보고서에서 인용된 특허문헌	공개일	대응특허문헌	공개일
KR 10-2017-0126775 A	2017/11/20	없음	
KR 10-2016-0102147 A	2016/08/29	없음	
KR 10-2015-0050266 A	2015/05/08	KR 10-1535853 B1	2015/07/13
JP 06-146066 A	1994/05/27	없음	
JP 2017-063185 A	2017/03/30	없음	

INTERNATIONAL SEARCH REPORT

International application No.
PCT/KR2019/001069

A. CLASSIFICATION OF SUBJECT MATTER

C25D 1/04(2006.01)i, C25D 3/38(2006.01)i, H01M 4/66(2006.01)i, H01M 4/13(2010.01)i, H01M 10/052(2010.01)i

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

C25D 1/04; B32B 15/01; B32B 3/30; C25D 3/38; C25D 3/56; C25D 5/06; C25D 7/06; H01L 23/36; H01M 4/66; H01M 4/13; H01M 10/052

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched
Korean utility models and applications for utility models: IPC as above
Japanese utility models and applications for utility models: IPC as above

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

eKOMPASS (KIPO internal) & Keywords: secondary battery, electrolytic copper foil, copper plating, texture coefficient, peak density, buffing, polishing, electrolyte, Mo, SPS, PEG

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	KR 10-2017-0126775 A (LS MTRON LTD.) 20 November 2017 See paragraphs [0047], [0070]-[0072], [0075], [0094] and figures 1, 5.	1-10
Y	KR 10-2016-0102147 A (LS MTRON LTD.) 29 August 2016 See paragraphs [0050]-[0051].	1-10
A	KR 10-2015-0050266 A (KOREA INSTITUTE OF INDUSTRIAL TECHNOLOGY) 08 May 2015 See paragraphs [0003], [0010]-[0011], [0024], [0031] and figure 1.	1-10
A	JP 06-146066 A (NKK CORP.) 27 May 1994 See paragraphs [0039]-[0043] and figures 1-5.	1-10
A	JP 2017-063185 A (FUJI ELECTRIC CO., LTD.) 30 March 2017 See paragraphs [0055]-[0058].	1-10

☐ Further documents are listed in the continuation of Box C.

☒ See patent family annex.

* Special categories of cited documents:

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier application or patent but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
07 MAY 2019 (07.05.2019)	**07 MAY 2019 (07.05.2019)**
Name and mailing address of the ISA/KR Korean Intellectual Property Office Government Complex Daejeon Building 4, 189, Cheongsa-ro, Seo-gu, Daejeon, 35208, Republic of Korea Facsimile No. +82-42-481-8578	Authorized officer Telephone No.

Form PCT/ISA/210 (second sheet) (January 2015)

INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/KR2019/001069

Patent document cited in search report	Publication date	Patent family member	Publication date
KR 10-2017-0126775 A	20/11/2017	None	
KR 10-2016-0102147 A	29/08/2016	None	
KR 10-2015-0050266 A	08/05/2015	KR 10-1535853 B1	13/07/2015
JP 06-146066 A	27/05/1994	None	
JP 2017-063185 A	30/03/2017	None	

Form PCT/ISA/210 (patent family annex) (January 2015)

특허협력조약

발신: 국제조사기관

수신:
특허법인 천문

대한민국 06225 서울시 강남구 역삼로 233, 5층 (역삼동, 신성빌딩)

PCT

국제조사기관의 견해서

(PCT규칙 43의2.1)

발송일 *(일/월/년)*	2019년 05월 07일 (07.05.2019)
출원인 또는 대리인의 서류참조기호 OP19KF001WO	**추가적인 조치** 아래 2를 참조

국제출원번호	국제출원일 *(일/월/년)*	우선일 *(일/월/년)*
PCT/KR2019/001069	2019년 01월 25일 (25.01.2019)	2018년 01월 31일 (31.01.2018)

국제특허분류(IPC)
C25D 1/04(2006.01)i, C25D 3/38(2006.01)i, H01M 4/66(2006.01)i, H01M 4/13(2010.01)i, H01M 10/052(2010.01)i

출원인
케이씨에프테크놀로지스 주식회사

1. 본 견해서는 다음 기재란에 관한 내용을 포함합니다.

- [x] 제1기재란 견해서의 기초
- [ ] 제2기재란 우선권
- [ ] 제3기재란 신규성, 진보성 및 산업상이용가능성에 관한 견해 부작성
- [ ] 제4기재란 발명의 단일성 결여
- [x] 제5기재란 신규성, 진보성 또는 산업상이용가능성에 관한 견해(PCT규칙 43의2.1(a)(i)), 이를 뒷받침하는 인용문헌 및 설명
- [ ] 제6기재란 특이 인용문헌
- [ ] 제7기재란 국제출원의 흠결
- [ ] 제8기재란 국제출원에 관한 의견

2. **추가적인 조치**

국제예비심사가 청구되면, 본 견해서는 국제예비심사기관("IPEA")의 견해서로 간주될 것입니다. 다만, 출원인이 본 기관 이외의 기관을 IPEA로 선택하고, 그 선택된 IPEA가 PCT규칙 66.1의2(b)에 따라 본 국제조사기관의 견해서가 위와 같이 간주되지 않을 것임을 국제사무국에 통보한 경우에는 그러하지 않습니다.

본 견해서가 상기와 같이 IPEA의 견해서로 간주되는 경우, 출원인은 서식 PCT/ISA/220의 발송일로부터 3월 또는 우선일부터 22월 중 늦게 만료되는 날 이전에 의견서 및 보정서(해당하는 경우)를 IPEA에 제출할 수 있습니다.

다른 선택사항에 대하여는 서식 PCT/ISA/220에 대한 안내문을 참조하십시오.

ISA/KR의 명칭 및 우편주소	본 견해서의 완료일	심사관
대한민국 특허청 (35208) 대전광역시 서구 청사로 189, 4동 (둔산동, 정부대전청사) 팩스번호 +82-42-481-8578	2019년 05월 07일 (07.05.2019)	김진호 전화번호 +82-42-481-8699

서식 PCT/ISA/237 (표지) (2015년 1월)

국제조사기관의 견해서

국제출원번호
PCT/KR2019/001069

제1기재란 본 견해서의 기초

1. **언어**와 관련하여, 본 견해서는 아래에 기초하여 작성되었습니다.

   ☒ 출원시의 언어로 된 국제출원

   ☐ 국제조사를 위하여 _____ 로 번역되어 제출된 국제출원의 번역문
   (PCT규칙 12.3(a) 및 23.1(b))

2. ☐ 본 견해서는 PCT규칙 91에 따라 당해 기관이 허가하였거나 당해 기관에 통보된 **명백한 잘못의 정정**을 고려하여 작성되었습니다(PCT규칙 43의2.1(a)).

3. ☐ 국제출원에 개시된 핵산염기 및/또는 아미노산 서열과 관련하여, 본 견해서는 아래에 기초하여 작성되었습니다.

   a. ☐ 아래의 형태로 출원시 국제출원의 일부를 구성하는 서열목록

      ☐ 부록 C/ST.25 텍스트 파일

      ☐ 서면 혹은 이미지 파일

   b. ☐ PCT 규칙 13의3.1(a)에 따라 국제출원과 함께 국제조사만을 목적으로 부록 C/ST.25 텍스트 파일의 형태로 제출된 서열목록

   c. ☐ 국제조사만을 목적으로 국제출원일 이후에 아래 형태로 제출된 서열목록

      ☐ 부록 C/ST.25 텍스트 파일 (규칙 13의3.1(a))

      ☐ 서면 혹은 이미지 파일 (규칙 13의3.1(b) 및 시행세칙 713)

4. ☐ 추가로 서열목록에 대하여 하나 이상의 버전이나 사본이 제출된 경우, 후속 버전 또는 추가된 사본에 기재되어 있는 정보가 출원시 출원의 일부를 구성하는 정보와 동일하거나 또는 출원시의 개시범위를 벗어나지 않는다는 진술서가 제출되었습니다.

5. 추가 의견:

국제조사기관의 견해서

국제출원번호
PCT/KR2019/001069

제5기재란 신규성, 진보성 또는 산업상이용가능성에 관한 견해(PCT규칙 43의2.1(a)(i)), 이를 뒷받침하는 인용문헌 및 설명

1. 견해

신규성 (N)	청구항	1-10	있음
	청구항	없음	없음
진보성 (IS)	청구항	없음	있음
	청구항	1-10	없음
산업상 이용가능성 (IA)	청구항	1-10	있음
	청구항	없음	없음

2. 인용문헌 및 설명:

참고한 인용문헌은 다음과 같습니다.

D1: KR 10-2017-0126775 A (엘에스엠트론 주식회사) 2017.11.20
D2: KR 10-2016-0102147 A (엘에스엠트론 주식회사) 2016.08.29

Ⅰ. 신규성 및 진보성(PCT 제33조(2) 및 (3))

1. 청구항 1-7

1.1. 청구항 1

청구항 1과 가장 근접한 인용문헌 D1에는 매트면(M) 및 그 반대편의 샤이니면(S)을 갖는 전해동박(100)이 개시되어 있습니다(단락 [0047] 및 도면 1 참조).

다만, 청구항 1은 수학식 1에 의해 정의되는 (220)면의 집합조직 계수가 0.4~1.32이고(특징 1-1), 전해동박의 제1 표면에서의 Rz/Ra와 제2 표면에서의 Rz/Ra 차이(|Δ(Rz/Ra)|)가 2.42미만이며(특징 1-2), 전해동박의 제1 표면 및 제2 표면에서의 피크 밀도(PD) 차이(|ΔPD|)가 96ea 이하인 점(특징 1-3)에서 인용문헌 D1과 차이가 있습니다.

그러나 특징 1-1은 인용문헌 D1의 유기 황화물(SPS)을 포함하는 전해액(11)(단락 [0072] 참조)으로부터 통상의 기술자가 쉽게 설계 변경하여 도출할 수 있고, 특징 1-2 및 1-3은 인용문헌 D1의 #800 내지 #1500의 입도(Grit)를 갖는 연마 브러시로 회전 음극드럼(12)의 표면을 연마하는 것(단락 [0075] 참조) 및 인용문헌 D2의 Mo과 PEG를 포함하는 도금액(단락 [0050]-[0051] 참조)으로부터 통상의 기술자가 쉽게 설계 변경하여 도출할 수 있습니다.

따라서 청구항 1은 인용문헌 D1 및 D2의 결합에 의해 진보성이 없습니다.

1.2. 청구항 2-7

추가 기재란에 계속

추가 기재란

이전 기재란의 공간이 충분하지 아니한 경우.
제5 기재란의 연속

청구항 2의 추가적인 특징은 인용문헌 D2의 Mo과 PEG를 포함하는 도금액으로부터 통상의 기술자가 쉽게 설계 변경하여 도출할 수 있습니다(단락 [0050]-[0051] 참조).

청구항 3의 추가적인 특징은 인용문헌 D1의 #800 내지 #1500의 입도(Grit)를 갖는 연마 브러시로 회전 음극드럼(12)의 표면을 연마하는 것으로부터 통상의 기술자가 쉽게 설계 변경하여 도출할 수 있습니다(단락 [0075] 참조).

청구항 4-7의 추가적인 특징들은 인용문헌 D1의 매트면(M) 및 그 반대편의 샤이니면(S)을 갖는 전해동박(100)(단락 [0047], [0070]-[0072], [0075] 및 도면 1, 5 참조) 및 인용문헌 D2의 구리 농도가 70~80g/L, 황산 농도가 80~110g/L인 도금액에 Mo, PEG, SPS를 첨가하는 것(단락 [0050]-[0051] 참조)으로부터 통상의 기술자가 쉽게 설계 변경하여 도출할 수 있습니다.

따라서 청구항 2-7은 인용문헌 D1 및 D2의 결합에 의해 진보성이 없습니다.

2. 청구항 8-10

2.1. 청구항 8

청구항 8과 가장 근접한 인용문헌 D1에는 전해조(10)에 담겨진 전해액(11) 내에 서로 이격되게 배치된 양극판(13) 및 회전 음극드럼(12)을 10 내지 80 ASD의 전류밀도로 통전시킴으로써 회전 음극드럼(12) 상에 구리를 전착시켜 메인 구리막(110)을 형성하는 전해동박(100)의 제조방법에 있어서, #800 내지 #1500의 입도(Grit)를 갖는 연마 브러시로 회전 음극드럼(12)의 표면을 연마하는 단계; 회전 음극드럼(12) 상에 구리를 전착시켜 메인 구리막(110)을 형성하는 단계; 및 전해동박(100)을 와인더(WR)에 권취하는 단계를 포함하며, 전해액(11)이 50 내지 100 g/L의 구리 이온, 50 내지 150 g/L의 황산, 17 내지 23 ppm의 염소 이온 및 유기 황화물(SPS)을 포함하는 전해동박(100)의 제조방법이 개시되어 있습니다(단락 [0070]-[0072], [0075], [0094] 및 도면 5 참조).

다만, 청구항 8은 전해액이 25 내지 50 ppm의 Mo 및 5 내지 25 ppm의 PEG를 포함하는 점에서 인용문헌 D1과 차이가 있으나, 이는 인용문헌 D2의 구리 농도가 70~80g/L, 황산 농도가 80~110g/L인 도금액에 Mo, PEG, SPS를 첨가하는 것으로부터 통상의 기술자가 쉽게 설계 변경하여 도출할 수 있습니다(단락 [0050]-[0051] 참조).

따라서 청구항 8은 인용문헌 D1 및 D2의 결합에 의해 진보성이 없습니다.

다음 페이지에 계속

추가 기재란

이전 기재란의 공간이 충분하지 아니한 경우.
이전 기재란의 연속

2.2. 청구항 9-10

청구항 9-10의 추가적인 특징들은 인용문헌 D2의 구리 농도가 70~80g/L, 황산 농도가 80~110g/L인 도금액에 Mo, PEG, SPS를 첨가하는 것과 실질적으로 동일합니다(단락 [0050]-[0051] 참조).

따라서 청구항 9-10은 인용문헌 D1 및 D2의 결합에 의해 진보성이 없습니다.

Ⅱ. 산업상 이용가능성(PCT 제33조(4))

청구항 1-10은 산업상 이용 가능합니다.

Espacenet

Bibliographic data: JP2017063185 (A) — 2017-03-30

HEAT RADIATION STRUCTURE AND SEMICONDUCTOR DEVICE, AND METHOD OF MANUFACTURING HEAT RADIATION STRUCTURE

Inventor(s): OGURA KEISUKE ± (小倉 圭輔)

Applicant(s): FUJI ELECTRIC CO LTD ± (富士電機株式会社)

Classification: **- international:** *H01L23/36*
- cooperative: H01L2224/32225 (EP); H01L2224/48091 (EP); H01L2224/48227 (EP); H01L2224/73265 (EP) more

Application number: JP20160159651 20160816 Global Dossier

Priority number (s): JP20150188731 20150925

Abstract of JP2017063185 (A)

PROBLEM TO BE SOLVED: To provide a heat radiation structure that comprises a bonding layer with a high bondability at a low cost.SOLUTION: Provided is a heat radiation structure that comprises: a heating element 17; a heat transfer core 11 formed by a copper plate or a copper alloy plate; and a copper plating layer 12A for bonding between the heating element and the heat transfer core. The heat radiation structure optionally comprises a heat conducting member 13A. Also provided is a method of manufacturing the heat radiation structure, that includes the following steps of: obtaining a laminate by laminating a heating element, a heat transfer core formed by the copper plate or the copper alloy plate, and a heat conducting member, in this order; fixing the laminate and immersing it in a copper plating bath; and making a cathode contact with the heat transfer core to perform electrolytic plating.SELECTED DRAWING: Figure 1

(19)日本国特許庁(JP)　(12)公開特許公報(A)　(11)特許出願公開番号
特開2017-63185
(P2017-63185A)
(43)公開日　平成29年3月30日(2017.3.30)

(51)Int.Cl.		F I		テーマコード（参考）
H01L 23/36	(2006.01)	H01L 23/36	D	5F136

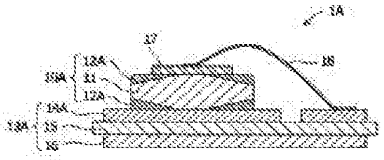
審査請求 未請求　請求項の数 10　ＯＬ　（全 16 頁）

(21)出願番号　特願2016-159651 (P2016-159651)
(22)出願日　平成28年8月16日 (2016.8.16)
(31)優先権主張番号　特願2015-188731 (P2015-188731)
(32)優先日　平成27年9月25日 (2015.9.25)
(33)優先権主張国　日本国 (JP)

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(54)【発明の名称】放熱構造及び半導体装置、並びに放熱構造の製造方法



[0001]　本発明は、放熱構造及び半導体装置、並びに放熱構造の製造方法に関する。本発明は、特には、安価で放熱性に優れ、接合層としての機能を兼ね備えた放熱構造及び半導体装置、並びに放熱構造の製造方法に関する。

[0002]　近年、パワーモジュールの分野では、大電流化に伴い、デバイスチップからの熱を逃がす高放熱構造が要求されている。現在、デバイスチップ下の放熱は、基板を介し、銅ブロックやアルミニウム放熱フィンへ逃がす構造が主に採用されている。

[0003]　図８は、従来技術に係る半導体装置の概念的な断面図である。図８に示す半導体装置１００においては、配線金属部１１４と絶縁層１１５と金属層１１６とから構成される絶縁回路基板１１３の配線金属部１１４に、はんだ接合層１１９を介して半導体チップ１１７が接合されている。半導体チップ１１７と配線金属部１１４とは、リードワイヤ１１８により接続されており、図示しない絶縁封止材により封止されている。一方、絶縁回路基板１１３の金属層１１６側の面には、図示しないはんだ接合層を介して、放熱フィン１２０が設けられている。

[0004] しかし、図示するような従来の構造においては、絶縁回路基板１１３の接合材であるはんだ接合層１１９や絶縁回路基板のセラミックスからなる絶縁層１１５の放熱性能が低く、大電流化に対して十分な放熱が困難となっている。そこで、放熱性能に優れた銀ナノ粒子や銅ナノ粒子を用いた接合材が開発されてきている。

[0005] デバイスチップ上に放熱板を設け、これをはんだ接合して放熱性を向上させた半導体装置が知られている（特許文献１）。また、ＬＥＤ素子の下に厚みのある銅めっき層と銅板を設けて放熱特性を良好なものとした発光ダイオードが知られている（特許文献２）。他には、絶縁回路基板の、半導体チップとは反対側の面に、Ｓｎ及びＮｉを含有する金属間化合物を介して設けられて接合されたＣｕもしくはＣｕ合金等からなる放熱体を備えるパワーモジュールが知られている（特許文献３）。

[0006] 【特許文献 1】 特開2006-310341号公報

【特許文献 2】 特開2002-43632号公報

【特許文献 3】 特開2004-296493号公報

[0007] 従来技術として用いられてきた銀ナノ粒子や銅ナノ粒子を用いた接合材は材料費、プロセスが高価になる上、やはり絶縁回路基板を構成するセラミックスの放熱性能に律速して、十分な放熱性が確保できないという問題があった。また、特許文献1に開示された構成では、はんだ材を使用していることから、Ｃｕに比べ放熱性能が劣ることが推測される。

さらに、はんだは融点が低いため、高温動作での利用には接合材としての信頼性が不十分である。特許文献2に開示された技術においては、ＬＥＤ素子の接合に、比較的高価な銀ペーストなどの導電性接着剤を必要とする。特許文献3に開示された構成においても、セラミクスから構成される絶縁回路基板が放熱の律速要因になりうるという問題があった。

[0008] また、デバイスチップ以外の発熱部材においても、高温動作での利用が可能な接合材が求められる。これらの問題に鑑みて、放熱性能に優れ、比較的安価な接合層を備えた放熱構造が求められる。

[0009] 本発明者らは、デバイスチップなどの発熱体と配線金属部を設けた絶縁回路基板との接合に通常用いられるはんだや金属ナノ粒子に代えて、放熱性の高い銅板もしくは銅合金板とめっきを用いて接合層を構成することを考え、本発明を完成するに至った。本発明は、一実施形態によれば、放熱構造であって、発熱体と、銅板もしくは銅合金板で形成される伝熱コアと、前記発熱体と前記伝熱コアとを接合する銅めっき層とを備えることを特徴とする。

[0010] 前記放熱構造において、前記銅めっき層によって前記伝熱コアに接合され、前記発熱体からの熱が伝熱される被伝熱部材をさらに備えることが好ましい。

[0011] 前記放熱構造において、前記伝熱コアは、銅めっき時に前記発熱体に当接する発熱体当接面と、銅めっき時に前記被伝熱部材に当接する被伝熱部材当接面と、銅めっき時に該発熱体および該被伝熱部材のいずれにも当接しない非当接面とを有し、該発熱体と該非当接面の間および該被伝熱部材と非当接面との間が前記銅めっき層により接合されていることが好ましい。

[0012] 前記放熱構造において、前記発熱体当接面および前記被伝熱部材当接面が当該伝熱コアの中心部を含む位置に設定されていることが好ましい。

[0013] 前記放熱構造において、前記伝熱コアが、平面視した場合に、長辺の長さＬ₀の矩形形状をなし、前記発熱体当接面と前記被伝熱部材当接面との距離で定義される当該伝熱コアの中央部厚みｄ₁と、側端部厚みｄ₂と、Ｌ₀とが、以下の関係

$$d_1 - d_2 \geq L_0/200$$

で表されることが好ましい。

[0014] 本発明は、別の実施形態によれば、前述のいずれかの放熱構造を備える半導体装置であって、前記発熱体がデバイスチップであり、前記被伝熱部材が、絶縁回路基板の少なくとも一方の面に、前記銅めっき層によって前記伝熱コアに接合される配線金属部を形成した絶縁回路基板であることを特徴とする半導体装置である。

[0015] 前記半導体装置において、前記伝熱コアに接合される配線金属部が、中央部が厚く、側端部が薄く構成されており、前記中央部に前記伝熱コアに当接する伝熱コア当接面を有することが好ましい。

[0016] 前記半導体装置において、前記伝熱コアに接合される配線金属部が、平面視した場合に、長辺の長さＭｓの矩形形状をなし、

前記配線金属部の中央部厚みｅｓと側端部の厚みｅｅとの差ｅｉが、以下の関係

$$e_i \geq M_s/200$$

で表されることが好ましい。

[0017] 前記半導体装置において、前記デバイスチップの接合面および前記配線金属部が、Ｃｕ、Ａｇ、Ａｕ、Ｎｉから選択される１以上の成分を含んで構成されていることが好ましい。

[0018] 本発明は、別の局面によれば、放熱構造の製造方法であって、発熱体と、銅板もしくは銅合金板で形成される伝熱コアと、被伝熱部材とをこの順に積層して積層体を得る工程と、前記積層体を固定し、銅めっき浴に浸漬する工程と、前記伝熱コアに、陰極を接触させて、電解めっきを行う工程とを含む。

[0019] 本発明によれば、従来のはんだ接合層に代えて、銅板もしくは銅合金板で形成される伝熱コアと、銅めっき層とから構成された接合層を備える放熱構造とすることで、安価に強固な接合を実現するとともに、接合層が放熱層としての機能を兼ねる構造とすることができる。発熱体の直下に放熱接合層を設けることで、発熱体で発生する熱を効率よく逃すことができる。このような放熱構造を備えてなる半導体装置は、高温動作に好適で、高い信頼性を有するとともに、経済的にも優れている。

[0021] 以下に、図面を参照して、本発明の実施の形態を説明する。ただし、本発明は、以下に説明する実施の形態によって限定されるものではない。特に、図示する各部材の寸法や、部材間の相対的な寸法、位置関係は、一例であり、図示するものには限定されない。

[0022] 本発明は、一実施形態によれば、放熱構造に関する。当該放熱構造は、発熱体と、前記発熱体と少なくとも一部において当接している銅板もしくは銅合金板で形成される伝熱コアと、前記発熱体と前記伝熱コアとを接合する銅めっき層とを備える。さらに、銅めっき層によって前記伝熱コアに接合され、前記伝熱コアと少なくとも一部において当接しており、前記発熱体からの熱が伝熱される被伝熱部材をさらに備えていてもよい。本実施形態による放熱構造は、はんだ材や金属ナノ粒子などの接合材を用いることなく、銅めっき層により接合され、かつ、銅めっき層と伝熱コアとで構成される接合層が、高い放熱機能を備えている。

[0023] 本発明の放熱構造は、特定の装置構成に限定されるものではないが、一例として、パワーモジュールとして用いられる半導体装置おける放熱構造を例示して本発明を説明する。

[0024] [第１実施形態]

図1は、第１実施形態に係る放熱構造を備える半導体装置を模式的に示す断面図である。図１を参照すると、パワーモジュールに用いられる放熱構造１Ａは、主として、発熱体であるデバイスチップ１７と、被伝熱部材である絶縁回路基板１３Ａと、これらの間に位置する接合層１０Ａとから構成される。接合層１０Ａは、銅板もしくは銅合金板で形成される伝熱コア１１と、銅めっき層１２Ａとから構成される。

[0025] 被伝熱部材である絶縁回路基板１３Ａは、アルミナなどの絶縁層１５と、絶縁層の一方の面に設けられた配線金属部１４Ａと、他方の面に設けられた金属層１６から構成される。絶縁回路基板１３Ａの配線金属部１４Ａは、一般的に用いられる材料で構成することができるが、特にはその表面が、Ｃｕ、Ａｇ、Ａｕ、Ｎｉを少なくとも１つ含む成分で構成されていることが好ましい。導電性に優れるためである。また、本実施形態における絶縁回路基板１３Ａは、平板状の配線金属部１４Ａ、絶縁層１５及び金属層１６から構成される、一般的に市販されている構造のものであってよい。

[0026] 発熱体であるデバイスチップ１７は、パワーモジュールにおける放熱構造１Ａの場合には、Ｓｉ素子、ＳｉＣ素子、ＧａＮ素子等であってよいが、これらには限定されない。デバイスチップは、裏面電極を備えており、この裏面電極が、接合層１０Ａとの接触面となる。裏面電極は、一般的な金属電極材料から構成することができるが、例えば、Ｃｕ、Ａｇ、Ａｕ、Ｎｉの少なくとも１つ含む成分で構成されていることが好ましい。導電性に優れるためである。

[0027] 接合層１０Ａは、絶縁回路基板１３Ａの配線金属部１４Ａと、デバイスチップ１７の裏面電極との間にあって、伝熱コア１１と、銅めっき層１２Ａとから形成される。伝熱コア１１と、銅めっき層１２Ａとが連続的に一体となって接合層１０Ａを形成し、全面接合して、デバイスチップ１７と絶縁回路基板１３Ａとの電気伝導性を確保する

とともに、デバイスチップ１７下の放熱体としても機能する。

[0028] 伝熱コア１１は、発熱体と被伝熱部材との両者に当接して、放熱性及び電気的接続性を確保するとともに、接合層１０Ａを形成する際の、支持部材として機能する。図１を参照すると、伝熱コア１１は、接合層１０Ａを形成する銅めっき時にデバイスチップ１７に当接する発熱体当接面と、銅めっき時に絶縁回路基板１３Ａに当接する被伝熱部材当接面と、デバイスチップ１７にも絶縁回路基板１３Ａにも当接しない非当接面と、側端部にある側端面とを有している。非当接面は、当接面に隣接して形成され、デバイスチップ１７または絶縁回路基板１３Ａに対向している。伝熱コア１１の側端部は、中央部よりも薄く構成され、側端部は、デバイスチップ１７にも、絶縁回路基板１３Ａにも接触しない部分を有する。このような伝熱コア１１の構造的特徴により、絶縁回路基板１３Ａ、伝熱コア１１、デバイスチップ１７をこの順に積層した際に、伝熱コア１１の非当接面とデバイスチップ１７との間、及び伝熱コア１１の非当接面と絶縁回路基板１３Ａとの間に、間隙が生じる。この間隙を、銅めっき層１２Ａにより埋めることで接合層１０Ａが形成される。

[0029] 代表的な態様においては、前記伝熱コア１１が、デバイスチップ１７側表面の中央部に設けられた発熱体当接面と、当該発熱体当接面から両側の側端部に向かって延びる、非当接面と、絶縁回路基板１３Ａ側表面の中央部に設けられた被伝熱部材当接面と、当該被伝熱部材当接面から両側の側端部に向かって延びる、非当接面とから構成されている。図１において、発熱体当接面が、紙面上方のデバイスチップ１７の図示しない裏面電極と接している。そして、発熱体当接面から、紙面左側端部及び右側端部に向けて、下り傾斜面となる、非当接面が形成されている。一方、被伝熱部材当接面は、紙面下方の絶縁回路基板１３Ａの配線金属部１４Ａの表面と接している。そして、被伝熱部材当接面から、紙面左側端部及び右側端部に向けて、上り傾斜面となる非当接面が形成されている。なお、上下といった表現は、図１の紙面における上下を示す相対的な表現であり、放熱構造１Ａにおける、絶対的な上下を区別する意図ではない。

[0030] 伝熱コア１１を構成する材料としては、銅板、もしくは、銅と亜鉛、鉄、ニッケル、コバルト、スズ、金、銀、クロム、モリブデン、タングステン、インジウムとの合金からなる板が挙げられるが、これらには限定されない。導電性及び放熱性の観点から、銅板を用いることが特に好ましい。

[0031] 一実施態様において、伝熱コア１１を放熱構造１Ａの積層方向から平面視した場合に、伝熱コア１１は、配線金属部１４Ａよりも小さく、デバイスチップ１７よりも大きい矩形形状、例えば長方形、好ましくは正方形をなしている。一方、伝熱コア１１の中央部付近で、当接面に垂直に伝熱コア１１を切断した断面は、略八角形をなしている。

[0032] 図２（ａ）は、図１に示す伝熱コア１１を、伝熱コア１１の中心付近で、放熱構造１Ａの積層方向に平行に切断した断面図である。断面における発熱体当接面の長さＬ$_a$、被伝熱部材当接面の長さＬ$_s$は、同一でも異なっていてもよいが、５０～２０００μｍであることが好ましく、１００～５００μｍであることがより好ましい。発熱体当接面及び被伝熱部材当接面は、後に詳述する製造法において、銅めっき層１２Ａが形成される領域を画定するスペーサ様の機能をする。したがって、絶縁回路基板１３Ａと伝熱コア１１ａとデバイスチップ１７とを、積層固定することが可能な程度の幅を有することが好ましい。一方、後述する製造法において、発熱体当接面と裏面電極との接触面、及び配線金属部１４Ａと被伝熱部材当接面との接触面において、めっきの回り込みによる接合が可能な程度に、十分狭い幅であることが好ましい。これらの両者の観点から、上記範囲内とすることが好ましい。

[0033] また、図中、Ｌ$_1$とＬ$_s$の長さは、同一でもよく異なってもよい。さらに、Ｌ$_a$とＬ$_s$の長さも同一であってもよく、異なっていてもよい。Ｌ$_1$とＬ$_a$の長さも同一でも異なっていてもよいが、発熱体当接面と被伝熱部材当接面が対向する部分が少なくとも存在することが好ましい。後述する製造方法において、積層体を固定する際の利便性からである。図示する実施形態では、断面における発熱体当接面の長さＬ$_a$、被伝熱部材当接面の長さＬ$_s$は、同一であり、Ｌ$_1$、Ｌ$_a$、Ｌ$_s$、Ｌ$_s$の長さもすべて略同一である。このような実施形態は、積層体の固定および伝熱コア１１を形成する銅板もしくは銅合金板の加工寸法の安定化の点から好ましい場合がある。

[0034] 伝熱コア１１ａの中央部厚みｄ$_1$は、発熱体当接面と被伝熱部材当接面との距離で定義される。厚みｄ$_1$は、接合層１０Ａの厚みを決定しうる。厚みｄ$_1$は任意であってよく、必要とされる放熱特性に応じて、当業者が適宜決定することができる。また、伝熱コア１１ａの側端部における厚みをｄ$_a$とし、伝熱コア１１ａの一辺の長さをＬ$_a$とすると、ｄ$_1$、ｄ$_a$、Ｌ$_a$とが、以下の関係を満たすことが好ましい。

$$d_1 - d_a \geq L_a / 200$$

ここで、ｄ$_a$は、０であってもよい。

[0035] 後述する製造方法におけるめっき接合時には、伝熱コア１１の非当接面とデバイスチップ１７の隙間および伝熱コア１１の非当接面と配線金属部１４Ａとの隙間をそれぞれ穴埋めする形式で、めっき液を隙間の奥まで送り込み

ながら銅めっき層１２Ａを析出させる必要がある。この穴埋めは、開口部の幅d_3、d_4と穴埋め深さとなる接合面長さL_1、L_3、L_4、L_5（伝熱コア１１中央部から側端部までの距離）との間に理論的な限界値が存在する。これは、アスペクト比（接合面長さ／開口部）で１００以下となる。そのため、上記d_1、d_3、L_5の関係を満たすように、伝熱コア１１の形状を設計することが好ましい。なお、図示するように、伝熱コア１１が、平面視した場合に正方形の場合は、一辺の長さをL_5として、上記の関係を満たすことが好ましいが、伝熱コア１１が、平面視した場合に長方形の場合は、長辺の長さをL_5として、上記の関係を満たせばよい。

[0036] デバイスチップ１７と伝熱コア１１の発熱体側の非当接面で形成される隙間の開口部を規定する長さd_3と、絶縁回路基板１３Ａの配線金属部１４Ａと伝熱コア１１の被伝熱部材側の非当接面で形成される隙間の開口部を規定する長さd_4とは、同一であっても異なっていてもよい。

[0037] 図２（ｂ）は、別の態様に係る伝熱コア１１ｂの構造の一例を示す断面図である。図２（ｂ）は別の態様に係る伝熱コア１１ｂの中心付近で、放熱構造１Ａの積層方向に切断した断面図である。伝熱コア１１ｂは、中央部が厚みd_1の厚板、周囲部（側端部）が厚みd_2の薄板から構成されている。このような態様においても、L_1～L_5の関係、d_3、d_4の関係、並びに、d_1、d_2、L_5の関係は、上記図２（ａ）を用いて説明したのと同様であってよい。ただし、この実施形態においては、厚みd_2はゼロではない。また、図示はしないが、さらなる変形形態として、図２（ｂ）に示す厚みd_2の薄板からなる周囲部と厚みd_1の中央部とのあいだに傾斜面が設けられていてもよい。いずれの態様であっても、伝熱コア１１ｂは、中央部の当接面で、発熱体及び被伝熱部材に接触し、少なくとも２つの対向する側端部には発熱体及び被伝熱部材に接触しない部分が存在し、銅めっき層１２Ａ形成のための隙間を形成しうる構造であればよい。

[0038] 伝熱コア１１において、当接面の設けられる態様は、種々であってよく、当接面の形状も特に限定されるものではないが、発熱体当接面および被伝熱部材当接面が、伝熱コア１１の中心部を含む位置に設定されていることが好ましい。図３は、伝熱コア１１の平面図を示す概念図である。図３（ａ）は、図１、２に示す実施形態であり、伝熱コア１１ｃの中央に、伝熱コアの平面視した形状と略相似形の当接面が設けられる。当接面の周囲部は、当該当接面から紙面上下左右の側端部に向かう四つの傾斜面からなる非当接面が形成されていてもよく、側端部と同じ厚みd_2を有する発熱体／絶縁回路基板に接触しない平板から構成される非当接面であってもよい。これらの態様では、めっき液の流れが良くめっき付き回りが優れており、量産時の安定した接合が得られうる。図３（ｂ）では、伝熱コア１１ｄの中央を横切る帯状当接面が設けられている。当該当接面の周囲部は、当該当接面から紙面左右の側端部に向かう二つの傾斜面からなる非当接面が形成されていてもよく、側端部と同じ厚みd_2を有する平板からなる非当接面であってもよい。これらの態様では、後述する製造方法において、接合前、すなわちめっき層を形成する前の積層体としての固定がしやすく、めっき液の回り込みが容易であるという利点がある。図３（ｃ）は、伝熱コア１１ｅの中央を左右及び上下に横切る十字状当接面が設けられる。当接面の周囲部は、当該当接面から伝熱コア１１ｅの四隅に向かう傾斜面からなる非当接面が形成されていてもよく、側端部と同じ厚みd_2を有する平板からなる非当接面であってもよい。いずれの実施形態も、傾斜面は平面であってもよく、曲面であってもよいし、側端部と同じ厚みd_2を有する平板の一部に曲面や凹凸があってもよい。さらに図示はしないが、当接面の形状としては、四角以外に円や接合面形状に合った幾何形状が考えられる。

[0039] 再び図１を参照すると、めっき層１２Ａは、上記伝熱コア１１の非当接面とデバイスチップ１７との間、及び伝熱コア１１の非当接面と絶縁回路基板１３Ａとの間に設けられる。好ましくは、図１に示すように、伝熱コア１１とデバイスチップ１７との間、及び伝熱コア１１と絶縁回路基板１３Ａとの間を隙間なく埋めて、全面接合層１０Ａを形成している。このとき、伝熱コア１１とめっき層１２Ａは、一つの塊状になって存在し、同様の形状の一枚の銅板もしくは銅合金板と同様に機能しうる。なお、伝熱コア１１の形状は、上記において説明したように種々であってよいが、いずれの場合も、伝熱コア１１の側端部が中央部よりも薄く形成されることで形成される間隙を、めっき層１２Ａが埋める状態となる。

[0040] 本実施形態において、発熱体であるデバイスチップ１７と伝熱コア１１との間、及び、被伝熱部材である絶縁回路基板１３Ａと伝熱コア１１との間には、はんだ材、金属ナノ粒子あるいは金属マイクロ粒子などの接合材を含まない。

[0041] 半導体装置を構成する放熱構造１Ａの場合には、当該放熱構造１Ａと、金属ワイヤとを図示しない絶縁性樹脂からなるケースに収納し、樹脂封止して、半導体装置とすることができる。あるいは、当該放熱構造１Ａと、デバイスチップ１７の上方に配置されたインプラント式プリント基板、並びにデバイスチップとインプラント式プリント基板との間、及び絶縁回路基板１３Ａの配線金属部１４Ａとの間を接続するインプラントピンとを絶縁性樹脂からなるケースに収納し、樹脂封止して、半導体装置とすることができる。絶縁回路基板１３Ａの接合層１０Ａと反対側の面には、さらに図示しないヒートシンクを設けることもできるが、本実施形態においては、接合層１０Ａが、放熱層としても機能するため、別途、ヒートシンクなどの放熱構造を設ける必要がない点で特に有利である。

[0042] なお、本発明に係る放熱構造における発熱体は、デバイスチップには限定されず、例えば、同様に大電流による発熱があり、近接して放熱構造を設けることが好ましい任意の部材であってよい。この場合、接合層の構成は上記と同様であってよい。また、被伝熱部材の構造も任意であってよい。一例として、このような放熱構造を、ペルチェ素子、あるいは放熱ファンに適用することができるが、特定の部材や装置への適用には限定されない。

[0043] [第２実施形態]

図4は、第２実施形態に係る放熱構造を備える半導体装置を模式的に示す断面図である。図４を参照すると、パワーモジュールに用いられる放熱構造１Ｂは、主として、発熱体であるデバイスチップ１７と、被伝熱部材である絶縁回路基板１３Ｂと、これらの間に位置する接合層１０Ｂとから構成される点で、第１実施形態による放熱構造１Ａと共通している。第２実施形態においては、被伝熱部材である絶縁回路基板１３Ｂを構成する配線金属部１４Ｂが、中央部が厚く、側端部が薄い構造をなしている。これにより、めっき層１２Ｂの形成前に、伝熱コア１１と配線金属部１４Ｂとの間隙が大きく、めっき液が回り易い構造としている。

[0044] 本実施形態においても、発熱体であるデバイスチップ１７の構造及び機能、並びに絶縁回路基板１３Ｂの機能については第１実施形態と同様であり、説明を省略する。また、伝熱コア１１の好ましい形状や材料についても、第１実施形態と同様である。

[0045] 本実施形態における配線金属部１４Ｂの構造について説明する。配線金属部１４Ｂは、銅めっき時に伝熱コア１１に当接する伝熱コア当接面と、伝熱コア当接面に隣接して形成される非当接面と、絶縁層１５に当接する絶縁層当接面と、側端部にある側端面とを有している。第２実施形態による非当接面は、伝熱コアに面しており、伝熱コア当接面と同一平面上に存在しない。そして、図4に示す実施形態において、非当接面は、伝熱コア当接面から、紙面左側端部及び右側端部に向けて、下り傾斜面となっている。配線金属部１４Ｂの絶縁層当接面の構造的特徴は、第１実施形態と同様である。すなわち、絶縁層１５に対向する面全体が同一平面上にあって、絶縁層１５に当接するように構成される。配線金属部１４Ｂが担う電気的な機能については、第１実施形態と同様である。なお、ここでも、上下といった表現は、図4の紙面における上下を示す相対的な表現であり、放熱構造１Ｂにおける、絶対的な上下を区別する意図ではない。

[0046] 図5は、図4に示す配線金属部１４Ｂを、配線金属部１４Ｂの中央部付近で、放熱構造１Ｂの積層方向に平行に切断した断面図である。一態様による配線金属部１４Ｂ（ａ）は、頂点を底面と平行に切り取った四角錐形状をしており、底面が絶縁層当接面を構成する。当該態様において、配線金属部１４Ｂ（ａ）の中央部厚みe_aは、配線金属部１４Ｂの伝熱コア当接面と、絶縁層当接面との距離で定義される。厚みe_aは、通常の平板状の配線金属部の厚みと同様に設計することができる。また、配線金属部１４Ｂ（ａ）の一辺の長さをM_aとし、側端部における厚みをe_sとし、中央部厚みe_aと側端部における厚みe_sとの差（$e_a - e_s$）を、e_1とすると、e_1、M_aが、以下の関係を満たすことが好ましい。

$$e_1 \geqq M_a / 200$$

これは、第１実施形態において、伝熱コア１１の設計態様として説明したのと同様に、穴埋めめっきにおけるアスペクト比（接合長さ／開口部）が１００以下となるように設計することが好ましいためである。なお、配線金属部１４Ｂ（ａ）が、平面視した場合に正方形の場合は、一辺の長さをM_aとして、上記の関係を満たすことが好ましいが、配線金属部１４Ｂ（ａ）が、平面視した場合に長方形の場合は、長辺の長さをM_aとして、上記の関係を満たせばよい。

[0047] 配線金属部１４Ｂ（ａ）中、M_aは、断面における伝熱コア当接面の長さを表す。M_aは、先に図２を用いて説明した伝熱コア１１の被伝熱部材当接面の長さであるL_sとの関係で決定することができ、L_sとM_aのいずれかが、大きくなる態様とすることが好ましい。伝熱コア１１の被伝熱部材当接面と、配線金属部１４Ｂの伝熱コア当接面とのいずれかの一方の面全体が、他方の面に接触した状態とすることが、めっき接合時に伝熱コアと配線金属部１４Ｂとを積層固定する観点から好ましいためである。M_1、M_3についても同様に、積層固定時に、伝熱コア１１の被伝熱部材当接面と、配線金属部１４Ｂの伝熱コア当接面とが、上記接触状態を可能にするように、設計することができる。

[0048] 別の態様による配線金属部１４Ｂ（ｂ）は、中央部が厚みe_aの厚板、周囲部（側端部）が厚みe_sの薄板から構成されている。このような態様においても、M_1～M_3の関係、並びに、e_1、M_aの関係は、上記１４Ｂ（ａ）について説明したのと同様であってよい。配線金属部１４Ｂ（ｂ）のさらなる変形形態も可能であり、これは、図２（ｂ）を参照して説明した伝熱コア１１の構造と同様であってよい。ただし、絶縁層に対向する面は、面全体が同一平面上にあり、絶縁層に当接するように構成される。

[0049] 配線金属部１４Ｂ（ａ）、（ｂ）の両者について、伝熱コア当接面及び非当接面を伝熱コア側から平面視した形

状は、図3の〈a〉～〈c〉に示す伝熱コア１１の被伝熱部材当接面の形状のいずれかと同様の形状であってよい。先に説明したように、銅めっき層１２Ｂの形成のための積層固定時に、伝熱コアの被伝熱部材当接面と、配線金属部１４Ｂの伝熱コア当接面とのいずれかの一方の面全体が、他方の面に接触した状態とすることができればよい。

[0050] 再び図４を参照すると、銅めっき層１２Ｂは、上記伝熱コア１１の非当接面とデバイスチップ１７との間、及び伝熱コア１１の非当接面と配線金属部１４Ｂの非当接面との間に設けられる。そして、好ましくは、図４に示すように、伝熱コア１１とデバイスチップ１７との間、及び伝熱コア１１と絶縁回路基板１３Ｂとの間を隙間なく埋めて、全面接合層１０Ｂを形成する。

[0051] 本実施形態においても、発熱体であるデバイスチップ１７と伝熱コア１１との間、及び、絶縁回路基板１３Ｂと伝熱コア１１との間には、はんだ材、金属ナノ粒子あるいは金属マイクロ粒子などの接合材を含まないことが好ましい。また、半導体装置を構成する放熱構造１Ｂの場合には、半導体装置を構成する他の部材については、第１実施形態と同様であってよい。

[0052] 第２実施形態による放熱構造は、第１実施形態と比較して、伝熱コア１１と、被伝熱部材との間隙が大きい構造となっており、めっき接合層１２Ｂの占める体積が大きくなる。このような構造とすることで、後述する製造方法における穴埋めめっき時に、めっき液が奥まで、すなわち、伝熱コア１１と被伝熱部材との当接面の近傍まで入り込みやすくなる。その結果として、めっき接合層１２Ｂが隙間なく形成され、めっき接合層１２Ｂによる接合強度が確保でき、放熱効果が大きくなる。

[0053] 次に、本発明を、製造方法の観点から説明する。本発明に係る放熱構造の製造方法は、発熱体と、伝熱コアと、被伝熱部材とをこの順に積層して積層体を得る工程と、前記積層体を固定し、銅めっき浴に浸漬する工程と、前記伝熱コアに、陰極を接触させて、電解めっきを行う工程とを含む。製造方法についても、図１に示す第１実施形態に係るパワーモジュールの放熱構造１Ａを例として説明するが、本発明の放熱構造の製造方法は、特定装置における放熱構造を製造する場合に限定されるものではない。

[0054] （１）積層工程

積層工程は、絶縁回路基板１３Ａと、伝熱コア１１と、裏面電極を備えるデバイスチップ１７とを順に積層して積層体を得る工程である。この工程においては、先に詳述した発熱体であるデバイスチップ１７、伝熱コア１１、絶縁回路基板１３Ａを、図１に示す順に積層する。

[0055] （２）固定・浸漬工程

次いで、この積層体を治具により固定し、めっき浴に浸漬する。積層体の全てがめっき浴に浸漬されることが好ましい。図６は、積層体及び治具の一例を示す概念図である。積層体は、絶縁性で耐薬品性に優れ、めっき処理中で変質しない材料、例えばポリ塩化ビニル、ポリプロピレンなどから構成される第１の平面板２３と第２の平面板２４とで挟み込んで固定する。第１、第２の平面板２４は、貫通孔を備えており、これによりめっき液の流れを形成することができる。また、第１の平面板２３には、積層体を固定した２枚の平面板２３、２４を、めっき装置の所定の位置に掛けるための部材２５が設けられている。

[0056] 陰極２１は、一方の端部が伝熱コア１１に接触しており、他方の端部は図示しない電解めっき装置の本体に接続される。陽極２２の一方の端部は、めっき浴中に浸漬され、他方の端部は図示しない電解めっき装置の本体に接続される。そして、治具２に固定された積層体は、部材２５を、引掛治具２６に掛けて、めっき浴に浸漬する。

[0057] めっき浴は、硫酸銅めっき浴であり、銅イオン、塩素イオンを含有する硫酸銅めっき浴に、当該硫酸銅めっき浴において使用できる析出抑制剤、促進剤を添加剤として加えたものであることが好ましい。硫酸銅めっき浴の主成分は、硫酸銅５水和物が１２０～２００ｇ／Ｌ、硫酸が３０～１２０ｇ／Ｌ、塩酸が５～１００ｍｇ／Ｌであることが好ましい。

本発明に係るめっき工程では、アスペクト比が大きいため、液流れの悪い伝熱コアの中央部に十分銅イオンを供給する必要があり、通常よりも高濃度の銅イオンが必要となる。よって硫酸銅５水和物は溶解でき、かつ高濃度となる１２０～２００ｇ／Ｌ、より好ましくは１５０～２００ｇ／Ｌである。硫酸は、導電性を確保するために必要であるが、本めっき浴では硫酸銅５水和物が多いため、導電性確保のためのイオンがある程度存在する。よって硫酸は、好ましくは３０～１２０ｇ／Ｌ程度、より好ましくは５０～１００ｇ／Ｌ程度であってよい。塩酸は銅イオンの還元反応に関わってくるため、硫酸銅濃度に対しての必要量が存在する。よって、好ましくは１０～１００ｍｇ／Ｌ、より好ましくは３０～６０ｍｇ／Ｌの濃度が必要となる。

[0058] 主成分の他、硫酸銅めっき浴に添加する微量添加剤のうち、Ｃｕめっき析出抑制剤としては、硫酸銅めっきで一般に用いられるポリマー系抑制剤、レベラー、ブライトナーが挙げられる。ポリマー系抑制剤としては、数平均分

子量が２０００～１２０００、より好ましくは６０００～８０００のポリエチレングリコール（ＰＥＧ）、ポリプロピレングリコールを用いることができる。その添加量は、０．２～０．５ｇ／Ｌとすることが好ましく、０．３～０．４ｇ／Ｌがより好ましい。濃度は低すぎると抑制効果が得られない場合があり、高すぎるとめっき浴の粘度が上がる場合があるためである。ポリマー（例えばＰＥＧ）の数平均分子量は２０００未満で抑制効果が見られず、１２０００以上になると濃度が高い場合めっき浴の粘度が高くなり、浴成分の撹拌に悪影響が出る場合がある。レベラーとしては、ヤヌスグリーン（ＪＧＢ）を用いることが好ましく、その添加量は、１～５ｍｇ／Ｌとすることが好ましい。濃度が低い（１ｍｇ／Ｌ未満）と抑制効果が得られない場合があり、高濃度では抑制効果が飽和する場合があるためである。さらには、１．５～３ｍｇ／Ｌとすることがより好ましい。またＪＧＢが多いとめっき浴が濃青色になり、浴内の様子が見えにくく、施工上の問題となる場合があるためである。ブライトナーとしては、ビス（３－スルホプロピル）ジスルフィド（ＳＰＳ）を用いることができる。その添加量は、０．５～１０ｍｇ／Ｌが好ましい。０．５ｍｇ／Ｌ未満の低濃度では促進効果が得られない場合があり、高濃度では促進効果が飽和するためである。特に高濃度であればめっきの残留応力を下げる効果があるため、５～１０ｍｇ／Ｌがより好ましい。

[0059] （３）電解めっき工程

次いで、電解めっきを実施する。電解めっきの際の条件としては、電流密度を、０．１～５Ａ／ｄｍ²とすることが好ましく、０．３～１．０Ａ／ｄｍ²とすることがさらに好ましい。低電流密度ではめっき速度が遅くなり量産に不向きとなる場合があり、一方高電流密度では穴埋めが困難になる場合がある。この際、めっき液がめっき処理中、常に流れるよう、任意の公知の手段で撹拌を行うことが好ましい。穴埋めめっきにおいて、隙間等が生じるのを防止するためである。また、この反応は、室温で実施することができる。

[0060] このような条件で穴埋めめっきを実施することで、伝熱コア１１の非当接面と絶縁回路基板１３Ａとの間、伝熱コア１１の非当接面とデバイスチップ１７との間にめっき層１２Ａが形成され、伝熱コア１１と銅めっき層１２Ａとが一体となった接合層１０Ａにより、デバイスチップ１７と絶縁回路基板１３Ａが全面接合される。めっき反応の終点は、目視にて確認することができる。

[0061] 図２に示す第２実施形態に係る放熱構造１Ｂも概ね同様の製造方法により製造することができる。第２実施形態においては、絶縁回路基板１３Ｂを構成する配線金属部１４Ｂが、通常用いられている平板構造とは異なり、絶縁層１５と接しない面において、中央部が厚く、側端部が薄く形成されている。したがって、配線金属部１４Ｂの製造時にこのような所定の形状に加工することができる。加工は、例えば、平板状の配線金属部の一部を化学的方法で溶解させ、あるいは、物理的に削ることで、実施することができるが、特定の方法には限定されない。配線金属部１４Ｂを所定の形状に加工した後、絶縁回路基板１３Ｂを製造し、積層工程を実施することができる。そして、第１実施形態に係る放熱構造１Ａの製造方法について説明したのと同様に、固定・浸漬工程、並びに電解めっき工程を実施し、銅めっき層１２Ｂを形成することができる。

[0062] 上記で説明した製造方法は、デバイスチップ以外の発熱体と被伝熱部材との間に接合層を形成する場合にも同様に実施することができる。また、治具の形態は一例であって、上記の形態に限定されるものではない。本実施形態による放熱構造の製造方法によれば、安価にかつ効率的に放熱構造を製造することができる点で有利である。

[0063] 銅伝熱コア、銅配線金属部を設けた絶縁回路基板間の銅めっき接合を実施した。実施例１では、伝熱コアの形状を矩形形状（図２の１１ｂおよび図３の１１ｅ）とし、絶縁回路基板上の配線金属部形状を矩形形状（図６の１４Ｂ（ｂ））とした。実施例２は伝熱コアのみ矩形形状（図２の１１ｂおよび図３の１１ｅ）とし、配線金属部は平面形状とした。比較例１は伝熱コアおよび配線金属部のそれぞれ接合面を平面形状とした。

[0064] 銅めっき浴成分、めっき処理条件は実施例１、２および比較例１のすべてについて、以下の内容で同一とした。めっき浴成分は、硫酸銅５水和物が１５０ｇ／Ｌ、硫酸が９０ｇ／Ｌ、塩酸が５０ｍｇ／Ｌ、平均分子量８０００のポリエチレングリコール（ＰＥＧ）が３００ｍｇ／Ｌ、ヤヌスグリーン（ＪＧＢ）が２ｍｇ／Ｌ、ビス（３－スルホプロピル）ジスルフィド（ＳＰＳ）が５ｍｇ／Ｌとした。めっき浴量は１Ｌとし、常時撹拌をしながらめっき処理を行った。まためっき条件は０．２Ａ／ｄｍ²とした。

[0065] 実施例１における銅めっき接合後の、伝熱コアと銅めっき層を含む接合層、及び配線金属部を備える絶縁回路基板の断面写真を図７に示す。図７（ａ）は、接合層と絶縁回路基板の断面を示す図である。伝熱コア１１と絶縁回路基板１３Ｂとの間に接合界面Ｉが確認できる。図７（ｂ）、（ｃ）、（ｄ）は、それぞれ、図７（ａ）の位置Ｘ、Ｙ、Ｚにおける拡大写真である。いずれの位置においても、伝熱コア１１と、配線金属部１４Ｂの間に、銅めっき層１２Ｂが形成されていることが確認できる。位置Ｙにおいては、一部にボイドＶの存在も認められるが、断面観察から見た接合面積率（実接合長さ／狙いの接合長さ（伝熱コア長さ）×１００（％））が９２％でほぼ全面の接合が確認された。また、図７（ｂ）、（ｃ）、（ｄ）から、伝熱コアと配線金属部が当接している箇所の両サイドに位置し、めっき液が入りにくい位置Ｘ、Ｙにおいても、端部に近い位置Ｚと同様の隙間ない接合が達成されて

いることが確認できる。実施例２でも、写真は示さないが、めっき接合層の存在が確認され、接合が可能であることがわかった。一方、比較例１では伝熱コアと配線金属部間の隙間がないため、めっき液が入らず接合が得られなかった。

[0066] 以上より、伝熱コア、配線金属部間を銅めっきで埋めるために必要な隙間を持つ形状にすることで、銅めっき接合可能な構造が提供できる。

[0067] 本発明に係る放熱構造は、高耐圧パワーモジュール、特には、ＩＧＢＴ、ＭＯＳ－ＦＥＴ、ダイオードを搭載した高耐圧パワーモジュールの製造において好ましく使用することができる。

[0068]

１Ａ，Ｂ	放熱構造
１０Ａ，Ｂ	接合層
１１	伝熱コア
１２Ａ，Ｂ	銅めっき層
１３Ａ，Ｂ	絶縁回路基板（被伝熱部材）
１４Ａ，Ｂ	配線金属部
１５	絶縁層
１６	金属層
１７	デバイスチップ（発熱体）
１８	金属ワイヤ
２	治具
２１	陰極
２２	陽極
２３	第１の平面板
２４	第２の平面板
２５	引掛部材
２６	引掛治具

【請求項１】
発熱体と、

銅板もしくは銅合金板で形成される伝熱コアと、

前記発熱体と前記伝熱コアとを接合する銅めっき層と、を備えることを特徴とする放熱構造。

【請求項２】
前記銅めっき層によって前記伝熱コアに接合され、前記発熱体からの熱が伝熱される被伝熱部材をさらに備えることを特徴とする請求項１に記載の放熱構造。

【請求項３】
前記伝熱コアは、銅めっき時に前記発熱体に当接する発熱体当接面と、銅めっき時に前記被伝熱部材に当接する被伝熱部材当接面と、銅めっき時に該発熱体および該被伝熱部材のいずれにも当接しない非当接面とを有し、該発熱体と該非当接面の間および該被伝熱部材と非当接面との間が前記銅めっき層により接合されていることを特徴とする請求項２に記載の放熱構造。

【請求項 4】

前記発熱体当接面および前記被伝熱部材当接面が当該伝熱コアの中心部を含む位置に設定されていることを特徴とする請求項3に記載の放熱構造。

【請求項 5】

前記伝熱コアが、平面視した場合に、長辺の長さＬaの矩形形状をなし、

前記発熱体当接面と前記被伝熱部材当接面との距離で定義される当該伝熱コアの中央部厚みｄ1と、側端部厚みｄ2と、Ｌaとが、以下の関係

ｄ1－ｄ2 ≧ Ｌa／２００で表される、請求項4に記載の放熱構造。

【請求項 6】

請求項2から5のいずれか1項に記載の放熱構造を備える半導体装置であって、

前記発熱体がデバイスチップであり、

前記被伝熱部材が、絶縁回路基板の少なくとも一方の面に、前記銅めっき層によって前記伝熱コアに接合される配線金属部を形成した絶縁回路基板であることを特徴とする半導体装置。

【請求項 7】

前記伝熱コアに接合される配線金属部が、中央部が厚く、側端部が薄く構成されており、前記中央部に前記伝熱コアに当接する伝熱コア当接面を有する、請求項6に記載の半導体装置。

【請求項 8】

前記伝熱コアに接合される配線金属部が、平面視した場合に、長辺の長さMaの矩形形状をなし、

前記配線金属部の中央部厚みｅ1と側端部の厚みｅ2との差ｅ1が、以下の関係

ｅ1 ≧ Ma／２００

で表される、請求項7に記載の半導体装置。

【請求項 9】

前記デバイスチップの接合面および前記配線金属部が、Ｃu、Ａg、Ａu、Ｎiから選択される1以上の成分を含んで構成されていることを特徴とする請求項6～8のいずれかに記載の半導体装置。

【請求項 10】

発熱体と、銅板もしくは銅合金板で形成される伝熱コアと、被伝熱部材とをこの順に積層して積層体を得る工程と、

前記積層体を固定し、銅めっき浴に浸漬する工程と、

前記伝熱コアに、陰極を接触させて、電解めっきを行う工程と

を含む放熱構造の製造方法。

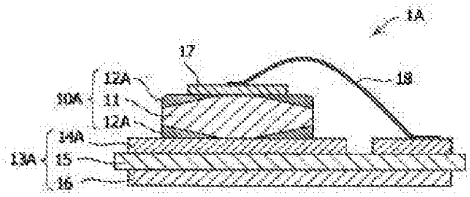
(57)【要約】

【課題】 安価で接合性の高い接合層を備える放熱構造を提供する。

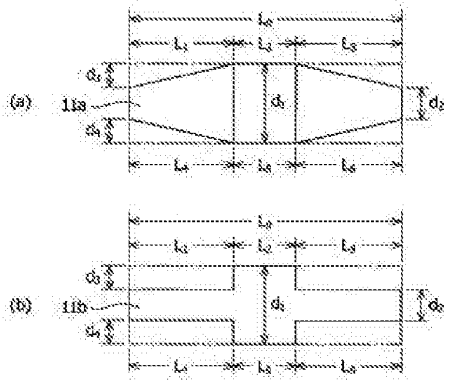
【解決手段】　発熱体１７と、銅板もしくは銅合金板で形成される伝熱コア１１と、前記発熱体と前記伝熱コアとを接合する銅めっき層１２Ａとを備え、任意選択的に被伝熱部材１３Ａを備えることを特徴とする放熱構造、並びに。発熱体と、銅板もしくは銅合金板で形成される伝熱コアと、被伝熱部材とをこの順に積層して積層体を得る工程と、前記積層体を固定し、銅めっき浴に浸漬する工程と、前記伝熱コアに、陰極を接触させて、電解めっきを行う工程とを含む放熱構造の製造方法。

【選択図】　図１

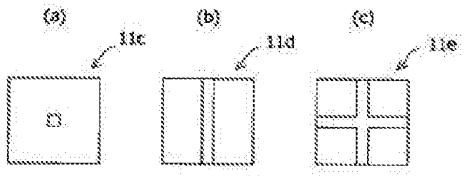
【図１】



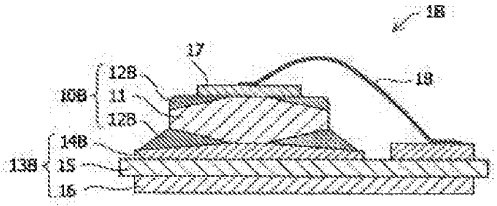
【図２】



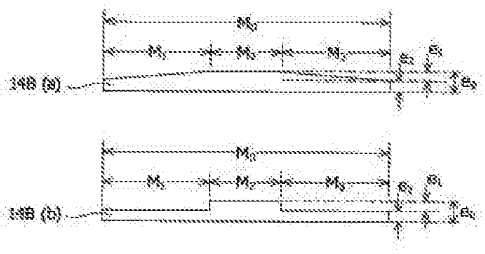
【図３】



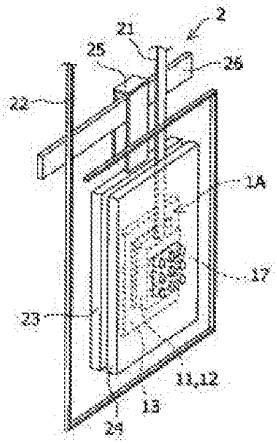
[圖 4]


18
17
12B
10B
11
12B
18
14B
13B
15
16

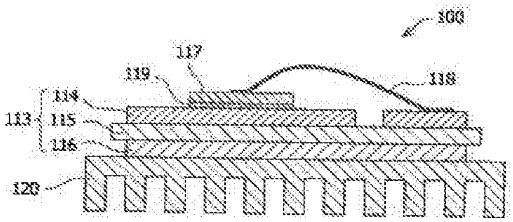
[圖 5]


148 (a)
148 (b)

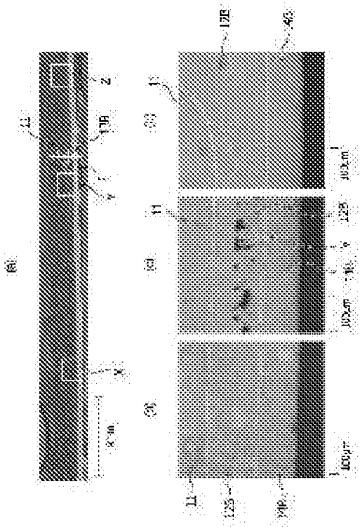
[圖 6]


2
21
25
26
22
1A
17
23
11,12
13
24

【図８】



【図７】



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Espacenet

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CONTINUOUS ELECTROLYTIC PROCESSOR

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Classification: **- international:** *C25D21/00; C25D5/06; C25D7/06; C25F7/00;* (IPC1-7): C25D21/00; C25D5/06; C25D7/06; C25F7/00

- cooperative:

Application number: JP19920321276 19921105

Priority number (s): JP19920321276 19921105

Abstract of JPH06146066 (A)

PURPOSE:To form on electroplating layer with high quality on the surface of a strip at high speed and with high current density and to apply electrocleaning to the surface of the strip at high speed and with high efficiency. CONSTITUTION:This processor is the one to apply electrolytic processing to the surface of a metallic strip 1 continuously, and it is constituted with a hollow roll 2 as an anode coming into contact with the surface of the metallic strip 1 which moves continuously and rotating at a prescribed speed, and a power source 10 to energize the roll 2 and the strip 1. Plural lines of anode parts 3 extending in the length direction and plural lines of electrolyte ejecting parts 4 provided with a large number of ejecting nozzles 5 and extending in the roll length direction are provided on the roll 2 alternately in the circumferential direction of the roll, and a nonconductive brush 7 is mounted on the surface of the roll uniformly, and the electrolytic processing is performed to the surface of the strip 1 by electrolyte that ejected from the ejecting nozzles 5 of the roll 2.

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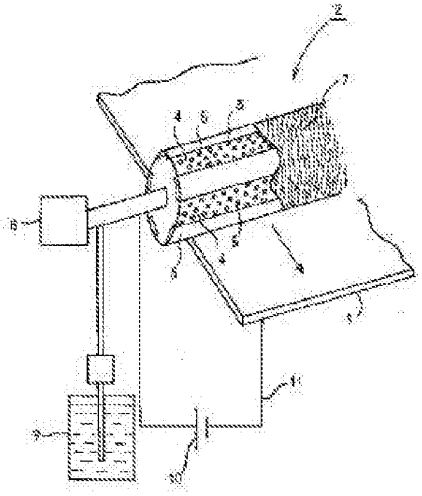
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(54)【発明の名称】　連続電解処理装置

(57)【要約】
【構成】　金属ストリップ１の表面に連続的に電解処理を施すための装置であって、連続的に移動する金属ストリップ１の表面に接触する、所定速度で回転する陽極としての中空状のロール２と、ロール２とストリップ１との間に通電するための電源10とからなり、ロール２には、その長さ方向にわたる陽極部分３と、多数の噴出孔５を有するロール長さ方向にわたる電解液噴出部分４とが、ロール周方向に交互に複数列設けられており、ロールの表面上には、非電導性のブラシ７が均一に取付けられており、ロール２の噴出孔５から噴出する電解液によって、ストリップ１の表面を電解処理する。
【効果】　ストリップの表面に高速且つ高電流密度で高品質の電気めっき層が形成され、または、ストリップの表面が高速且つ高効率で電解洗浄される。



【特許請求の範囲】

【請求項１】　連続的に移動する金属ストリップの少なくとも１つの表面に接触する、その表面に多数の電解液噴出孔を有する、陽極としての少なくとも１つの中空状の金属ロールと、前記金属ロールを所定速度で且つ制御自在に回転させるための駆動機構と、前記中空状の金属ロール内に電解液を供給し、電解液を前記噴出孔から前記金属ストリップの表面に噴出させるための電解液供給機構と、前記陽極としての金属ロールと前記金属ストリップとの間に、前記噴出する電解液を通って通電するための電源とからなる、前記金属ストリップに対し連続的に電解処理を施すための連続電解処理装置において、

前記陽極としての金属ロールには、通電のためのその長さ方向にわたる陽極部分と、多数の電解液噴出孔を有する同じくその長さ方向にわたる電解液噴出部分とが、ロール周方向に交互に複数列設けられており、そして、前記金属ロールの全表面上には、非電導性のブラシが均一に取り付けられており、前記電解液噴出孔から噴出する電解液が、前記金属ストリップと前記金属ロールとの間に、前記ブラシによって保持されるようになっていることを特徴とする連続電解処理装置。

【請求項２】　前記電気めっき処理が、実質的に水平に移動する金属ストリップに対して施される水平型電気めっき装置によって行われ、前記実質的に水平に移動する金属ストリップの一方の表面に接触するように前記陽極としての中空状の金属ロールが設けられている、請求項１記載の装置。

【請求項３】　前記電気めっき処理が、実質的に垂直に移動する金属ストリップに対して施される垂直型電気めっき装置によって行われ、前記実質的に垂直に移動する金属ストリップを間に挟んで、その両表面に接触するように前記陽極としての中空状の金属ロールが設けられている、請求項１記載の装置。

【請求項４】　前記電気めっき処理が、その移動通路中に設けられた大径のコンダクターロールに沿って湾曲しながら移動する金属ストリップに対して施されるラジアルセル型電気めっき装置によって行われ、前記湾曲しながら移動する金属ストリップの一方の表面に接触するように前記陽極としての中空状の金属ロールが設けられている、請求項１記載の装置。

【請求項５】　前記中空状の金属ロールの、前記電解液噴出部分に設けられた多数の電解液噴出孔の各々の直径が0.5 ～15mmの範囲内であり、そして、前記金属ロールの全表面積に対する前記噴出孔の合計面積が、５～50％の範囲内である、請求項１から４の何れか１つに記載の装置。

【請求項６】　前記中空状の金属ロールの全表面上に取り付けられた非電導性のブラシの各々の直径が0.5mm 以下であり、その各々の長さが３mm以上であり、そして、各ブラシ間の間隔が２mm以下である、請求項１から４の何れか１つに記載の装置。

【請求項７】　電解反応を起こさず、前記電気めっき液に可溶で且つ前記電気めっき液の電気化学反応を阻害しない、有機または無機の増粘剤が、前記めっき液中に添加されており、かくして、前記めっき液の動粘度が1.8cSt以上である、請求項１から４の何れか１つに記載の装置。

【発明の詳細な説明】

【０００１】

【産業上の利用分野】この発明は、金属ストリップの少なくとも１つの表面上に対する電気めっきまたは電解洗浄等の電解処理を効率的に行うための連続電解処理装置に関するものである。

【０００２】

【従来の技術】金属ストリップの少なくとも１つの表面を連続的に電解処理するための装置として、次の連続電解処理装置が知られている。

(1) 電解液を収容するための水平型電解槽と、前記電解槽内を水平に移動中の金属ストリップと実質的に平行に、前記電解槽内に配置された少なくとも１つの電極板とからなる水平型連続電解処理装置。

(2) 電解液を収容するための垂直型電解槽と、前記電解槽内を下方に次いで上方に向って垂直に移動中の金属ストリップを間に挟んで、その両側に実質的に平行に、前記電解槽内に配置された電極板からなる垂直型連続電解処理装置。

(3) 大径のコンダクターロールと、前記コンダクターロールに沿って湾曲しながら移動する金属ストリップとを間に挟んで、前記コンダクターロールの外側に所定間隔をあけて湾曲して設けられた電極板と、前記電極板と前記コンダクターロールとの間の間隙内に電解液を供給するための電解液供給機構とからなるラジアルセル型連続電解処理装置。

【０００３】上述した従来の連続電解処理装置は、何れも、移動中の金属ストリップを陰極となしそして電極板を陽極となし、金属ストリップと電極板との間に、電解液を通って直流電流を通じることによって、金属ストリップの表面を電解処理するものである。

【０００４】以下に、上述した連続電解処理装置において、電解液として電気めっき液を使用し、金属製ストリップの表面を電気めっきする場合の問題について述べる。一般に、電気めっき液を通って電流を通じる場合、陰極と陽極との間の距離が大きいと、電気めっき液による抵抗が大になって、電力コストが増大する問題が生ずる。従って、可能な限り陰極と陽極との極間距離を小さくする必要がある。しかしながら、水平型連続電気めっき装置においては、水平型電気めっき槽内を移動する金属ストリップがその重力によって撓むために、極間距離を小さくすることは困難である。また、垂直型連続電気めっき装置およびラジアルセル型連続電気めっき装置に

おいては、極間距離をある程度小さくすることも可能ではあるが、それにも限界がある。

【０００５】そのために、水平型連続電気めっき装置においては、例えば、水平型電気めっき槽内を移動する金属ストリップに向けてその上方および下方からポンプによってめっき液の噴流を与え、その圧力によって金属ストリップの撓みを防止し、極間距離を短縮することが行われている。

【０００６】近年、生産性を上げるために、電流密度を高めることが大きな課題になっているが、電流密度を高めると、上述した何れの形式の電気めっき装置においても、陰極としての金属ストリップに対する金属陽イオンの供給が十分に行われず、その結果、金属陽イオンの析出が不充分になって、いわゆるめっき焼け現象が生じやすくなり、且つ、電解効率も悪化する。そこで、このようなめっき焼けを防止するために、電気めっき液を、金属ストリップと陽極板との間に強制的に流動させて、金属ストリップと電気めっき液との相対流速を高め、金属イオンの供給を円滑に行わせることが行われている。

【０００７】上述した従来の連続電気めっき装置には、次のような問題がある。

(1) 電気めっき槽内には、大量の電気めっき液が収容されているから、前述した電気めっき液の噴流機構や電気めっき液の管理機構が大型になり、従って、多額の設備費および維持管理費が必要になる。

(2) 現状の噴流機構では、金属ストリップと電気めっき液との相対流速に限界があるので、電流密度をある値以上には高めることができない。また、金属ストリップの幅方向および長さ方向に電気めっき液の流速分布が変化するために、合金電気めっきのように、合金電気めっき層の組成が電気めっき液の流速によって大きな影響を受けるような場合には、均一な組成の合金電気めっき層を形成することが非常に困難である。

(3) 陰極である金属ストリップと陽極との間には、ある程度の距離を必要とするから、電気めっき液による抵抗を小になし、電力コストを減少させるには限界がある。

【０００８】次に、前述した連続電解処理装置において、電解液として電解洗浄液を使用し、金属製ストリップの表面を電解洗浄する場合の問題について述べる。電気めっきラインにおいて、金属ストリップに対し施される清浄処理は、電解槽内に酸またはアルカリの電解洗浄液を入れ、その中を通る金属ストリップと電極板との間に通電することにより電解洗浄を行い、次いで、ブラシを金属ストリップに接触させそして回転させ、機械的に金属ストリップ上の不純物を除去することによって行われる。

【０００９】上述した電解洗浄時の電解電流値は、電気めっき時におけるめっき電流値と比較すると極めて小さいにもかかわらず、電解洗浄装置の大きさは、電気めっき装置の大きさとほとんど変わらず、しかも、電解洗浄装置とは別個に、ブラシによる機械的研磨装置が必要になる。従って、金属ストリップに対し施される清浄処理は、電気めっきライン中において非常に大きい部分を占める結果、多額の設備費および維持管理費が必要になる。その他、陰極と陽極との極間距離が大きく電解洗浄液による抵抗によって電力コストが増大する等の問題は、電気めっき装置の場合と同様である。

【００１０】上述した問題を解決する手段として、特開平2-182893号公報には、下記からなる電解処理装置（以下、先行技術という）が開示されている。連続的に移動する金属ストリップの少なくとも１つの表面に接触する、その表面に多数の表面処理用ペースト流出孔を有する、陽極としての少なくとも１つの中空状の金属ロールと、前記金属ロールを回転させるための駆動機構と、前記中空状の金属ロール内に表面処理用ペーストを供給するための表面処理用ペースト供給機構と、前記金属ロールを被嵌し、前記流出口から流出する前記表面処理用ペーストを含浸し、外周面に浸出させるための、前記金属ストリップと接触する帯状のパッドと、前記パッドを前記金属ロールと相対的に回転させるためのパッド駆動機構と、前記金属ロールと前記金属ストリップとを前記表面処理用ペーストを介して通電する通電機構とからなる電解処理装置。

【００１１】上述した先行技術によれば、表面処理剤としてペーストが使用され、この表面処理用ペーストが、陽極としての中空状の金属ロールに設けられた流出口から、帯状のパッドおよび金属ストリップの表面に供給され、金属ロールとパッドとが相対回転しながら、金属ロールと金属ストリップとの間に、表面処理用ペーストを介して通電され、これによって、金属ストリップの表面が電解処理される。

【００１２】

【発明が解決しようとする課題】上述した先行技術には、次のような問題がある。

先行技術においては、金属ロールを回転させるための金属ロール駆動機構、および、帯状のパッドを金属ロールと相対的に回転させるためのパッド駆動機構の、２つの駆動機構が必要である。その結果、装置全体が複雑になり、電解処理用の金属ロールを複数個配置することが困難になる。

【００１３】　陽極としての金属ロールは、使用に伴って劣化するために交換する必要があるが、その場合、金属ロール全体を交換しなければならないので、その作業が容易ではなく、且つ、コストが上昇する。

【００１４】　不溶性陽極として、最近多く使用されている、例えば、酸化イリジウムが被覆されたチタン電極のような、金属上に貴金属酸化物が被覆された電極の場合は、これをロール状に加工することが困難である。

【００１５】　パッドは変形しやすいので、金属ロールと相対的に回転する帯状パッドは、激しく摩耗する。

従って、筒状パッドを頻繁に交換しなければならず、その作業が煩雑になり、且つ、コストが上昇する。

【００１６】従って、この発明の目的は、上述した問題を解決し、装置全体が簡単で、電解処理用の金属ロールを複数個配置することができ、陽極としての金属ロールが、使用に伴って劣化した場合、金属ロール全体を交換する必要がなく、不溶性陽極として、加工が困難な、金属上に貴金属酸化物が被覆された電極も使用することが可能であり、パッドのように変形によって頻繁に交換する部材も必要とせず、金属ストリップの少なくとも１つの表面上に、高速且つ高電流密度で高品質の電気めっき皮膜を形成し、または、金属ストリップの少なくとも１つの表面を、高速且つ高効率で電解洗浄することができる、連続電解処理装置を提供することにある。

【００１７】

【課題を解決するための手段】本発明者等は、上述した問題を解決すべく鋭意研究を重ねた。その結果、次の知見を得た。即ち、連続的に移動する金属ストリップの少なくとも１つの表面に接触する、その表面に多数の電解液噴出孔を有する、陽極としての少なくとも１つの中空状の金属ロールを、通電のためのその長さ方向にわたる陽極部分と、多数の電解液噴出孔を有する同じくその長さ方向にわたる電解液噴出部分とが、ロール周方向に交互に複数列設けられた構造となし、そして、金属ロールの全表面上に、非電導性のブラシを均一に取り付ければ、陽極が劣化しても、金属ロール全体を交換する必要がなく、不溶性陽極として、加工が困難な、金属上に貴金属酸化物が被覆された陽極も使用することができ、パッドのように変形によって頻繁に交換する部材も必要とせず、金属ストリップの少なくとも１つの表面上に、高速且つ高電流密度で高品質の電気めっき皮膜を形成し、または、金属ストリップの少なくとも１つの表面を、高速且つ高効率で電解洗浄することができる。

【００１８】この発明は、上記知見に基づいてなされたものであって、この発明は、連続的に移動する金属ストリップの少なくとも１つの表面に接触する、その表面に多数の電解液噴出孔を有する、陽極としての少なくとも１つの中空状の金属ロールと、前記金属ロールを、所定速度で且つ制御自在に回転させるための駆動機構と、前記中空状の金属ロール内に電解液を供給し、電解液を前記噴出孔から前記金属ストリップの表面に噴出させるための電解液供給機構と、前記陽極としての金属ロールと前記金属ストリップとの間に、前記噴出する電解液を通って通電するための電源とからなる、前記金属ストリップに対し連続的に電解処理を施すための連続電解処理装置において、前記陽極としての金属ロールには、通電のためのその長さ方向にわたる陽極部分と、多数の電解液噴出孔を有する同じくその長さ方向にわたる電解液噴出部分とが、ロール周方向に交互に複数列設けられており、そして、前記金属ロールの全表面上には、非電導性のブラシが均一に取り付けられており、前記電解液噴出孔から噴出する電解液が、前記金属ストリップと前記金属ロールとの間に、前記ブラシによって保持されるようになっていることに特徴を有するものである。

【００１９】

【作用】この発明において、連続的に移動する金属ストリップの少なくとも１つの表面に接触する、その表面に多数の電解液噴出孔を有する、陽極としての少なくとも１つの中空状の金属ロールは、通電のためのその長さ方向にわたる陽極部分と、多数の電解液噴出孔を有する同じくその長さ方向にわたる電解液噴出部分とが、ロール周方向に交互に設けられた構造となっており、そして、金属ロールの全表面上に、非電導性のブラシを均一に取り付けられている。

【００２０】従って、電解液噴出孔から噴出する電解液が、金属ストリップと金属ロールとの間に、ブラシによって常に適量保持されるので、陽極としての金属ロールと陰極である金属ストリップとの間の距離を極限まで短縮することができる。その結果、電解液による電圧ロスが抑えられ、電力コストを最小に低減することができ、液切れによる通電不良が防止される。

【００２１】また、金属ロールの回転数を制御して、金属ストリップと電解液との相対流速を制御することにより、限界電流密度が高められ、高電流密度での操業が可能になる。これらによって、金属ストリップの少なくとも１つの表面上に、高速且つ高電流密度で高品質の電気めっき層を形成し、または、金属ストリップの少なくとも１つの表面を、高速且つ高効率で電解洗浄することができる。

【００２２】更に、陽極が劣化した場合でも、金属ロールの陽極部分のみを交換すればよく、陽極は細長い短冊状であるから、加工が困難な、金属上に貴金属酸化物が被覆された電極も使用することができ、パッドのように変形によって頻繁に交換する部材も必要としない。

【００２３】図１はこの発明の装置の第１実施態様を示す概略斜視図、図２はその概略側面図、図３は金属ロールの拡大垂直断面図である。第１実施態様の装置は、実質的に水平に移動する金属ストリップに対しめっき処理が施される水平型電気めっき装置にこの発明の装置を適用したものであって、図面に示すように、連続的に移動する金属ストリップ１の少なくとも１つの表面に接触するように、陽極としての中空状の金属ロール２が設けられている。金属ロール２は、駆動機構８によって所定速度で回転する。金属ロール２の回転速度は、駆動機構８によって自在に制御することができる。

【００２４】陽極としての金属ロール２は、通電のためのその長さ方向にわたる陽極部分３と、多数の電解液噴出孔５を有する同じくその長さ方向にわたる電解液噴出部分４とが、金属ロール２の周方向に交互に複数列設けられている。陽極部分３は、金属ロール２の表面に設け

られた、陽極部分３とほぼ同じ幅および同じ長さの溝６に着脱可能に嵌挿され、例えば、図示しないボルトによって固定されている。陽極部分３としては、例えば、チタンを基体としその表面が金属酸化物で被覆された、通電により電極自身が溶解することのない不溶性陽極を使用する。

【００２５】中空状の金属ロール２の陽極部分３および電解液噴出部分４を含む全表面上には、非電導性のブラシ７が均一に取り付けられている。ブラシ７は、例えば、繊維製の基体の表面にブラシが植えつけられたものを金属ロール１の表面に被せてもよく、または、陽極部分３および電解液噴出部分４の各々に直接ブラシを植えつけたものでもよい。ブラシ７の材質は、例えばナイロンのように、非電導性であって、金属ストリップ１に接触してこれを傷つけることなく、且つ、摩耗しにくいものであることが必要である。

【００２６】中空状の金属ロール２には、その内部に電解液を供給し、電解液を噴出孔５から金属ストリップ１の表面に噴出させるための電解液供給機構９が接続されている。陽極としての金属ロール２と陰極としての金属ストリップ１とは、噴出孔５から噴出する電解液を通って通電するための電源10に導線11によって接続されている。

【００２７】図２に示すように、中空状の金属ロール２は、上方から油底の圧力をかけられて金属ストリップ１の上面に接している。金属ストリップ１の下面に接するように金属ストリップ１の下方の、金属ロール２と対称の位置には、サポートロール12が設けられている。従って、金属ロール２とサポートロール12によって、金属ストリップ１は弛まないように水平に維持される。

【００２８】駆動機構８によって、中空状の金属ロール２を所定速度で回転する。電解液供給機構９によって、金属ロール２の内部に電気めっき液を供給する。その結果、電気めっき液は、金属ロール２の電解液噴出部分４に設けられた多数の噴出孔５から噴出する。噴出した電気めっき液は、ブラシ７によって保持され、且つ、めっき液自体が粘性を有していることによって、金属ロール２の表面上に、ほぼ一定の厚さの層を形成する。

【００２９】このように金属ロール２の表面に形成された電気めっき液の層13は、金属ロール２が金属ストリップ１に接触したときに金属ストリップ１に移される。そして、電源10によって、金属ロール２と金属ストリップ１との間に、電気めっき液を通って通電することにより、金属ストリップ１の表面上に電気めっき層が形成される。

【００３０】なお、金属ストリップ１との接触部における金属ロール２の押し付け力が強すぎると、通電部分において、めっき液の液切れによりスパークが発生する原因となり、一方、金属ロール２の押し付け力が弱すぎると、電気めっき液と金属ストリップ１との相対流速が小さくなって、限界電流密度も小さくなる。従って、金属ロール２の押し付け力を、適切に調整することが必要である。

【００３１】図４は、この発明の装置の第２実施態様を示す概略正面図である。第２実施態様の装置は、実質的に垂直に移動する金属ストリップに対しめっき処理が施される垂直型電気めっき装置にこの発明の装置を適用した例である。図面に示すように、第２実施態様の装置は、連続的に移動する金属ストリップ１を下方に向って実質的に垂直に導き、そして、金属ストリップ１に通電するための、装置入側に設けられた第１コンダクタロール14と、下方に向って導かれた金属ストリップ１の移動方向を上方に向って反転させるためのデフレクターロール15と、デフレクターロール15によって反転した金属ストリップ１を上方に向って実質的に垂直に導き、そして、金属ストリップ１に通電するための、装置出側に設けられた第２コンダクタロール16と、そして、第１コンダクタロール14とデフレクターロール15との間、および、デフレクターロール15と第２コンダクタロール16との間において、各々実質的に垂直に移動する金属ストリップ１を間に挟んでその両表面に接触するように設けられた、少なくとも１対の陽極としての中空状の金属ロール２，２’とからなっている。

【００３２】第１コンダクタロール14とデフレクターロール15との間を下方に向って実質的に垂直に移動し、そして、デフレクターロール15と第２コンダクタロール16との間を上方に向って実質的に垂直に移動する金属ストリップ１は、その両表面に接触するように設けられた少なくとも１対の陽極としての中空状の金属ロール２，２’によって、その両表面上に、上述したと同様に電気めっき層が形成される。

【００３３】第２実施態様の装置によれば、装置全体が垂直型であるから、小さなスペースによって、金属ストリップ１の両表面上に電気めっき層を形成することができる。そして、第１コンダクタロール14とデフレクターロール15との間、および、デフレクターロール15と第２コンダクタロール16との間に配置される中空状の金属ロール２，２’を、適切な数例えば６対以上に選定することにより、コンパクトな電気めっき設備により、極めて効率的に電気めっき層を形成することができる。

【００３４】図５は、この発明の装置の第３実施態様を示す概略正面図である。第３実施態様の装置は、大型のコンダクターロールに沿って湾曲しながら移動する金属ストリップに対しめっき処理が施されるラジアルセル型電気めっき装置にこの発明の装置を適用した例である。図面に示すように、第３実施態様の装置は、大径のコンダクターロール17と、コンダクターロール17に沿って湾曲しながら移動する金属ストリップ１の表面上に接触するように、コンダクターロール17の外側に設けられた複数個の陽極としての中空状の金属ロール２とからなって

いる。18は、コンダクターロール17への入側および出側に設けられたデフレクターロールである。なお、図示の例では、コンダクターロール17および金属ロール２は、水平に移動する金属ストリップ１の移動ラインの上方に設けられているが、これらを、上記移動ラインの下方に設けてもよい。

【００３５】第３実施態様の装置によれば、装置がラジアルセル型であるから、１セル当たりのめっき部分の面積を広くとることができ、従って、小さなスペースによって、金属ストリップ１の一方の表面上に連続的に電気めっき層を形成することができる。そして、大径のコンダクターロール17に沿ってその外側に設けられた複数個の金属ロール２を、適切な数例えば６個以上に選定することにより、極めて効率的に電気めっき層を形成することができる。

【００３６】上述した各実施態様の装置において、中空状の金属ロール２の、電解液噴出部分４に設けられた多数の電解液噴出孔５の各々の直径を、0.5～15mmの範囲内となし、そして、金属ロール２の全表面積に対する噴出孔５の面積の総和を、５～50% の範囲内とすることが好ましい。

【００３７】電解液噴出孔５の各々の直径が0.5 mm未満では、めっき液自体がある程度の粘性を有しているので、噴出孔５からめっき液が噴出しにくくなる結果、めっき液の供給量即ち金属イオンが不足して、金属ストリップ１の表面上に適切なめっきを行うことが困難になる場合が生ずる。一方、電解液噴出孔５の各々の直径が15mmを超えると、噴出孔５から噴出するめっき液が過剰になって、金属ロール２の表面に取り付けられたブラシ７によるめっき液の保持が困難になる結果、金属ストリップ１上のめっき液に部分的な枯渇や過剰が生じやすくなり、電気めっき層が斑点状になって、めっき外観が著しく劣化する場合が生ずる。

【００３８】中空状の金属ロール２の全表面積に対する噴出孔５の合計面積が５% 未満では、電気めっき液の供給量が不足し、金属ロール２の全周を電気めっき液によって覆うことができなくなる結果、通電不良が発生しやすくなる。一方、金属ロール２の全表面積に対する噴出孔５の合計面積が50% を超えると、これに伴って、金属ロール２の全周に取り付けられてたブラシ７の面積の合計が50% 未満になり、金属ロール２の表面に取り付けられたブラシ７によるめっき液の保持が困難になる結果、金属ストリップ１上のめっき液に部分的な枯渇や過剰が生じやすくなって、電気めっき層が斑点状になり、めっき外観が著しく劣化する場合が生ずる。

【００３９】図１に示した第１実施態様の水平型電気めっき装置にこの発明の装置を適用した場合には、中空状の金属ロール２の数は４個以上であることが好ましい。即ち、金属ロール２の数が４個未満では、金属ロール２の陽極部分３に金属ストリップ１が接したときと、電解液噴出部分４に金属ストリップ１が接したときとの差が顕著に現れるため、金属ストリップ１の長手方向にむらが発生しやすくなる。これに対し、金属ロール２を４個以上設置すれば、金属ロール１と金属ストリップ２とが接する部分は、金属ロール２の回転および金属ストリップ１の移動による、両者の相対速度が早いために、常に等しい電解条件とみなすことができ、金属ストリップ１の長手方向に均一に電気めっき層を形成することができる。

【００４０】中空状の金属ロール２の全表面上に取り付けられた非電導性のブラシ７の各々の直径は0.5mm 以下であり、その各々の長さは３mm以上であり、そして、各ブラシ７間の間隔は２mm以下であることが好ましい。ブラシ７の直径が0.5mm を超えると、陰極である金属ストリップ１の表面との接触抵抗が大になる結果、金属ストリップ１の表面に疵が発生しやすくなる。また、ブラシ７の各々の長さが３mm未満では、陰極と陽極との極間距離が小さくなる結果、連続的に移動する金属ストリップ１に生ずる揺れや機械的振動等により、陰極と陽極とが接触する場合が生じて、通電不良が発生したり、スパークによる疵によって金属ストリップの表面外観が劣化する場合が生ずる。また、各ブラシ７間の間隔が２mmを超えると、ブラシ７により適量のめっき液を保持することが困難になる結果、金属ストリップ１上のめっき液に部分的な枯渇や過剰が生じて、電気めっき層が斑点状になり、めっき外観が著しく劣化する場合が生ずる。

【００４１】中空状の金属ロール２の内部に供給される電気めっき液に、電解反応を起こさず、電気めっき液に可溶で且つ電気めっき液の電気化学反応を阻害しない有機または無機の増粘剤を添加し、電気めっき液の動粘度を1.8cSt以上に保つことが望ましい。

【００４２】即ち、電気めっき液の動粘度は、一般に1.2 ～1.6cStであって低い。そのために、上述した各実施態様の装置によって、金属ストリップに対し電気めっきを施す場合に、中空状の金属ロール２の噴出孔５から噴出した電気めっき液を、ブラシ７によっても、金属ロール２の表面に均一に保持することができず、液切れによる通電不良のためにスパークが発生し、また、電気めっき層自体にも悪影響が生じて、金属ストリップの表面上に美麗な外観の電気めっき層を形成することができない場合が生ずる。

【００４３】そこで、電気めっき液に、電解反応を起こさず、電気めっき液に可溶で且つ電気めっき液の電気化学反応を阻害しない有機または無機の増粘剤を添加し、電気めっき液の動粘度を1.8cSt以上に保つようにすれば、中空状の金属ロール２の噴出孔５から噴出した電気めっき液を、ブラシ７によって、金属ロール２の表面に均一に保持することができ、液切れによる通電不良のためにスパークや、めっき皮膜自体に悪影響が生ずるようなことがなく、金属ストリップの表面上に美麗な外観の

電気めっき層を形成することができる。

【００４４】有機増粘剤としては、例えば、メチルセルロース、エチルセルロース、ポリエチレングリコール等が使用され、無機増粘剤としては、例えば、硫酸アルミニウム、水ガラス等が使用される。１種類の増粘剤では、溶解度が超えるような場合には、互いに電気化学的に安定な複数種の増粘剤を添加してもよい。

【００４５】次に、この発明の電解処理装置により、電解液として電解洗浄液を使用し、金属製ストリップの表面を電解洗浄する場合について述べる。即ち、図１に示した第１実施態様の装置において、電解液供給機構９によって、陽極としての中空状の金属ロール２の内部に電解洗浄液を供給する。その結果、電解洗浄液は、金属ロール２の電解液噴出部分４に設けられた多数の噴出孔５から噴出し、ブラシ７によって保持され、金属ストリップ１の表面上に均一に移される。そして、電源10によって、金属ロール2 と金属ストリップ1 との間に、電解洗浄液を通って通電することにより、金属ストリップ１の表面は電解洗浄される。

【００４６】このような電解洗浄は、図４に示した、この発明の装置の第２実施態様の垂直型装置によっても行うことができる。また、中空状の金属ロール２の、電解液噴出部分４に設けられた多数の電解液噴出孔５の各々の直径が0.５～15mmの範囲内であり、そして、金属ロール２の全表面積に対する噴出孔５の合計面積が、５～50％の範囲内であることが好ましいこと、および、電解反応を起こさず、前記電解洗浄液に可溶で且つ前記電解洗浄液の電気化学反応を阻害しない、有機または無機の増粘剤を、電解洗浄液中に添加して、洗浄液の動粘度を1.8cSt以上に保つことが好ましいことは、前述した電気めっきの場合と同様である。

【００４７】このように、金属ストリップの電解洗浄にこの発明の装置を使用すれば、従来の装置のように、電解洗浄装置とは別個に、ブラシによる機械的研磨装置を設ける必要なく、金属ストリップに対し、コンパクトな装置によって、高速且つ高電流密度で電解洗浄を施すと同時に研磨も施すことができる。

【００４８】

【実施例】次ぎに、この発明を、実施例により更に説明する。

（実施例１）図１に示した第１実施態様の水平型装置を使用し、幅1,000mm 、厚さ0.6mm の冷延鋼板の一方の表面上に、下記条件によって電気亜鉛めっき層を形成し、表１に示す、この発明の装置による電気亜鉛めっき鋼板の供試体（以下、本発明供試体という）No. １～15を調製した。

(1) 電気亜鉛めっき液

成分組成：$ZnSO_4 \cdot 7H_2O$：500 g/l 、

Na_2SO_4　　：　50 g/l 、

pH値　　：　１、

温度　　：　70 ℃。

【００４９】(2) 金属ロール

寸法　　：直径200mm 、長さ1200mm、

回転速度：120m p.m（金属ストリップの移動方向と反対方向に回転）

陽極部分：Tiを基体としてその上に酸化イリジウムが被覆された構造

ブラシ　：ナイロン製

表１に、電解液噴出部分の噴出孔直径、噴出孔の合計面積、ブラシの直径および長さ、ブラシ相互間の間隔、陽極の個数、ならびに、電流密度を示す。

【００５０】

【表１】

No.		噴出孔		ブラシ			陰極個数	電流密度 (A/dm²)	表面外観	通電状態
		直径 (mm)	合計面積(%)	直径 (mm)	長さ (mm)	間隔 (mm)				
本発明供試体	1	0.3	50	0.3	4	1.0	6	300	○	○
	2	0.5	50	0.3	4	1.0	6	250	◎	◎
	3	1.0	60	0.3	4	1.0	8	400	△	○
	4	1.0	40	0.8	4	1.0	8	250	◎	◎
	5	3.0	30	0.7	4	1.0	12	300	△	○
	6	3.0	30	0.4	4	1.0	12	200	◎	◎
	7	5.0	25	0.4	2	0.8	6	250	○	△
	8	5.0	25	0.4	5	0.8	6	100	◎	◎
	9	8.0	5	0.3	3	2.5	4	100	△	○
	10	8.0	5	0.3	3	1.0	4	80	◎	◎
	11	10.0	8	0.2	5	1.5	8	100	○	△
	12	10.0	5	0.2	5	1.5	8	50	◎	◎
	13	15.0	10	0.4	3	1.5	8	200	◎	◎
	14	20.0	40	0.3	5	2.0	12	400	○	○
	15	25.0	15	0.4	4	2.0	12	300	△	○

【００５１】上述のようにして調製された各供試体の電気亜鉛めっき層の表面外観および電気めっき時の通電状態を調べ、その結果を、表１に併せて示した。なお、表面外観および通電状態の評価基準は下記の通りである。

【００５２】表面外観：

◎：めっき量が全体にわたり均一であって、めっき肩にすじ、むら、斑点等が生ぜず、表面外観が極めて美麗である。

○：めっき量がほぼ均一であって、めっき肩に生じたすじ、むら、斑点等が少なく、表面外観が良好である。

△：めっき量がやや不均一で、めっき肩にすじ、むら、斑点等の生じた部分があり、表面外観がやや不良である。

【００５３】通電状態：

◎：極めて良好。

○：良好。

△：スパークの発生する場合があり、やや不良。

【００５４】表１から明らかなように、噴出孔の合計面積が50% 超の金属ロールを使用した供試体No. 3、ブラシの直径が0.5mm 超の金属ロールを使用した供試体No. 5、ブラシ間の間隔が2mm 超の金属ロールを使用した供試体No. 9、および、噴出孔の直径が15mm超の金属ロールを使用した供試体No. 15は、表面外観がやや不良であり、そして、ブラシ長さが3mm未満の金属ロールを使用した供試体No. 7および噴出孔合計面積が5% 未満の金属ロールを使用した供試体No. 11は、通電状態がやや不良であったが、それ以外の供試体は、何れも、表面外観および通電状態が共に優れていた。

【００５５】（実施例２）図４に示した第２実施態様の垂直型装置を使用し、下記条件の金属ロールを使用し、300A/dm²の電流密度で電気めっきしたほかは、実施例１と同様の条件によって、冷延鋼板の両表面上に電気亜鉛めっき層を形成し、表２に示す本発明供試体No. 16 ～21を調製した。

【００５６】金属ロール
寸法　　：直径200mm 、長さ1200mm
回転速度：120ｍｐｍ（金属ストリップの移動方向と反対方向に回転）
陽極部分：Tiを基体としてその上に酸化イリジウムが被覆された構造
陽極個数：８個
ブラシ　：ナイロン製
電解液噴出孔の直径　　：1.0mm
電解液噴出孔の合計面積：60%。
ブラシの直径　　：0.3mm
ブラシの長さ　　：4.0mm
ブラシ相互間の間隔　：1.0mm。
【００５７】表２に、使用した金属ロールの個数、図１に示した第１実施態様の水平型装置のライン長さを100%としたときの、この装置の長さの割合、および、調製された各供試体の電気亜鉛めっき層の表面外観を示す。なお、表面外観の評価基準は前述した通りである。
【００５８】
【表２】

No.		金属ロールの個数（対数）	装置の長さの割合（%）	表面外観
本発明供試体	16	2（1対）	118	◎
	17	4（2対）	110	◎
	18	8（4対）	103	◎
	19	12（6対）	95	◎
	20	16（8対）	89	◎
	21	20（10対）	82	◎

【００５９】表２から明らかなように、供試体の表面外観は何れも優れており、そして、金属ロールの個数を１２個（６対）以上とした場合には、ラインの長さを、水平型装置の場合に比べて短くすることができ、装置全体をコンパクトにすることができた。
【００６０】（実施例３）図５に示した第３実施態様のラジアルセル型装置を使用し、実施例２と同一条件の金属ロールを使用し、300A/dm²の電流密度で電気めっきしたほかは、実施例１と同様の条件によって、冷延鋼板の一方の表面上に電気亜鉛めっき層を形成し、表３に示す本発明供試体No.22～27を調製した。
【００６１】表３に、使用した金属ロールの個数、図１に示した第１実施態様の水平型装置のライン長さを100%としたときの、この装置の長さの割合、および、調製された各供試体の電気亜鉛めっき層の表面外観を示す。なお、表面外観の評価基準は前述した通りである。
【００６２】
【表３】

No.		金属ロールの個数	装置の長さの割合 (%)	表面外観
本発明供試体	22	2	110	◎
	23	4	102	◎
	24	6	97	◎
	25	8	94	◎
	26	10	90	◎
	27	12	84	◎

【００６３】表３から明らかなように、供試体の表面外観は何れも優れており、そして、金属ロールの個数を６個以上とした場合には、水平型装置の場合に比べてラインの長さが短くなり、装置全体をコンパクトにすることができた。

【００６４】（実施例４）図１に示した第１実施態様の水平型装置を使用し、下記増粘剤を含有する電気亜鉛めっき液を使用したほかは、実施例１と同様の条件により、表４に示す本発明供試体No.28 ～34を調製した。

【００６５】電気亜鉛めっき液

成分組成： $ZnSO_4 \cdot 7H_2O$ ：600 g/l、

Na_2SO_4 ：100 g/l、

$Al_2(SO_4)_3 \cdot 18H_2O$ ：０～800g/l（増粘剤）、

pH値 ： 1、

温度 ： 50 ℃。

【００６６】表４に、電気めっき液の動粘度(cSt)、通電状態および調製された各供試体の電気亜鉛めっき層の表面外観および通電状態を示す。なお、表面外観および通電状態の評価基準は、実施例１と同様である。

【００６７】表４から明らかなように、増粘剤を含有せず、動粘度（cSt）が1.2 以下の電気めっき液を使用した供試体No. 28および29は、通電時にスパークの発生する場合が生じ、形成された電気めっき層の表面にむらが生じてめっき外観がやや不良であり、また、増粘剤の含有量が少なく、動粘度（cSt）が1.5 の電気めっき液を使用した供試体No. 30も、めっき外観がやや不良であった。これに対し、増粘剤を含有し、動粘度（cSt）が1.8 以上である電気めっき液を使用した供試体No. 31～34は、表面外観および通電状態が共に優れていた。

【００６８】

【表４】

No.		めっき後の粗さ (σSi)	金属外観	通電状態
本発明供試体	28	1.0	△	△
	29	1.2	△	△
	30	1.5	△	○
	31	1.8	◎	◎
	32	2.2	◎	◎
	33	2.5	◎	◎
	34	3.0	◎	◎

【００６９】（実施例５）図１に示した第１実施態様の水平型装置を使用し、幅1,000mm、厚さ0.6mmの冷延鋼板を、電解洗浄液として硫酸またはオルソけい酸ソーダ（40g/l）を使用し、下記条件によって電解洗浄し、表５に示す。この発明の装置による電解洗浄された供試体No.35～39を調製した。

【００７０】金属ロール：

寸法　　：直径200mm、長さ1200mm

回転速度：120m.p.m（金属ストリップの移動方向と反対方向に回転）

陽極部分：Tiを基体としてその上に酸化イリジウムが被覆された構造

陽極個数：８個

ブラシ　：ナイロン製

電解液噴出孔の直径　　：1.0mm

電解液噴出孔の合計面積：60%

ブラシの直径　　：0.2mm

ブラシの長さ　　：8.0mm

ブラシ相互間の間隔　：1.0mm

【００７１】表５に、金属ストリップの移動速度、使用した電解洗浄液、電解電流密度および電解洗浄効果を示す。なお、電解洗浄効果の評価基準は、下記の通りである。

◎：ストリップの全面にわたり、スケール等の付着物を均一に除去することができた。

○：ストリップのほぼ全面にわたり、スケール等の付着物を除去することができた。

【００７２】表５から明らかなように、供試体に対し、何れも高速且つ高電流密度で電解洗浄を施すことができた。

【００７３】

【表５】

No.		ストリップの移動速度 (mpm)	電解洗浄液	電流密度 (A/dm^2)	洗浄効果
本発明供試体	35	10	オルソけい酸ソーダ：40g/l	10	○～◎
	36	50	H_2SO_4 ： 50g/l	15	○～◎
	37	100	H_2SO_4 ： 80g/l	20	◎
	38	180	H_2SO_4 ： 100g/l	30	◎
	39	300	H_2SO_4 ： 100g/l	50	○～◎

【００７４】

【発明の効果】以上述べたように、この発明によれば、

装置全体が簡単で、電解処理用の金属ロールを複数個配置することができ、陽極としての金属ロールが、使用に伴って劣化した場合、金属ロール全体を交換する必要がなく、不溶性陽極として、加工が困難な、貴金属上に金属酸化物が被覆された電極も使用することが可能であり、パッドのように変形によって頻繁に交換する部材も必要とせず、金属ストリップの少なくとも１つの表面上に、高速且つ高電流密度で高品質の電気めっき皮膜を形成し、または、金属ストリップの少なくとも１つの表面を、高速且つ高効率で電解洗浄することができる、工業上有用な効果が発揮される。

【図面の簡単な説明】

【図１】この発明の装置の第１実施態様を示す概略斜視図である。

【図２】この発明の装置の第１実施態様を示す概略側面図である。

【図３】この発明の装置に使用される金属ロールの拡大垂直断面図である。

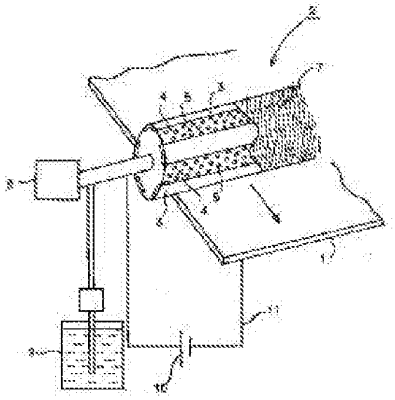
【図４】この発明の装置の第２実施態様を示す概略正面図である。

【図５】この発明の装置の第３実施態様を示す概略正面図である。

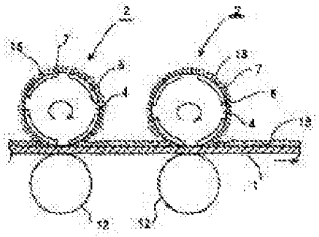
【符号の説明】

１　金属ストリップ、
２　金属ロール、
３　陽極部分、
４　電解液噴出部分、
５　電解液噴出孔、
６　溝、
７　ブラシ、
８　駆動機構、
９　電解液供給機構、
10　電源、
11　導線、
12　サポートロール、
13　電気めっき層、
14　第１コンダクターロール、
15　デフレクターロール、
16　第２コンダクターロール、
17　コンダクターロール、
18　デフレクターロール。

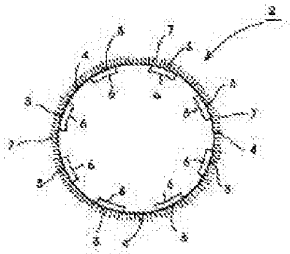
【図１】



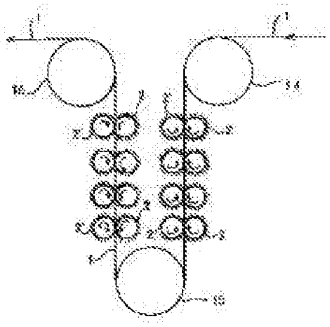
【図２】



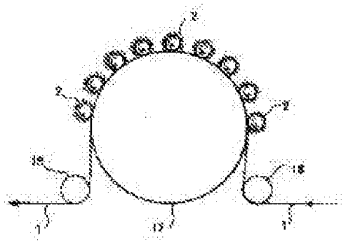
【図３】



【図4】



【図5】



13-13

Espacenet

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MANUFACTURING METHOD OF HIGH STRENGTH COPPER FOIL USING MICRO-HARDENING AND HIGH STRENGTH COPPER FOIL MANUFACTURED BY THE SAME

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Abstract of KR20150050266 (A)

The present invention relates to a manufacturing method for copper foil capable of being suitably used to improve performance of copper foil for an electrode for a secondary battery and a PCB as the present invention forms a very thin copper foil having a thickness of 4 μm through electrolytic plating and has high strength, capable of coiling the very thin copper foil. According to the present invention, the manufacturing method for copper foil forms electrolytic copper foil containing tin with electrolysis of copper plating solution which contains copper (Cu) ion 0.5 to 1 mol / L, tin (Sn) ion 0.025 to 0.1 mol / L, sulfuric acid (H_2SO_4) 30 to 90 g / L, and chlorine (Cl) ion to extract copper and tin on a substrate.

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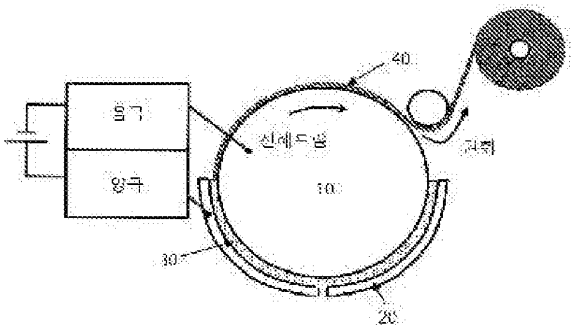
(54) 발명의 명칭 **마이크로 하드닝을 이용한 고강도 동박의 제조방법 및 이에 의해 제조된 고강도 동박**

(57) 요 약

본 발명은 두께 4㎛ 정도의 매우 얇은 동박을 전해도금을 통해 형성한 후 이를 권취(coiling)할 수 있을 정도의 높은 강도를 가져, 2차 전지용 전극이나 PCB용 동박의 성능을 향상시키는데 적합하게 사용될 수있는 동박의 제조방법에 관한 것이다.

본 발명에 따른 동박의 제조방법은, 동(Cu) 이온 0.5~1몰/L, 주석(Sn) 이온 0.025~0.1몰/L, 황산(H_2SO_4) 30~90g/L와, 염소(Cl) 이온을 포함하는 동 도금액을 전기분해하여 기판 상에 동과 주석을 석출시켜 주석이 포함된 전해동박을 형성하는 것을 특징으로 한다.

대 표 도 - 도1



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특허청구의 범위

청구항 1

동(Cu) 이온 0.5~1몰/L, 주석(Sn) 이온 0.025~0.1몰/L, 황산(H_2SO_4) 30~90g/L와, 염소(Cl) 이온을 포함하는 동도금액을 전기분해하여 기판 상에 동과 주석을 석출시켜 주석이 포함된 전해동박을 형성하는 것을 특징으로 하는 전해동박의 제조방법.

청구항 2

제1항에 있어서,

상기 동 도금액에는, PEG, MPS, SPS, 젤라틴, HEC 중에서 선택된 1종 이상의 제1첨가제 50ppm 이하와, 알데히드계 물질 또는 아민계 물질로 이루어진 제2첨가제 50ppm 이하를 더 포함하는 것을 특징으로 하는 전해동박의 제조방법.

청구항 3

제2항에 있어서,

상기 제2첨가제는, 포름알데히드(formaldehyde), 프로피온알데히드(propionaldehyde), 벤즈알데히드(benzaldehyde), 데실글루코사이드(decyl glucoside), 에틸렌디아민(ethylendiamine), N,N-디에틸에틸렌다아민(N,N-diethylethylendiamine) 및 에탄올아민(ethanolamine) 중에서 선택된 1종 이상을 포함하는 것을 특징으로 하는 전해동박의 제조방법.

청구항 4

제1항에 있어서,

상기 전해동박의 두께는 3~6㎛인 것을 특징으로 하는 전해동박의 제조방법.

청구항 5

제1항에 있어서,

상기 전해동박의 두께는 4~5㎛인 것을 특징으로 하는 전해동박의 제조방법.

청구항 6

제1항에 있어서,

상기 전해동박에 포함되는 주석(Sn)의 함량은 1~3.5질량%인 것을 특징으로 하는 전해동박의 제조방법.

청구항 7

제1항에 있어서,

상기 전해동박의 인장강도는 650MPa 이상인 것을 특징으로 하는 전해동박의 제조방법.

청구항 8

전해동박으로,

두께가 3~6㎛이고,

전착종료후 120분 이내에 20℃에서의 인장강도가 650MPa 이상이며,

전기전도성이 80% IACS 이상인 것을 특징으로 하는 전해동박.

청구항 9

제8항에 있어서,

상기 인장강도가 700MPa 이상인 것을 특징으로 하는 전해동박.

청구항 10

제8항 또는 제9항에 있어서,

상기 전해동박은 2차전지 음극용 집전체용 또는 PCB용인 것을 특징으로 하는 전해동박.

청구항 11

제8항 또는 제9항에 있어서,

상기 전해동박은 제1항 내지 제7항 중 어느 한 항에 기재된 방법에 의해 제조된 것을 특징으로 하는 전해동박.

명 세 서

기 술 분 야

[0001] 본 발명은 마이크로 하드닝 기술을 이용하여 고강도를 갖는 동박의 제조방법과 이 방법에 의해 제조된 고강도 동박에 관한 것으로, 보다 상세하게는 두께 4㎛ 정도의 매우 얇으면서도 전해도금을 통해 형성한 후 이를 권취(Coiling)하는데 문제가 없을 정도의 높은 강도를 가져, 2차 전지용 전극이나 PCB용 동박의 성능을 향상시키는데 적합하게 사용될 수 있는 동박의 제조방법과 이 방법에 의해 제조된 동박에 관한 것이다.

배 경 기 술

[0002] 전해 동박(Electrolytic Copper Foil)은 휴대폰, 노트북 컴퓨터, MP3 플레이어, 평판 디스플레이와 같은 전자기기에 요구되는 PCB(Printed Circuit Board: 인쇄회로기판)나 전자부품의 배선재료로 널리 사용되고 있을 뿐 아니라, 2차 전지의 음극 집전체로서도 많이 사용되고 있다.

[0003] 이러한 전해 동박은, 도 1에 도시된 바와 같이, 일반적으로 황산-황산구리 수용액의 전해액(30)에, 백금(Pt) 또는 백금 산화물로 피복한 티타늄판으로 이루어진 불용성 양극(20)과 이 양극에 대향하는 티타늄으로 이루어진 드럼 형상의 음극(10)을 사용하여, 상기 양극(20)과 음극(10) 사이에 전류를 인가하여 상기 드럼(10)면에 구리를 석출시키는 방식으로 동박을 형성하고, 형성된 동박(40)을 상기 드럼면으로부터 분리하여 연속적으로 권취하는 방법에 의해 제조된다.

[0004] 그런데, 최근 전자 제품의 두께 및 무게가 점차적으로 감소함에 따라 상기 전자 제품에 소요되는 전자재료의 크기가 작아지고 두께가 얇아지고 있다. 또한 2차 전지 분야에 있어서도, 음극 집전체 재료인 동박의 두께가 감소하면 단일 면적 내 더 많은 커패시터를 실장시킬 수 있을 뿐만 아니라 최종제품의 두께도 얇아질 수 있기 때문에, 가능한 한 얇게 제조한 전해 동박에 대한 요구가 점차 증가하고 있다.

[0005] 한편, 전해 동박의 두께를 지나치게 얇게 형성할 경우, 상기 드럼면에서 형성된 전해 동박을 분리하여 권취할 때, 형성된 동박이 권취 공정에서 가해지는 하중을 견디지 못하여 찢어지거나 변형이 생기기 쉬워 양산성이 확보되지 않거나 권취가 되더라도 전자 제품의 제조 공정 시에 변형되거나 파손되기 쉬워, 현재로서는 양산 가능한 전해 동박의 최소 두께는 약 8㎛ 정도인 것으로 알려져 있다.

[0006] 이러한 문제점을 해결하기 위해, 하기 특허문헌에는 동박 내에 미세한 SnO2 분산 입자를 분산시키는 방법을 통해 강도를 높이는 구성이 개시되어 있는데, 이 방법은 SnO2 분산 입자를 형성하는 공정이 복잡하고, 전기전도도가 떨어질 수 있는 한계가 있다.

[0007] 이외에도 전해 동박의 강도를 향상시키기 위한 방법으로, 합금화 또는 결정립 제어와 같은 방법이 알려져 있으나, 고속도 전해 도금에 적합하지 않거나, 강도는 향상되더라도 비저항이 증가하여 전해 동박에 요구되는 전기전도성을 만족하지 못하는 문제점이 있다.

선행기술문헌

특허문헌

[0008] (특허문헌 0001) 유럽공개특허공보 제10790057호

발명의 내용

해결하려는 과제

[0009] 본 발명은 전술한 종래기술의 문제점을 해결하기 위한 창안된 것으로, 2차 전지의 전극 또는 PCB 회로용에 적합한 전기전도도를 가지면서 두께 4㎛ 정도의 매우 얇은 두께의 동박을 형성한 후 이를 권취(coiling)할 수 있을 정도의 강도를 구현할 수 있는, 고강도 동박의 제조방법과 이 방법에 의해 제조된 고강도 동박을 제공하는 것을 과제로 한다.

과제의 해결 수단

[0010] 상기 과제를 해결하기 위한 본 발명의 제1측면은, 동(Cu) 이온 0.5~1몰/L, 주석(Sn) 이온 0.025~0.1몰/L, 황산(H_2SO_4) 30~90g/L와, 염소(Cl) 이온을 포함하는 동 도금액을 전기분해하여 기판 상에 동과 주석을 석출시켜 주석이 포함된 전해동박을 형성하는 것을 특징으로 하는 전해동박의 제조방법을 제공하는 것이다.

[0011] 또한, 상기 동 도금액에는, PEG, MPS, SPS, 젤라틴, HEC 중에서 선택된 1종 이상의 제1첨가제 50ppm 이하와, 알데히드계 물질 또는 아민계 물질로 이루어진 제2첨가제 50ppm 이하를 더 포함할 수 있다. 바람직하게는 상기 제1첨가제 및 제2첨가제는 1ppm 이상, 보다 바람직하게는

[0012] 또한, 상기 제2첨가제는, 포름알데히드(formaldehyde), 프로피온알데히드(propionaldehyde), 벤즈알데히드(benzaldehyde), 데실글루코사이드(decyl glucoside), 에틸렌디아민(ethylendiamine), N,N-디에틸에틸렌디아민(N,N-diethylethylendiamine) 및 에탄올아민(ethanolamine) 중에서 선택된 1종 이상을 포함할 수 있다.

[0013] 또한, 상기 전해동박의 두께는 3~6㎛, 바람직하게는 4~5㎛일 수 있다.

[0014] 또한, 상기 전해동박에 포함되는 주석(Sn)의 함량은 1~3.5질량%, 바람직하게는 2~3질량%일 수 있다.

[0015] 또한, 상기 전해동박의 인장강도는 650MPa 이상, 바람직하게는 700MPa 이상일 수 있다.

[0016] 상기 과제를 해결하기 위한 본 발명의 제2측면은, 상기한 방법에 의해 제조되는 전해동박으로서, 그 두께가 3~6㎛이고, 전착종료후 120분 이내에 20℃에서의 인장강도가 650MPa 이상이며, 전기전도성이 80% IACS 이상인 것을 특징으로 하는 전해동박을 제공하는 것이다.

[0017] 또한, 상기 전해동박은 그 인장강도가 700MPa 이상일 수 있다.

[0018] 또한, 상기 전해동박은 2차전지 음극용 집전체용 또는 PCB용일 수 있다.

발명의 효과

[0019] 본 발명에 따른 전해동박의 제조방법은, 동 도금액에 주석 이온을 소량 포함시켜 고용체 형태로 주석이 포함된 동박을 형성하고, 알데히드계 또는 아민계로 이루어진 첨가제를 소량 첨가함으로써 결정립이 미세화된 동박을 얻을 수 있어, 전착종료후 120분 이내에 20℃에서의 인장강도를 650MPa 이상의 고강도로 구현할 수 있어 두께 약 4㎛ 정도의 매우 얇은 동박을 형성하더라도 권취하중을 극복할 수 있어, 매우 얇은 전해동박의 제조가 가능하게 된다.

[0020] 본 발명에 따라 제조된 전해동박은 그 두께가 종래에 비해 약 1/4~1/2 정도 줄어들기 때문에, 점차 얇아지고 미세화되는 PCB용 기판이나 보다 높은 충전용량이 요구되는 2차전지의 음극집전체용에 적합하게 적용될 수 있다.

도면의 간단한 설명

[0021] 도 1은 전해동박의 제조과정에 대한 개략도이다.

도 2는 전해액 내 Sn(II) sulfate 농도 변화에 따른 Sn 첨가량의 변화를 나타낸 것이다.

도 3은 전해액 내 Cu(II) sulfate 농도 변화에 따른 Sn 첨가량의 변화를 나타낸 것이다.

도 4는 전해액 내 황산 농도 변화에 따른 Sn 첨가량의 변화를 나타낸 것이다.

도 5는 전해액의 온도 변화에 따른 Sn 첨가량의 변화를 나타낸 것이다.

발명을 실시하기 위한 구체적인 내용

[0022] 이하 본 발명의 실시예에 대하여 첨부된 도면을 참고로 그 구성 및 작용을 설명하기로 한다.

[0023] 하기에서 본 발명을 설명함에 있어, 관련된 공지 기능 또는 구성에 대한 구체적인 설명이 본 발명의 요지를 불필요하게 흐릴 수 있다고 판단되는 경우에는 그 상세한 설명을 생략할 것이다. 또한, 어떤 부분이 어떤 구성요소를 "포함"한다고 할 때, 이는 특별히 반대되는 기재가 없는 한 다른 구성요소를 제외하는 것이 아니라 다른 구성요소를 더 포함할 수 있는 것을 의미한다.

[0024] 본 발명에 있어서 '전해동박'이란, 동(Cu) 이온을 포함하는 동(Cu) 도금액을 전기분해함에 의해 전극면에 동(Cu)을 석출시켜 얻어지는 박(foil)을 의미한다.

[0025] 또한, 본 발명에 있어서 '인장강도'란, 전해도금 종료후 120분 이내에 20℃에서 수행한 인장시험을 통해 측정한 인장강도를 의미한다.

[0026] 본 발명에 따른 전해동박은 그 제조방법에 특별히 제한은 없으나, 예를 들어, 하기에 제시한 제조방법에 의해 보다 적합하게 제조할 수가 있다.

[0027] 본 발명에 따른 전해동박의 제조방법은, 동(Cu) 이온 0.5~1몰/L, 주석(Sn) 이온 0.025~0.1몰/L, 황산(H_2SO_4) 30~90g/L와, 염소(Cl) 이온을 포함하는 동 도금액을 전기분해하여 기판 상에 동과 주석을 석출시키는 것을 특징으로 한다.

[0028] 상기 동(Cu) 이온은 바람직하게는 황산구리오수화물(copper(Ⅱ) sulfate pentahydrate) 형태로 도금액에 투입하여 공급되며, 그 농도는 0.5~1몰/L가 바람직하고, 보다 바람직한 농도는 0.7~0.9몰/L이다.

[0029] 상기 주석(Sn) 이온은 황산주석(tin(Ⅱ) sulfate) 형태로 도금액에 투입하여 공급되며, 그 농도는 0.025~0.1몰/L가 바람직하며, 보다 바람직한 농도는 0.05~0.5몰/L이다.

[0030] 상기 동(Cu) 이온과 주석(Sn) 이온의 비율은 상기 전해동박의 제조 시 생성되는 전해동박에 포함되는 주석(Sn)의 함량이 1~3.5질량%의 범위가 되도록 상대 비율이 조절되어야 한다. 형성되는 전해동박 내의 주석(Sn)의 함량이 1질량% 미만일 경우, 주석(Sn)에 의한 고용강화 효과가 충분하지 않아 4㎛ 두께의 동박을 권취할 수 있을 정도의 강도를 얻기 어렵고, 주석(Sn)의 함량이 3.5질량%를 초과할 경우 PCB 회로용 또는 2차전지 음전극 집전체용에 요구되는 전기전도성을 만족하기 어렵기 때문이다. 보다 바람직한 주석(Sn)의 함량은 2~3질량%이다.

[0031] 상기 동 도금액에는 추가로 유기첨가제인 PEG(polyethylene glycol), MPS(mercaptopropane sulfonic acid), SPS(bis(sulfopropyl)disulfide), 젤라틴, HEC(hydroxy ethyl cellulose) 중에서 선택된 1종 이상의 제1첨가제와, 알데히드계 물질 또는 아민계 물질로 이루어진 제2첨가제를 포함할 수 있다. 상기 제1첨가제는 동 도금에 있어서 가속제 또는 억제제의 역할을 수행하여 형성되는 동박의 결정립을 제어하기 위한 것이고, 제2첨가제는 동 도금액에 포함되는 주석 이온의 전착 시에 형성되는 주석의 효과를 제어하여 등박의 미세화를 위한 것으로, 제1첨가제와 제2첨가제의 투입에 의하여, 형성되는 전해동박의 결정립이 소정 크기 이하로 미세화되며 이러한 결정립 미세화는 동박의 강도를 향상시키는 역할을 한다.

[0032] 상기 제2첨가제로 바람직하게는, 포름알데히드(formaldehyde), 프로피온알데히드(propionaldehyde), 벤즈알데히드(benzaldehyde), 데실글루코사이드(decyl glucoside), 에틸렌디아민(ethylenediamine), N,N-디에틸에틸렌디아민(N,N-diethylethylenediamine) 및 에탄올아민(ethanolamine) 중에서 선택된 1종 이상이 사용될 수 있으나, 반드시 이에 제한되는 것은 아니다.

[0033] 또한, 상기 제1첨가제 및 제2첨가제는 상기 동도금액에 500ppm 이하, 바람직하게는 50ppm 이하로 첨가될 수 있다.

[0034] 이하, 본 발명의 바람직한 실시예에 기초하여 본 발명을 보다 상세하게 설명하나, 본 발명은 하기 실시예에 의해 한정되는 것은 아니다.

[0035] [실시예]

[0036] 본 발명의 실시예에 따른 전해동박은 하기 표 1의 동도금액과 같이 제1첨가제와 제2첨가제를 포함하는 전해액을 이용하여 공지의 전해도금의 방법을 이용하여 얻었다.

표 1

[0037] 본 발명의 실시예에 따른 동 도금액의 조성

도금액	Copper(II) sulfate pentahydrate	0.5 ~ 1 Mol/L
	Tin(II) sulfate	0.025 ~ 0.1 Mol/L
	Sulfuric acid	30 ~ 90 g/L
	Cl^-	50 ppm
제1첨가제	PEG	0 ~ 100 ppm
	MPS	0 ~ 30 ppm
	SPS	0 ~ 30 ppm
	젤라틴	0 ~ 50 ppm
제2첨가제	포름알데히드	0 ~ 5 ml /L
	프로피온 알데히드	0 ~ 5 ml /L
	벤즈알데히드	0 ~ 5 ml /L
	데실 글루코사이드	0.1 ~ 5 mMol/L
	에틸렌디아민	0.01 ~ 0.1 Mol/L
	N,N-디에틸에틸렌디아민 (N,N-diethylethylendiamine)	0.01 ~ 0.1 Mol/L
	에탄올아민	0.01 ~ 0.1 Mol/L
	베타-나프톨	0.001 ~ 0.01 Mol/L

[0038] 또한, 전해도금의 공정조건은 하기 표 2의 조건으로 수행하였다.

표 2

[0039] 전해동박 제조용 공정조건

공정조건	전류밀도	20 ~ 30 A/dm²
	전해액 온도	30 ~ 50℃
	퍼들 속도(Puddle rate)	50 ~ 200 rpm
	용액 유동 속도(Solution flow rate)	2 L / min
	양극	불용성 양극
	음극	티타늄 플레이트
	극간 거리	3 cm

[0040] 이상과 같은 동 도금액과 공정조건을 사용하여 전해동박을 얻는데 있어서, 첨가원소에 따른 공정변수 최적조건과, 첨가원소의 첨가가 인장강도에 미치는 효과를 다음과 같이 시험하였다.

[0041] 먼저, 마이크로하드닝(Micro-hardening) 첨가원소가 동박 전해도금 공정조건에 미치는 영향을 평가하기 위해 Hull-cell 시험을 수행하여, 전해도금액 조성과 온도가 첨가원소에 미치는 영향을 확인하였다.

[0042] 먼저, 전해액 내 tin(II) sulfate 농도 변화에 따른 전해동박 내 주석(Sn) 첨가량 변화에 대해 측정한 결과, 도 2에 나타난 바와 같이, 전류밀도가 증가할수록 Sn 첨가량이 증가하는 경향을 나타내었다. tin(II) sulfate 함량이 증가할수록 전류밀도 6A/dm² 이상에서 주석(Sn) 원소 첨가량이 2.4질량%에서 최대 18.8질량까지 증가하였다. 동박 제조 시 전기전도도가 크게 증가하지 않는 범위 (Sn 3.5질량%, 바람직하게는 3질량% 이내)를 고려하면, 전해액 내 tin(II) sulfate 0.025M/L에서 전류밀도 6A/dm² 까지 가능함을 알 수 있다.

[0043] 또한, 전해액 내 copper(II) sulfate 농도 변화에 따른 전해동박 내 주석(Sn) 함량 변화에 대해 측정한 결과, 도 3에 나타난 바와 같이 copper (II) sulfate 함량이 증가하면 주석(Sn) 함량이 감소하는 경향을 나타내었다. 이로부터 3질량% 이하로 도금할 경우, 전류밀도 범위는 15A/dm²까지 가능함을 알 수 있다.

[0044] 또한, 전해액 내 황산 농도 변화에 따른 주석(Sn) 함량을 측정한 결과, 도 4에 나타난 바와 같이, 황산 함량이 증가하면 전해동박 내 주석(Sn) 함량이 증가하는 경향을 보였다. 이로부터 전해동박 내 주석(Sn) 함량 3질량% 이하를 안정적으로 유지하기 위해서는, 전류밀도를 5A/dm²로 이하로 유지하는 것이 바람직함을 알 수 있다.

[0045] 또한, 전해액의 온도에 따른 전해동박 내 주석(Sn) 함량을 측정한 결과, 도 5에 나타난 바와 같이, 전해액의 온도가 증가할수록 주석(Sn) 함량은 감소하는 경향을 보였다. 이는 온도가 증가함에 따라 전해액 내 발생한 주석(Sn) 슬러지가 발생하였고 그로 인해 전해동박 내 Sn 감소에 영향을 미친 것으로 판단된다. 그러므로 주석 석출의 효율을 고려할 때, 전해액의 온도는 30~50℃가 바람직하다.

[0046] 이상과 같은 사전 시험결과를 바탕으로 전해동박을 제조하였다. 구체적으로, 전해액은 황산구리 중 구리가 60g/L, 황산주석 중 주석이 10g/L, 황산 30g/L, Cl^-이온 50ppm, MPS 15ppm, 젤라틴 30ppm을 잘 교반시켜 동도금 전해액을 제조하였다. 제조된 동도금액을 온도를 유지 가능하고, 용액 내 불순물을 제거시킬 수 있는 필터 시스템을 가진 동도금 반응조에서 양극은 불용성 양극, 음극으로는 티타늄 플레이트를 사용하였다. 동도금 전해액의 온도는 35℃를 유지, 전극간 거리는 3cm, 전류밀도는 30A/dm²를 인가하여 동 도금을 실시하였다. 이때, 전극 사이에 교반기를 이용하여 120rpm 속도로 교반시켰다. 제작된 동박은 산(acid)에 용해시킨 후 희석시켜 고주파 유도 결합 플라즈마 (ICP) 장비를 이용하여 구리 와 주석 성분의 함량을 측정하였다. 또한, 전해동박에 포함되는 주석의 함량에 따른 물성의 차이를 비교하기 위하여, 주석의 함량은 0.5질량%, 2질량%, 3질량%가 되도록 각각 조절하였다.

[0047] [비교예]

[0048] 본 발명의 실시예에 따른 전해동박의 물성을 대비하기 위하여, 종래의 방법으로 제조한 전해동박을 제조하였다.

[0049] 구체적으로, 종래의 동박은 황산구리 중 구리가 60g/L, 황산 120g/L, Cl^- 이온 20ppm과 MPS 15ppm, 젤라틴 30ppm을 잘 교반시킨 동도금 전해액을 사용하였다. 전해액의 온도는 50℃, 양극전극으로는 불용성 전극, 음극 전극으로는 티타늄 플레이트를 사용하였고 전극간 거리는 3cm를 유지시켰다. 이때 전극 사이 교반기를 사용하여 120rpm 속도로 교반시켰다. 전류밀도 30A/dm² 를 인가시켜서, 동박의 두께는 본 발명의 실시예와 동일하게 하였다.

[0050] 인장시험 결과

[0051] 이상과 같은 조건으로 얻어진 전해동박으로, 가로 1.27 ㎝, 세로 8㎝, 두께 약 6㎛의 인장시편을 제작하였다.

[0052] 인장시험은 LLoyd Instrument사의 LR-30K 인장시험기를 사용하여 100N load-cell, 2inch/min 인장속도, 3cm의 게이지 길이로 수행하였으며, 하기 표 3은 그 결과를 나타낸 것이다.

표 3

[0053] 인장시험 결과

종류	인장강도(MPa)	연신율(%)	비고
전해동박	221.8	3.82	비교예
Cu-0.5%Sn	290.2	3.07	비교예
Cu-2%Sn	654.9	2.75	실시예
Cu-3%Sn	680.9	2.29	실시예

[0054] 상기 표 3에서 확인되는 바와 같이, 주석(Sn)을 포함하지 않은 전해동박의 인장강도는 221.8MPa에 불과하였고, 주석(Sn)의 첨가량이 증가할수록 인장강도는 증가하여, 주석(Sn) 함량 3질량%에서 인장강도는 680.9MPa로 증가함을 알 수 있다.

[0055] 650MPa 이상의 인장강도는 전해동박의 두께를 4㎛ 수준으로 낮추더라도, 권취공정에서 변형이나 파손 가능성을 현저하게 줄일 수 있는 물성치이다.

[0056] 한편, 주석의 함량이 0.5질량% 미만인 경우에는 주석이 포함되지 않은 경우에 비해서는 인장강도가 높아지나,

전해동박의 두께를 4㎛ 수준으로 얇게 하였을 때 권취 시 발생하는 변형이나 파손을 막기에는 충분하지 않다. 따라서, 주석의 함량은 0.5질량%를 초과하도록 첨가하여야 하며, 바람직하게는 1질량% 이상, 보다 바람직하게는 2질량% 이상이 되도록 하며, 주석의 함량이 지나치게 높으면 전기전도도가 저하하므로, 주석의 함량은 3.5질량% 이하가 바람직하다.

부호의 설명

[0057] 10: 전해드럼

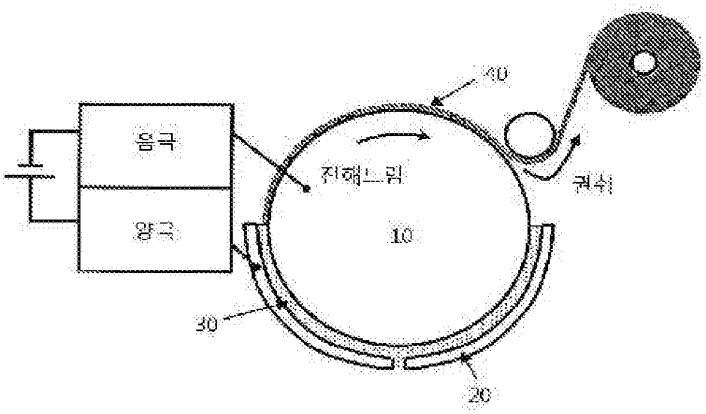
20: 양극

30: 도금액

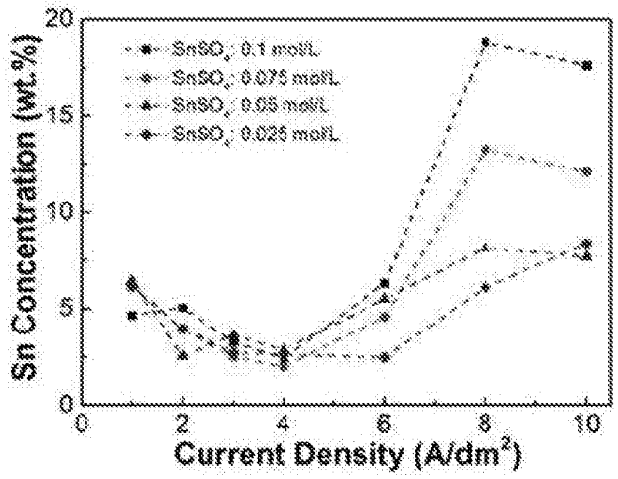
40: 전해동박

도면

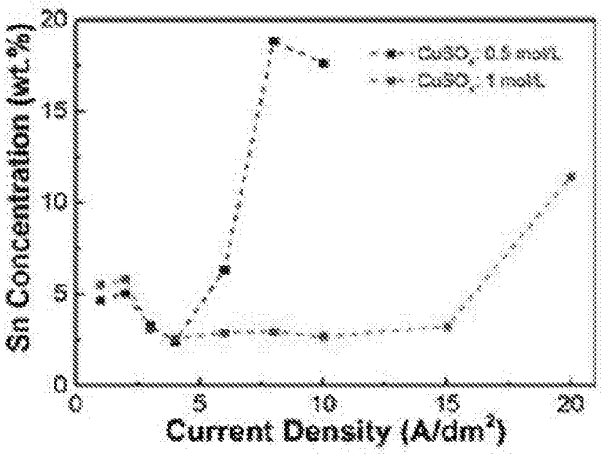
도면1



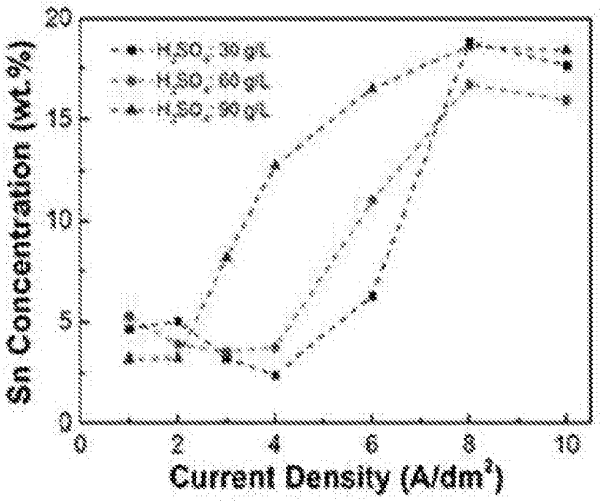
도면2


Sn Concentration (wt.%)
Current Density (A/dm²)
SnSO4: 0.1 mol/L
SnSO4: 0.075 mol/L
SnSO4: 0.05 mol/L
SnSO4: 0.025 mol/L

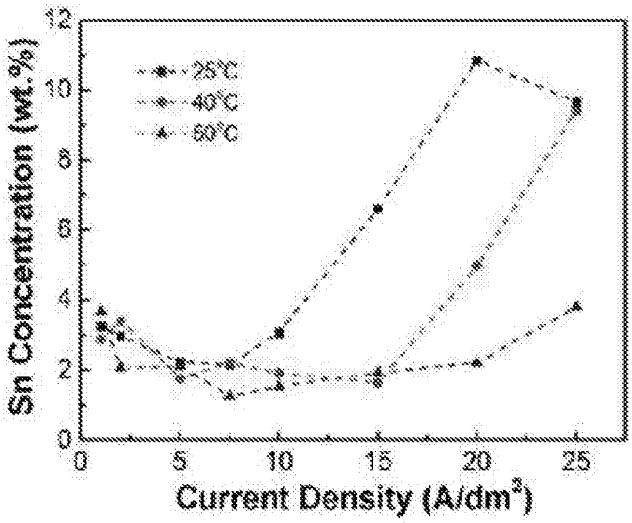
도면3


Sn Concentration (wt.%)
Current Density (A/dm²)
CuSO4: 0.5 mol/L
CuSO4: 1 mol/L

도면4


Sn Concentration (wt.%)
Current Density (A/dm²)
H₂SO₄: 30 g/L
H₂SO₄: 60 g/L
H₂SO₄: 90 g/L
0
5
10
15
20
0
2
4
6
8
10

도면5


Sn Concentration (wt.%)
Current Density (A/dm²)
25℃
40℃
50℃
0
2
4
6
8
10
12
0
5
10
15
20
25

Espacenet

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ELECTROLYTIC COPPER FOIL AND CURRENT COLLECTOR FOR LITHIUM SECONDARY BATTERY AND SECONDARY BATTERY COMPRISING THE ELECTROLYTIC COPPER FOIL

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Classification: - international: *C25D3/38; C25D7/06*
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Abstract of KR20160102147 (A)

According to an embodiment of the present invention, an electrolytic copper foil is an electrolytic copper foil applied to a lithium secondary battery. The electrolytic copper foil has a fracture coefficient (f) corresponding to a range of 5.0-18.0 when the electrolytic copper foil is annealed for one hour at 190C; the fracture coefficient (f) is defined by f= {(C-B)/A}1000 where A represents stress of the electrolytic copper foil at a time point when the fracture of the electrolytic copper foil starts in a tension test for the electrolytic copper foil, B represents elongation at the time point when the fracture of the electrolytic copper foil starts, and C represents elongation at the time point when the fracture of the electrolytic copper foil ends; the time point when the fracture of the electrolytic copper foil starts corresponds to the time point when the stress which has been increased in accordance with an increase in elongation of the electrolytic copper foil starts to decrease in the tension test; and the time point when the fracture of the electrolytic copper foil is ended corresponding to the time point when the electrolytic copper foil is broken and separated into two or more pieces.

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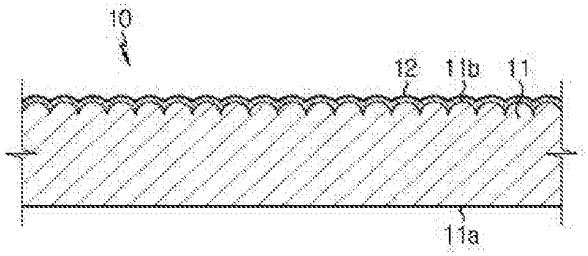
전체 청구항 수 : 총 10 항

(54) 발명의 명칭 **전해 동박과, 이 전해 동박을 포함하는 리튬 이차전지용 집전체 및 리튬 이차전지**

(57) 요 약

본 발명의 일 실시예에 따른 전해 동박은, 리튬 이차전지용 집전체로 적용되는 전해 동박이며, 상기 전해 동박은 190℃ 에서 1시간 동안 어닐링 되었을 때 5.0 내지 18.0 범위에 해당하는 파단특성계수(f)를 가지며, 여기서 상기 파단특성계수(f)는 f=((C-B)/A)×1000 으로 정의되고, 상기 A는 상기 전해 동박에 대한 인장 시험에 있어서 상기 전해 동박의 파단이 개시되는 시점에 전해 동박이 갖는 응력을 나타내고, 상기 B는 상기 전해 동박의 파단이 개시되는 시점에서의 연신율을 나타내며, 상기 C는 상기 전해 동박의 파단이 종료되는 시점에서의 연신율을 나타내고, 상기 전해 동박의 파단이 개시되는 시점은 상기 인장 시험에 있어서 상기 전해 동박의 연신율이 증가함에 따라 증가하던 응력이 감소되기 시작하는 시점에 해당하며, 상기 전해 동박의 파단이 종료되는 시점은 상기 전해 동박이 파괴되어 2 이상의 조각으로 분리되는 시점에 해당한다.

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특허청구의 범위

청구항 1

리튬 이차전지용 집전체로 적용되는 전해 동박에 있어서,

상기 전해 동박은 190℃ 에서 1시간 동안 어닐링 되었을 때 5.0 내지 18.0 범위에 해당하는 파단특성계수(f)를 가지며,

f=((C-B)/A)×1000 으로 정의되고,

상기 A는 상기 전해 동박에 대한 인장 시험에 있어서 상기 전해 동박의 파단이 개시되는 시점에 전해 동박이 갖는 응력(kgf/㎟)을 나타내고,

상기 B는 상기 전해 동박의 파단이 개시되는 시점에서의 연신율을 나타내며,

상기 C는 상기 전해 동박의 파단이 종료되는 시점에서의 연신율을 나타내고,

상기 전해 동박의 파단이 개시되는 시점은 상기 인장 시험에 있어서 상기 전해 동박의 연신율이 증가함에 따라 증가하던 응력이 감소되기 시작하는 시점에 해당하며,

상기 전해 동박의 파단이 종료되는 시점은 상기 전해 동박이 파괴되어 2 이상의 조각으로 분리되는 시점에 해당하는 것을 특징으로 하는 전해 동박.

청구항 2

제1항에 있어서,

상기 전해 동박은,

표면에 형성된 보호 층을 구비하며,

상기 보호 층은 크로메이트(chromate), BTA(benzotriazole) 및 실란 커플링제 중 선택된 적어도 어느 하나로 이루어지는 것을 특징으로 하는 전해 동박.

청구항 3

제1항에 있어서,

상기 전해 동박은,

20㎛ 미만의 두께를 갖는 것을 특징으로 하는 전해 동박.

청구항 4

제1항에 있어서,

상기 전해 동박은,

0 초과 2㎛ 이하의 표면거칠기(Rz)를 갖는 것을 특징으로 하는 전해 동박.

청구항 5

구리 농도가 70g/L 내지 80g/L 이고 황산 농도가 80g/L 내지 110g/L 인 황산동 수용액에 첨가제로서 루기금속 4 ~ 5ppm, 레벨러 2ppm 이하 및 브라이트너 2ppm 이하를 첨가하여 전해액을 제조하고, 이 전해액의 전해 온도를 40℃ 내지 45℃로 하고, 전류밀도를 40ASD 내지 70ASD로 하여 제박기의 드럼 표면에 구리(Cu)를 전착하는 것에 의해 제조되는 리튬 이차전지용 집전체로 적용되는 전해 동박으로서,

상기 전해동박을 1시간 동안 어닐링 하였을 때 5.0 내지 18.0 범위에 해당하는 파단특성계수(f)를 가지며,

f=((C-B)/A)×1000 으로 정의되고,

상기 A는 상기 전해 동박에 대한 인장 시험에 있어서 상기 전해 동박의 파단이 개시되는 시점에 전해 동박이 갖

는 응력(kgf/mm²)을 나타내고,

상기 B는 상기 전해 동박의 파단이 개시되는 시점에서의 연신율을 나타내며,

상기 C는 상기 전해 동박의 파단이 종료되는 시점에서의 연신율을 나타내고,

상기 전해 동박의 파단이 개시되는 시점은 상기 인장 시험에 있어서 상기 전해 동박의 연신율이 증가함에 따라 증가하던 응력이 감소되기 시작하는 시점에 해당하며,

상기 전해 동박의 파단이 종료되는 시점은 상기 전해 동박이 파괴되어 2 이상의 조각으로 분리되는 시점에 해당하는 것을 특징으로 하는 전해 동박.

청구항 6

제5항에 있어서,

상기 전해 동박은,

표면에 형성된 보호 층을 구비하며,

상기 보호 층은 크로메이트(chromate), BTA(benzotriazole) 및 실란 커플링제 중 선택된 적어도 어느 하나로 이루어지는 것을 특징으로 하는 전해 동박.

청구항 7

제5항에 있어서,

상기 전해 동박은,

20㎛ 미만의 두께를 갖는 것을 특징으로 하는 전해 동박.

청구항 8

제5항에 있어서,

상기 전해 동박은,

0 초과 2㎛ 이하의 표면거칠기(Rz)를 갖는 것을 특징으로 하는 전해 동박.

청구항 9

제1항 내지 제8항 중 어느 한 항에 따른 전해 동박으로 이루어진 리튬 이차전지용 전극 집전체.

청구항 10

제9항에 따른 리튬 이차전지용 전극 집전체를 포함하는 리튬 이차전지.

발명의 설명

기술 분야

[0001] 본 발명은 전해 동박과, 이 전해 동박을 포함하는 리튬 이차전지용 집전체 및 리튬 이차전지에 관한 것으로서, 좀 더 구체적으로는 파단특성계수 값이 일정 범위로 제한됨으로써 이차전지의 특성을 향상시킬 수 있는 전해 동박 및 이 전해 동박을 포함하는 리튬 이차전지용 집전체 및 리튬 이차전지에 관한 것이다.

배경 기술

[0002] 리튬 이차전지는 여타의 이차전지에 비해 상대적으로 에너지 밀도가 높고, 작동전압이 높을 뿐만 아니라 우수한 보존 및 수명특성을 보이는 등 많은 장점이 있어 개인용 컴퓨터, 캠코더, 휴대용 전화기, 휴대용 CD 플레이어, PDA 등 각종 휴대용 전자기기에 널리 사용되고 있다.

[0003] 일반적으로 리튬 이차전지는 전해질을 사이에 두고 배치된 양극 및 음극을 포함하는 구조를 가지며, 상기 양극은 양극 집전체에 양극 활물질이 부착된 구조를 가지고, 상기 음극은 음극 집전체에 음극 활물질이 부착된 구조를 갖는다.

[0004] 리튬 이차전지에 있어서 음극 집전체의 소재로는 주로 전해 동박이 사용되는데, 이러한 전해 동박은 이차전지의 충방전에 따라 이차전지 내부에 가혹 조건이 반복적으로 형성되더라도 이차전지의 성능이 유지될 수 있도록 우수한 물성을 가져야 한다.

[0005] 상기 전해 동박이 가져야 할 물성으로는, 예를 들어, 충방전에 따른 가혹 조건이 반복되더라도 크랙이 잘 발생되지 않을 것, 충방전이 진행됨에 따른 방전용량 유지율의 저하 속도가 지나치게 빠르지 않을 것, 내부 과열로 인한 이차전지의 성능저하 및/또는 안전사고의 우려가 없을 것 등을 들 수 있다.

[0006] 한편, 이러한 전해 동박의 우수한 물성은 여러가지 인자들의 조절에 따라 확보될 수 있는데, 어떠한 인자를 어떠한 범위로 조절함으로써 원하는 물성을 얻을 수 있는지 밝혀내는 데에는 많은 어려움이 따른다.

발명의 내용

해결하려는 과제

[0007] 본 발명은 상술한 문제점을 고려하여 창안된 것으로서, 리튬 이차전지의 우수한 성능 발현을 위한 중요한 인자를 찾아내고 이를 조절함으로써 전해 동박이 리튬 이차전지의 우수한 성능 발현을 위한 물성을 갖도록 하는 것을 일 목적으로 한다.

[0008] 다만, 본 발명이 이루고자 하는 기술적 과제는 상술한 과제에 제한되지 않으며, 위에서 언급되지 않은 또 다른 기술적 과제들은 아래에 기재된 발명의 설명으로부터 당업자에게 명확하게 이해될 수 있을 것이다.

과제의 해결 수단

[0009] 본 발명자들은 상술한 기술적 과제를 해결하기 위해 반복적인 연구와 실험을 거듭하였으며, 그 결과 파단특성계수가 적절히 조절된 전해 동박을 리튬 이차전지용 집전체에 적용함으로써 반복된 충방전에도 리튬 이차전지의 특성이 우수하게 유지될 수 있음을 알아내었다.

[0010] 이처럼 리튬 이차전지의 특성을 우수하게 유지시킬 수 있는 본 발명의 일 실시예에 따른 전해 동박은, 리튬 이차전지용 집전체로 적용되는 전해 동박이며, 상기 전해 동박은 190℃ 에서 1시간 동안 어닐링 되었을 때 5.0 내지 18.0 범위에 해당하는 파단특성계수(f)를 갖는다.

[0011] 여기서, 상기 파단특성계수(f)는 $f=\{(C-B)/A\}\times 1000$ 으로 정의되고, 상기 A는 상기 전해 동박에 대한 인장 시험에 있어서 상기 전해 동박의 파단이 개시되는 시점에 전해 동박이 갖는 응력을 나타내고, 상기 B는 상기 전해 동박의 파단이 개시되는 시점에서의 연신률을 나타내며, 상기 C는 상기 전해 동박의 파단이 종료되는 시점에서의 연신률을 나타내고, 상기 전해 동박의 파단이 개시되는 시점은 상기 인장 시험에 있어서 상기 전해 동박의 연신율이 증가함에 따라 증가하던 응력이 감소되기 시작하는 시점에 해당하며, 상기 전해 동박의 파단이 종료되는 시점은 상기 전해 동박이 파괴되어 2 이상의 조각으로 분리되는 시점에 해당한다.

[0012] 상기 전해 동박은, 표면에 형성된 보호 층을 구비하며, 상기 보호 층은 크로메이트(chromate), BTA(benzotriazole) 및 실란 커플링제 중 선택된 적어도 어느 하나로 이루어질 수 있다.

[0013] 상기 전해 동박은, 20㎛ 미만의 두께를 가질 수 있다.

[0014] 상기 전해 동박은, 0 초과 2㎛ 이하의 표면거칠기(Rz)를 가질 수 있다.

[0015] 한편, 상기 전해 동박은, 본 발명의 일 실시예에 따른 전해 동박 제조방법에 의해 제조될 수 있는데, 이러한 본 발명의 일 실시예에 따른 전해 동박 제조방법은, 190℃ 에서 1시간 동안 어닐링 되었을 때 5.0 내지 18.0 범위에 해당하는 파단특성계수(f)를 갖는 전해 동박을 제조하는 방법으로서, (a) 구리 농도가 70g/L 내지 80g/L 이고 황산 농도가 80g/L 내지 110g/L 인 황산동 수용액을 제조하는 단계; 및 (b) 상기 황산동 수용액을 전해액으로 하여 40℃ 내지 45℃ 의 온도에서 40A/㎡ 내지 70A/㎡ 의 전류밀도로 제박기의 드럼 표면에 구리(Cu)를 전착하는 단계를 포함한다.

[0016] 상기 전해 동박 제조방법은, (c) 전착된 구리 층의 표면에 크로메이트(chromate), BTA(benzotriazole) 및 실란 커플링제 중 선택된 적어도 어느 하나로 이루어지는 보호 층을 형성하는 단계;를 포함할 수 있다.

[0017] 한편, 상술한 기술적 과제는, 상술한 전해 동박으로 이루어진 리튬 이차전지용 전극 집전체에 의해서 달성될 수 있을 뿐만 아니라, 이러한 리튬 이차전지용 전극 집전체를 포함하는 리튬 이차전지에 의해서도 달성 가능하다.

발명의 효과

[0018] 본 발명에 따르면 리튬 이차전지의 충방전에 의해 이차전지 내부에 발생되는 가혹조건이 반복되더라도 리튬 이차전지의 용량 유지율이 감소되는 현상의 최소화 및/또는 내부 과열에 의한 발화 발생 방지 등을 가능하게 하며, 이로써 이차전지의 성능 향상 및/또는 이차전지 사용상의 안전성 확보를 가능하게 한다.

도면의 간단한 설명

[0019] 본 명세서에 첨부되는 다음의 도면들은 본 발명의 바람직한 실시예를 예시하는 것이며, 후술되는 발명의 상세한 설명과 함께 본 발명의 기술사상을 더욱 이해시키는 역할을 하는 것이므로, 본 발명은 그러한 도면에 기재된 사항에만 한정되어 해석되어서는 아니 된다.

도 1은 본 발명의 일 실시예에 따른 전해 동박을 나타내는 단면도이다.

도 2는 전해 동박에 대한 인장 시험에 있어서 전해 동박이 파단되는 과정을 나타내는 도면이다.

도 3은 파단특성계수를 설명하기 위한 응력-연신율 그래프이다.

발명을 실시하기 위한 구체적인 내용

[0020] 이하, 첨부된 도면을 참조하여 본 발명의 바람직한 실시예를 상세히 설명하기로 한다. 이에 앞서, 본 명세서 및 청구범위에 사용된 용어나 단어는 통상적이거나 사전적인 의미로 한정해서 해석되어서는 아니 되며, 발명자는 그 자신의 발명을 가장 최선의 방법으로 설명하기 위해 용어의 개념을 적절하게 정의할 수 있다는 원칙에 입각하여 본 발명의 기술적 사상에 부합하는 의미와 개념으로 해석되어야만 한다. 따라서, 본 명세서에 기재된 실시예와 도면에 도시된 구성은 본 발명의 가장 바람직한 일부 실시예에 불과할 뿐이고 본 발명의 기술적 사상을 모두 대변하는 것은 아니므로, 본 출원시점에 있어서 이를을 대체할 수 있는 다양한 균등물과 변형예들이 있을 수 있음을 이해하여야 한다.

[0021] 도 1을 참조하여 본 발명의 일 실시예에 따른 전해 동박(10)의 구성을 설명하기로 한다.

[0022] 도 1은 본 발명의 일 실시예에 따른 전해 동박을 나타내는 단면도이다.

[0023] 도 1을 참조하면, 본 발명의 일 실시예에 따른 전해 동박(10)은 구리 층(11) 및 상기 구리 층(11) 표면에 선택적으로 형성되는 보호 층(12)을 포함한다.

[0024] 상기 전해 동박(10)은 리튬 이차전지의 음극 집전체로 사용되는 것이 바람직하다. 즉, 리튬 이차전지에 있어서, 음극 활물질과 결합되는 음극 집전체로는 전해 동박(10)이 사용되는 것이 바람직하다. 반면, 양극 활물질과 결합되는 양극 집전체로는 알루미늄(Al)으로 이루어진 박(foil)이 사용되는 것이 일반적이다.

[0025] 이에 따라, 본 발명에서는 상기 전해 동박(10)이 사용되는 본 발명의 일 실시예에 따른 이차전지용 집전체가 음극 집전체에 해당하는 경우를 예로 들어 설명하기로 한다.

[0026] 상기 전해 동박(10)은 리튬 이차전지의 집전체로 이용되는 경우 반복적인 충방전에 의한 전극의 부피 팽창으로 인해 힘을 받게 되는데, 이 경우 전해 동박(10)의 파단강도를 넘어서는 인장력이 가해지더라도 즉시 파단이 이루어지는 것은 아니다.

[0027] 즉, 도 2를 참조하면, 전해 동박(10)은 넥킹 단계, 보이드(void) 발생 단계, 보이드의 성장 및 결합 단계, 및 표면에서의 전단 발생 단계를 거쳐 완전 파단에 이르게 된다.

[0028] 이러한 파단형태를 연성파단이라 하며, 도 3을 참조하면, 상기 전해 동박(10)은, 이러한 연성파단을 나타내는 응력-연신율 그래프에 있어서 전해 동박이 갖는 응력이 파단강도에 이른 이후에는 연신율이 증가함에 따라 응력이 점점 줄어드는 경향을 보이다가 결국 완전 파단에 이르게 된다.

[0029] 응력이 파단강도에 이른 시점 이 후 전해 동박(10)이 완전 파단에 이를 때까지의 연신율의 변화량을 파단이 시작될 때의 응력 값, 즉 파단강도 값으로 나눈 값에 1000을 곱한 값을 파단특성계수(f)라고 한다.

[0030] 도 3을 참조하면, 이러한 파단특성계수(f)는 다음과 같은 수식으로 나타낼 수 있다:

[0031] $f=((C-B)/A)\times 1000$

[0032] 여기서, A, B 및 C는 각각 상기 전해 동박에 대한 인장 시험에 있어서 상기 전해 동박의 파단이 개시되는 시점

에 전해 동박이 갖는 응력, 상기 전해 동박의 파단이 개시되는 시점에서의 연신율 및 상기 전해 동박의 파단이 종료되는 시점에서의 연신율을 나타낸다.

[0033] 상기 전해 동박의 파단이 개시되는 시점은, 도 3의 응력-연신율 그래프에 있어서 연신율이 증가함에 따라 함께 증가하던 응력이 오히려 감소하기 시작하는 지점(P1)에 대응되는 시점을 의미한다.

[0034] 또한, 상기 전해 동박의 파단이 종료되는 시점은 도 3의 응력-연신율 그래프에 있어서 연신율이 증가함에 따라 감소하던 응력이 0이 되는 지점(P2)에 대응되 시점을 의미하는 것으로서, 이 시점에서 전해 동박은 파괴되어 2 이상의 조각으로 분리된다.

[0035] 상기 파단특성계수(f)가 지나치게 작은 값을 갖는 경우 전해 동박(10)이 외부 힘에 의해 찢겨질 때 단 시간 내에 찢어지게 되며, 이에 따라 전해 동박(10)를 리튬 이차전지의 집전체로 이용하는 경우 반복적인 충방전에 따른 이차전지 내의 가혹조건에서 이차전지의 성능 유지가 어려운 문제점이 있다.

[0036] 반대로 상기 파단특성계수(f)가 지나치게 큰 값을 갖는 경우 전해 동박(10)이 외부 힘에 의해 찢겨지는 상황에서 불안정한 상태가 오래 지속되기 때문에 과도한 열 발생이 있을 수 있고, 이로 인해 전지의 성능 저하의 문제점 및 이차전지 사용상의 안전성 확보가 어려운 문제점이 있을 수 있다.

[0037] 따라서, 상기 파단특성계수(f)는 적절한 범위를 유지해야 하는데, 바람직하게는 5.0 내지 18.0 범위를 유지해야 한다.

[0038] 이러한 파단특성계수(f)는 전해 동박(10)이 190℃ 에서 1시간 동안 어닐링 된 상태에서 측정된 것으로서, 이러한 어닐링은 전해 동박(10)을 집전체로 적용하여 리튬 이차전지를 제작하는 과정에서 거치게 되는 고온의 조건이 적용되도록 하기 위한 것이다.

[0039] 상기 파단특성계수(f)는 전해 동박(10)의 제조 과정에서 도금을 위한 도금액(전해액)에 함유되는 구리, 황산의 농도 변화, 도금액에 선택적으로 첨가될 수 있는 각종 첨가제(무기 첨가제, 레벨러, 브라이트너 등)의 농도 변화, 도금 시의 전류밀도의 변화 및 도금액의 온도 변화 등을 통해 조절이 가능하다.

[0040] 한편, 전기 도금에 의해 제조되는 상기 전해 동박(10)은 상대적으로 표면거칠기(Rz)(surface roughness)가 낮게 형성되는 샤이니 면(Shiny surface)(11a) 및 그와 반대측 면으로서 이른바 산(Mountain) 구조에 의해 상대적으로 표면거칠기(Rz)가 높게 형성되는 매트 면(Matte surface)(11b)으로 이루어진다.

[0041] 상기 샤이니 면(11a)의 표면거칠기(Rz)는 동이 석출되는 원통형 드럼(음극)이 연마된 정도에 따라 결정되는 반면, 매트 면(11b)의 표면거칠기(Rz)는 전해 동박(10)의 제조 과정에서 도금액을 구성하는 물질의 조성, 전해 반응시의 전류 밀도 등을 변화시킴으로써 조절이 가능하다.

[0042] 한편, 이러한 전해 동박(10)의 매트 면(11b)이 갖는 표면거칠기(Rz)가 지나치게 높은 경우에는 활물질과 전해 동박(10)의 접촉이 균일하게 이루어지기 어려워 리튬 이차전지의 방전용량 유지율이 저하될 수 있다. 따라서, 표면거칠기(Rz)를 적절한 수준으로 조절할 필요가 있는데, 전해 동박(10)의 매트 면(11b)이 갖는 표면거칠기(Rz)는 대략 2㎛ 이하로 억제하는 것이 바람직하다.

[0043] 상기 보호 층(12)은 전해 동박(10)의 방청 처리를 위해 구리 층(11)의 표면에 선택적으로 형성되는 것으로서, 크롬산염(Chromate), BTA(Benzotriazole) 및 실란 커플링(Silane coupling)제 중 선택된 적어도 어느 하나로 이루어질 수 있다. 상기 보호 층(12)은 전해 동박(10)에 대해 방청 특성뿐만 아니라, 내열 특성 및/또는 활물질과의 결합력 증대 특성을 부여하는 역할 또한 할 수 있다.

[0045] **1. 전해 동박의 제조**

표 1

	동 도금액(g/L)			첨가제(ppm)			전류밀도
	구리	황산	온도	무기금속	레벨러	브라이트너	(ASD)
실시예1	70	80	40	4	0	0	40
실시예2	80	80	45	4	0.5	0.5	70
실시예3	75	85	45	4.5	0.5	1	50
실시예4	70	110	40	4.5	1	2	40
실시예5	80	110	45	5	1	2	70
실시예6	70	100	45	4.5	2	0.5	70
비교예1	70	95	45	4	0.5	0.5	50
비교예2	80	105	45	5	1	2	70
비교예3	80	95	45	5	1	1.5	70
비교예4	70	105	45	4.5	0.5	1	60

[0046]

[0047] 본 발명의 일 실시예에 따른 전해 동박은 황산동 수용액을 도금액(전해액)으로서 이용해 일정속도로 회전하는 원통형의 음극 및 반대쪽에 위치한 양극 사이에 도금액을 공급하여 회전하는 원통형의 음극 면에 구리를 전착, 환원 석출시킴으로써 제조되었으며, 대략 20㎛ 미만의 두께로 제조되었다(전해 동박의 두께가 얇을수록 활물질이 부착된 집전체가 이차전지 내에 많이 들어갈 수 있으므로 고용량화에 유리한 반면 그 두께가 두꺼울수록 이차전지에 적용 시에 고용량화가 어려울 수 있으므로, 전해 동박의 두께는 20㎛ 를 초과하지 않는 것이 바람직함). 실시예와 비교예에서 적용된 각각의 조건들은 아래의 설명에 따랐다:

[0048] 일반적으로 전해도금에 의해 생성되는 전해 동박에는 두 가지의 서로 다른 면이 있다. 즉, 전해 동박에는 음극 드럼에 접해 있는 면(shiny side, S면)과 석출에 의해 결정립이 성장하는 방향에 위치한 면(Matt side, M면)이 있다. 이러한 전해 동박의 S면과 M면의 표면거칠기(Rz)는 대략 2㎛ 이하의 범위에서 형성되었다.

[0049] (실시예)

[0050] 표 1과 같이, 구리 농도가 70 ~ 80g/L, 황산 농도가 80 ~ 110g/L 인 도금액을 제조하였으며, 각종 첨가제(무기금속, 레벨러, 브라이트너)를 첨가하여 대략40 ~ 45℃ 범위의 온도, 대략 40 ~ 70ASD 의 전류밀도 조건으로 전해 동박을 제조하였다(다만, 반드시 이러한 범위로 한정되는 것은 아니며, 본 발명의 목적을 달성할 수 있는 범위 내에서 적절히 조절될 수 있음).

[0051] 여기서, 무기 첨가제로는 Fe, W, Zn, Mo 등이 적용되었고, 레벨러로는 젤라틴, 콜라겐, PEG(polyethylene glycol)가 이용되었으며, 브라이트너로는 SPS(bis(3-sulfopropyl)disulfide), MPS(mercapto-propane sulphonic acid), UPS(3-N,N-dimethylaminodithiocarbamoyl-1-propanesulphonic acid)가 이용되었다.

[0052] 한편, 상기와 같은 공정 조건에 따라 제조된 전해 동박에 대한 보호(방청 등)를 위해 표면에 크로메이트(Chromate) 처리를 하였다.

[0053] (비교예)

[0054] 표 1과 같이, 구리농도가 70 ~ 80g/L, 황산 농도가 95 ~ 105g/L 인 도금액에 각종 첨가제(실시예와 동일한 첨가제)를 첨가하여, 대략 45℃의 온도, 대략 50 ~ 70ASD 의 전류밀도 조건으로 전해 동박을 제조하였다.

[0056] **2. 파단 특성계수의 측정**

[0057] 상술한 바와 같은 공정조건에 따라 제조된 본 발명의 실시예에 따른 전해 동박과 비교예에 따른 전해 동박에 대한 파단특성계수(f)를 측정하였다.

[0058] 전해 동박이 갖는 파단특성계수(f)는 표준화된 측정방법인 UTM을 통해 측정하였으며, 이 때 적용된 UTM 조건은 표점거리 50mm, 폭 12.7mm, 측정속도 2mm/min 였다.

[0059] 전해 동박에 대한 파단특성계수(f)의 측정은 상술한 조건에 따라 제조된 실시예/비교예에 따른 전해 동박이 완성된 리튬 이차전지 내에서의 조건과 등등한 조건을 갖도록 하기 위해 190℃ 에서 1시간 동안 어닐링을 수행한 이후에 시행되었다. 즉, 리튬 이차전지는 그 제조 시에 통상적으로 일정시간 동안 고온 상태가 유지되는 과정을 거치게 될 수 있는데, 이와 유사한 조건을 만들어 주기 위해 전해 동박을 어닐링 하는 것이다.

[0060] 이러한 어닐링 과정을 거친 전해 동박의 파단특성계수(f) 측정 결과는 아래 표 2에 나타나 있다.

표 2

	(A)인장강도 (kgf/mm²)	(B)신율 (%) (C)파단종류	D=C-B	(D/A)	1=((D/A)*1000)
실시예1	25.82973	18.452 18.606	3.156	0.0860	6.0
실시예2	25.72026	17.829 17.971	3.142	0.0055	5.5
실시예3	25.01256	16.162 16.267	3.125	0.0060	6.0
실시예4	25.05213	13.666 13.441	3.575	0.0143	14.3
실시예5	24.79587	12.504 12.728	3.724	0.0171	17.1
실시예6	24.69445	12.106 12.549	3.445	0.0160	16.0
비교예1	27.57101	10.818 10.860	0.04265	0.0015	1.5
비교예2	27.33273	9.918 10.050	0.132	0.0046	4.8
비교예3	31.62038	5.258 5.265	0.008	0.0002	0.2
비교예4	24.56685	12.112 12.561	3.449	0.0183	18.3

[0061]

[0062] 표 2의 결과를 참조하면, 실시예 1 내지 6의 전해 동박의 경우 5.0 내지 18.0 범위의 파단특성계수값을 나타내는 반면, 비교예 1 내지 3의 전해 동박은 5.0 미만의 파단특성계수 값을 나타내고, 비교예 4의 전해 동박은 18.0을 초과하는 파단특성계수 값을 나타냈다.

[0064] **3. 리튬 이차전지의 제조**

[0065] **- 양극판 및 음극판의 제조**

[0066] (양극재 혼합물의 조성)

[0067] 양극재(LiCoO2): 85wt%

[0068] 도전재(아세틸렌블랙): 8wt%

[0069] 바인더(폴리불화비닐리덴): 7wt%

[0070] (음극재 혼합물의 조성)

[0071] 음극재(그라파이트 또는 탄소재): 95~98wt%

[0072] 바인더(폴리불화비닐리덴): 2~5wt%

[0074] 상기 재료에 N-메틸피롤리돈을 첨가하여 슬러리로 만든다음 각각 알루미늄 박으로 이루어진 양극 집전체 및 전해 동박으로 이루어진 음극 집전체의 표면에 도포하여 용제를 증발시킨 후, 압연 및 일정사이즈로 슬리팅하여 양극판 및 음극판을 제작하였다.

[0076] **- 리튬 이차전지의 조립**

[0077] 양극판, 세퍼레이터(친수 처리한 다공질 폴리에틸렌 필름), 음극판 3장을 순차적으로 적층 및 권취하고, 이것을 용기에 넣어 전해액을 주입/밀봉 함으로써 원통형 전지를 완성하였다. 전지의 규격은 일반적인 원통형인 18650 형을 사용하였다.

[0078] 여기서, 전해액으로는 에틸렌카보네이트(EC) 및 디메틸카보네이트(DMC)를 1:1로 체적비로 혼합한 용매에 1M의 $LiPF_6$ 을 용해시킨 것을 사용하였다.

[0080] **4. 충방전 시험**

[0081] 상술한 조건에 따라 제작된 리튬 이차전지 중, 표 1에 나타난 실시예 1 내지 6에 따른 전해 동박이 적용된 음극 집전체를 이용하여 제작된 리튬 이차전지(본 발명의 실시예에 따른 이차전지)를 각각 실시예 1 내지 6에 따른 리튬 이차전지로 하였다.

[0082] 마찬가지로, 표 1에 나타난 비교예 1 내지 4에 따른 전해 동박이 적용된 음극 집전체를 이용하여 제작된 리튬 이차전지를 각각 비교예 1 내지 4에 따른 리튬 이차전지로 하였다.

[0083] 이와 같이 마련된 리튬 이차전지들을 대상으로 500회의 반복적인 충방전 시험을 진행하였다. 이 때, 충전은 CCCV(정전류 정전압) 모드, 충전 전압은 4.3V, 충전 전류는 0.2C(5시간 동안 충전을 함으로써 완전 충전될 수 있는 전류)과 같은 조건으로 실시하였으며, 방전은 CC(정전류) 모드, 방전 전압 3.0V, 방전 전류0.5C(2시간만에 완전 방전 될 수 있는 전류)과 같은 조건으로 실시하였다.

[0084] 이와 같이, 반복적인 충방전을 완료한 다음, 리튬 이차전지의 용량 유지율, 발열 정도 및 집전체를 이루는 전해 동박에 크랙이 발생하였는지 여부에 대한 측정을 하여 표 3에 나타내었다.

표 3

	1	2	3	4	5	6	1*	2*	3*	4*
크랙발생 여부	X	X	X	X	X	X	O	미세 크랙	O	X
용량 유지율 (%)	87	86	84	87	99	33	27	42	24	83
온도(℃)	25	25	26	28	25	27	25	26	25	41

(1~6: 본 발명의 실시예, 1*~4*: 비교예)

[0085]

[0086] 상기 표 3을 참조하면, 전해 동박의 파단특성계수(f)가 5.0 내지 18.0 범위 내에 있는 본 발명의 실시예에 따른 리튬 이차전지들(실시예 1 내지 6)은 500회의 충방전이 완료된 이 후에도 집전체에 크랙이 발생되지 않았고, 용량 유지율 또한 처음의 용량 대비 대략 84% 내지 93%로 높게 유지되었다(500회의 충방전 사이클 수행의 경우, 통상 대략 80% 내지 90% 가량의 용량 유지율을 나타내며, 이차전지 내부에 문제가 발생된 경우 급격히 떨어져 이러한 정상적인 수치와는 큰 차이를 보이게 됨).

[0087] 또한, 실시예 1 내지 6의 리튬 이차전지는, 항온 챔버 내에서 충방전 테스트가 이루어지는 방식으로 진행된 발열 측정에 있어서도 표면 온도가 대략 25℃ 내지 28℃ 정도로 정상적인 온도 범위(대략 30℃ 이내이면 정상 범위로 볼 수 있으며, 일시적으로 온도가 상승하는 경우라도 특별한 이상이 없다면 40℃를 넘지 않음)를 나타냈다.

[0088] 반면, 전해 동박의 파단특성계수(f)가 5.0 미만인 비교예에 따른 리튬 이차전지들(비교예 1 내지 3)은 반복된 충방전으로 인해 집전체에 크랙이 발생하였으며, 용량 유지율 또한 처음의 용량 대비 대략 24% 내지 42% 수준으로 나타나 이차전지로서의 기능을 크게 상실한 것으로 나타났다. 집전체에 발생된 크랙은 집전체에 부착된 전극 활물질이 탈락되는 원인이 되므로 이러한 크랙 발생은 용량 유지율 저하에 직접적인 영향을 미치게 되는 것이다.

[0089] 한편, 전해 동박의 파단특성계수(f)가 18.0을 초과하는 비교예에 따른 리튬 이차전지(비교예 4)는 반복된 충방전에도 크랙이 발생되지 않고 용량 유지율 또한 비교적 높게 유지되었으나, 발열 측정에 있어서는 대략 41℃의 온도를 나타냄으로써 통상 정상 범위로 볼 수 있는 30℃를 크게 초과하였다. 이러한 비정상적인 발열 현상은 리튬 이차전지의 성능을 저하시킬 수 있음은 물론 안전사고의 위험 또한 증가시킬 수 있다.

[0091] 상기 실험 결과로부터 전해 동박(10)의 파단특성계수(f)가 일정 범위 내(5.0 내지 18.0)로 유지되는 경우 반복적인 충방전에 의한 가혹조건 속에서도 이차전지의 성능을 유지할 수 있고, 이로써 이차전지 사용상의 안정성 또한 확보할 수 있음을 명확히 알 수 있다.

[0092] 이상에서 본 발명은 비록 한정된 실시예와 도면에 의해 설명되었으나, 본 발명은 이것에 의해 한정되지 않으며 본 발명이 속하는 기술분야에서 통상의 지식을 가진 자에 의해 본 발명의 기술사상과 아래에 기재될 특허청구범위의 균등범위 내에서 다양한 수정 및 변형이 가능함은 물론이다.

부호의 설명

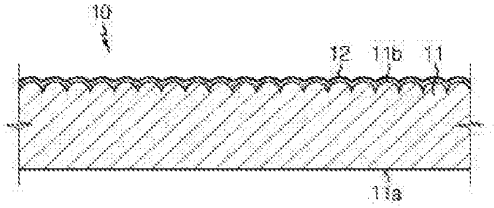
[0093] 10: 전해 동박 11: 구리 층

11a: 매트 면(Matte surface) 11b: 샤이니 면(Shiny surface)

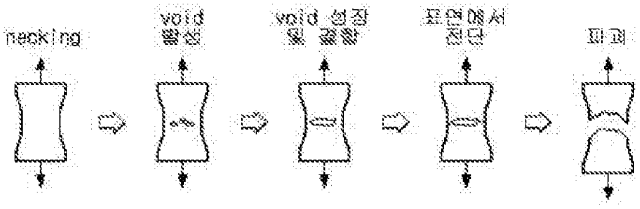
12: 보호 층

도면

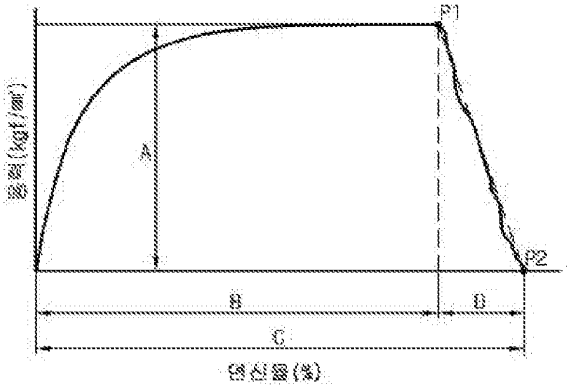
도면1



도면2



도면3



Espacenet

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Electrolytic Copper Foil Having Low Surface Roughness Method for Manufacturing The Same Flexible Copper Clad Laminate Comprising The Same Anode Comprising The Same and Secondary Battery Comprising The Same

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- cooperative:

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Abstract of KR20170126775 (A)

Disclosed are an electrolytic copper foil having low surface roughness, a method for manufacturing the same, a flexible copper clad laminate having excellent peeling strength between the electrolytic copper foil and a nonconductive polymer membrane, a negative electrode having excellent adhesion between the electrolytic copper foil and a negative electrode active material and a secondary battery having excellent charging and discharging capacity maintenance rates. The electrolytic copper foil of the present invention comprises: a plurality of nodules arranged on the mat surface; and a plurality of fine nodules located on at least one surface of the nodules and having the longest diameter of 0.2 m or less.

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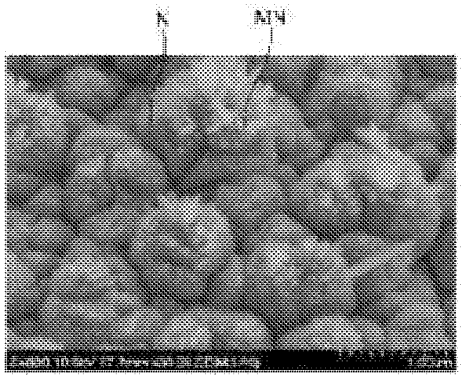
전체 청구항 수 : 총 21 항

(54) 발명의 명칭 **낮은 표면조도를 갖는 전해동박, 그 제조방법, 그것을 포함하는 연성동박적층필름, 그것을 포함하는 음극, 및 그것을 포함하는 이차전지**

(57) 요 약

본 발명은 낮은 표면조도를 갖는 전해동박 및 그 제조방법, 전해동박과 비전도성 고분자막 사이의 우수한 박리강도를 갖는 연성동박적층필름, 전해동박과 음극 활물질 사이의 우수한 접착력을 갖는 음극, 및 우수한 충방전 용량유지율을 갖는 이차전지가 개시된다. 본 발명의 전해동박은, 매트면에 배치된 다수의 노듈들; 및 상기 노듈들 중 적어도 하나의 표면 상에 위치하며 0.2㎛ 이하의 최장직경을 갖는 다수의 미세노듈들을 포함한다.

대 표 도 - 도2



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특허청구의 범위

청구항 1

매트면 및 그 반대편의 샤이니면을 갖는 전해동박에 있어서,

상기 매트면에 배치된 다수의 노듈들; 및

상기 노듈들 중 적어도 하나의 표면 상에 위치하며 0.2㎛ 이하의 최장직경을 갖는 다수의 미세노듈들 - 여기서, 상기 최장직경은 상기 샤이니면에 평행한 방향의 최대 직경을 의미함 - 을 포함하는 것을 특징으로 하는,

전해동박.

청구항 2

제1항에 있어서,

상기 미세노듈들은 Cu, Ni, Zn, Fe, Cr, 및 Mo 중 적어도 하나를 포함하는 것을 특징으로 하는,

전해동박.

청구항 3

제1항에 있어서,

상기 매트면의 R_z는 0.8 내지 3 ㎛인 것을 특징으로 하는,

전해동박.

청구항 4

제1항에 있어서,

상기 미세노듈들은 구상 형태(spherical shape) 또는 침상 형태(needle shape)를 갖는 것을 특징으로 하는,

전해동박.

청구항 5

제1항에 있어서,

상기 전해동박의 두께는 1 내지 70 ㎛인 것을 특징으로 하는,

전해동박.

청구항 6

제1항에 있어서,

상기 전해동박은,

메인 구리막(copper main film);

상기 메인 구리막 상의 구리 노듈층(copper nodule layer) - 상기 구리 노듈층은 상기 노듈들을 포함함 -; 및

상기 구리 노듈층 상의 미세노듈층(micro-nodule layer) - 상기 미세노듈층은 상기 미세노듈들을 포함함 -; 및

상기 미세노듈층 상의 베리어층(barrier layer)을 포함하는 것을 특징으로 하는,

전해동박.

청구항 7

제6항에 있어서,

상기 베리어층은,

상기 미세노듈층 상의 제1 서브 베리어층; 및

상기 제1 서브 베리어층 상의 제2 서브 베리어층을 포함하는 것을 특징으로 하는,

전해동박.

청구항 8

제7항에 있어서,

상기 제1 서브 베리어층은 아연 또는 아연합금을 포함하고,

상기 제2 서브 베리어층은 크롬을 포함하는,

전해동박.

청구항 9

제8항에 있어서,

상기 제2 서브 베리어층의 표면은 실란 커플링제로 개질된 것을 특징으로 하는,

전해동박.

청구항 10

전해도금을 통해 메인 구리막을 형성하는 단계;

상기 메인 구리막 상에 구리 노듈층을 형성하는 단계; 및

0.2㎛ 이하의 최장직경을 갖는 다수의 미세노듈들을 포함하는 미세노듈층을 상기 구리 노듈층 상에 형성하는 단계 - 여기서, 상기 최장직경은 상기 사이너면에 평행한 방향의 최대 직경을 의미함 - 를 포함하는 것을 특징으로 하는,

전해동박 제조방법.

청구항 11

제10항에 있어서,

상기 구리 노듈층 형성 단계는,

상기 메인 구리막 상에 노듈 핵을 생성하기 위한 파우더링(powdering) 공정을 수행하는 단계; 및

상기 노듈 핵을 안정화시키기 위한 캡슐링(capsuling) 공정을 수행하는 단계를 포함하는 것을 특징으로 하는,

전해동박 제조방법.

청구항 12

제11항에 있어서,

상기 파우더링 공정은 20 내지 30 ℃로 유지되는 제1 도금액 내에서 20 내지 50 ASD의 전류밀도로 수행되고,

상기 제1 도금액은 15 내지 35 g/L의 구리 이온, 90 내지 210 g/L의 황산, 0.01 내지 5 g/L의 첨가제를 포함하며,

상기 첨가제는 Ti, V, Cr, Fe, Co, Mo, W, Ni, 또는 이들 중 적어도 1종 또는 2종 이상의 혼합물인 것을 특징으로 하는,

전해동박 제조방법.

청구항 13

제12항에 있어서,

상기 캡슐링 공정은 40 내지 60 ℃로 유지되는 제2 도금액 내에서 5 내지 40 ASD의 전류밀도로 수행되고,

상기 제2 도금액은 40 내지 60 g/L의 구리 이온 및 90 내지 210 g/L의 황산을 포함하는 것을 특징으로 하는,

전해동박 제조방법.

청구항 14

제13항에 있어서,

상기 파우더링 공정과 상기 캡슐링 공정을 번갈아 가면서 각각 2회 이상 수행하는 것을 특징으로 하는,

전해동박 제조방법.

청구항 15

제10항에 있어서,

상기 미세노듈을 형성 단계는 20 내지 30 ℃로 유지되는 제3 도금액 내에서 5 내지 20 ASD의 전류밀도로 수행되고,

상기 제3 도금액은 7 내지 10 g/L의 구리 이온, 14 내지 16 g/L의 니켈 이온, 및 90 내지 210 g/L의 황산을 포함하는 것을 특징으로 하는,

전해동박 제조방법.

청구항 16

제10항에 있어서,

상기 미세노듈층 상에 베리어층을 형성하는 단계를 더 포함하는 것을 특징으로 하는,

전해동박 제조방법.

청구항 17

제16항에 있어서,

상기 베리어층을 형성하는 단계는,

상기 미세노듈층 상에 아연 또는 아연합금을 포함하는 제1 서브 베리어층을 형성하는 단계; 및

상기 제1 서브 베리어층 상에 크롬을 포함하는 제2 서브 베리어층을 형성하는 단계를 포함하는,

전해동박 제조방법.

청구항 18

제17항에 있어서,

상기 제2 서브 베리어층의 표면을 실란 커플링제로 개질하는 단계를 더 포함하는,

전해동박 제조방법.

청구항 19

제1항 내지 제9항 중 어느 한 항의 전해동박; 및

상기 전해동박의 매트면 상의 비전도성 고분자막을 포함하는 것을 특징으로 하는,

연성동박적층필름.

청구항 20

제1항 내지 제9항 중 어느 한 항의 전해동박; 및

상기 전해동박의 매트면 상의 음극 활물질층을 포함하는,

음극.

청구항 21

양극;

제20항의 음극;

상기 양극과 음극 사이에서 리튬 이온이 이동할 수 있는 환경을 제공하는 전해질(electrolyte); 및

상기 양극과 상기 음극을 전기적으로 절연시켜 주는 분리막(separator)을 포함하는 것을 특징으로 하는,

이차전지.

명 세 서

기 술 분 야

[0001] 본 발명은 낮은 표면조도를 갖는 전해동박 및 그 제조방법에 관한 것이며, 또한 전해동박과 비전도성 고분자막 사이의 우수한 박리강도를 갖는 연성동박적층필름, 전해동박과 음극 활물질 사이의 우수한 접착력을 갖는 음극, 및 우수한 충방전 용량유지율을 갖는 이차전지에 관한 것이다.

배 경 기 술

[0002] 노트북 컴퓨터, 휴대폰, PDA, 소형 비디오 카메라 및 전자수첩 등의 전자기기들이 점점 소형화 및 경량화됨에 따라 TAB(Tape Automated Bonding), COF(Chip On Film) 등에 적용될 수 있는 연성인쇄회로기판(Flexible Printed Circuit Board: FPCB)에 대한 수요가 증가하고 있다. 그 결과, FPCB 제조에 이용되는 연성동박적층필름(Flexible Copper Clad Laminate: FCCL)에 대한 수요도 증가하고 있다.

[0003] 연성동박적층필름은 비전도성 고분자막과 동박의 적층체이다. 연성동박적층필름의 동박을 선택적으로 제거하여 상기 비전도성 고분자막 상에 소정의 회로 패턴을 형성함으로써 연성인쇄회로기판이 얻어질 수 있다.

[0004] 회로 패턴을 형성할 때 제거되어야 할 동박 부분이 완전히 제거되지 않고 그 일부가 잔존하게 되면[즉, 잔동(remaining copper)이 존재하면], 회로의 단락이 유발되어 연성인쇄회로기판(FPCB) 자체는 물론이고 그것이 적용되는 전자기기의 수율 및 신뢰성을 저하시킨다.

[0005] 한편, 상기 비전도성 고분자막과 동박 사이의 박리강도가 낮으면, 상기 비전도성 고분자 기재 상에 회로 패턴을 형성하기 위하여 상기 동박을 선택적으로 식각할 때 식각액이 상기 회로 패턴과 비전도성 고분자막 사이로 침투함으로써 상기 회로 패턴이 상기 비전도성 고분자 기재로부터 박리될 위험이 있다.

[0006] 연성동박적층필름은, i) 동박을 제조한 후 코팅 또는 라미네이팅 공정을 통해 상기 동박 상에 비전도성 고분자막을 형성하거나, 또는 ii) 비전도성 고분자막 상에 구리를 증착함으로써 형성될 수 있다. 일반적으로, 비전도성 고분자막과 동박 사이의 박리강도 측면에서, 전자의 방법이 후자의 방법에 비해 더 우수한 연성동박적층필름을 제공할 수 있다.

[0007] 그러나, 전자의 방법에 의해 제조되는 연성동박적층필름이라고 하더라도 비전도성 고분자막과 동박 사이의 박리강도가 만족스러운 수준은 아니다.

[0008] 박리강도를 증가시킬 목적으로, 상기 비전도성 고분자막과 접촉하는 상기 동박의 표면조도(R_z)를 높이는 것을 고려하여 볼 수도 있다. 그러나, 스마트폰과 같은 휴대 전자기기가 소형화됨에 따라 폴리이미드 필름과 같은 비전도성 고분자막의 두께가 감소되어야 하고, 이러한 비전도성 고분자막 두께의 감소는 낮은 표면조도(R_z)(예를 들어 3.0㎛ 이하)를 갖는 동박을 요구한다. 즉, 종래기술에 의하면, 비전도성 고분자막에 대한 동박의 박리강도를 높이면 휴대 전자기기 소형화에 부응할 수 없게 되는 것이다.

[0009] 반대로, 휴대 전자기기의 소형화에 부응하기 위해 동박의 표면조도(R_z)를 낮추면 동박이 비전도성 고분자막으로부터 쉽게 박리되는 문제가 발생한다. 특히, 전자기기가 점점 더 소형화됨에 따라 연성인쇄회로기판(FPCB)이 전자기기 내에서 접히는 각도도 더욱 예리해지면서 회로 패턴의 박리 위험이 커지고 있다. 비전도성 고분자막과 동박 사이의 불충분한 박리강도로 인한 회로 패턴의 박리는 연성인쇄회로기판(FPCB) 자체는 물론이고 그것이 적용되는 전자기기의 수율, 내구성, 및 신뢰성을 저하시킨다.

[0010] 한편, 리튬 이차전지는 음극을 포함하고, 상기 음극은 동박과 그 위에 코팅된 음극활물질을 포함한다. 리튬 이차전지의 충방전이 반복됨에 따라 음극 활물질의 수축 및 팽창이 번갈아 발생하고, 이것은 상기 동박과 음극 활물질의 분리를 유발하여 리튬 이차전지의 충방전 용량 유지율을 저하시킨다. 특히, 동박과 음극 활물질 사이의 접착 강도가 약할수록 리튬 이차전지의 충방전 용량 유지율이 심각하게 저하된다.

발명의 내용

해결하려는 과제

[0011] 따라서, 본 발명은 위와 같은 관련 기술의 제한 및 단점들에 기인한 문제점들을 방지할 수 있는 전해동박, 그 제조방법, 그것을 포함하는 연성동박적층필름, 그것을 포함하는 음극, 및 그것을 포함하는 이차전지에 관한 것이다.

[0012] 본 발명의 일 관점은, 낮은 표면조도를 가지면서도 비전도성 고분자막과 또는 음극 활물질과의 접착력이 우수한 전해동박을 제공하는 것이다.

[0013] 본 발명의 다른 관점은, 낮은 표면조도를 가지면서도 비전도성 고분자막 또는 음극 활물질과의 접착력이 우수한 전해동박을 제조하는 방법을 제공하는 것이다.

[0014] 본 발명의 또 다른 관점은, 전해동박이 낮은 표면조도를 가짐으로써 전자기기의 소형화에 부응할 수 있을 뿐만 아니라 비전도성 고분자막과 전해동박 사이의 박리강도가 우수한 연성동박적층필름을 제공하는 것이다.

[0015] 본 발명의 또 다른 관점은 전해동박과 음극 활물질 사이의 우수한 접착력을 갖는 음극을 제공하는 것이다.

[0016] 본 발명의 또 다른 관점은 우수한 충방전 용량 유지율을 갖는 이차전지를 제공하는 것이다.

[0017] 위에서 언급된 본 발명의 관점들 외에도, 본 발명의 다른 특징 및 이점들이 이하에서 설명되거나, 그러한 설명으로부터 본 발명이 속하는 기술분야에서 통상의 지식을 가진 자에게 명확하게 이해될 수 있을 것이다.

과제의 해결 수단

[0018] 위와 같은 본 발명의 일 관점에 따라, 매트면 및 그 반대편의 샤이니면을 갖는 전해동박으로서, 상기 매트면에 배치된 다수의 노듈들; 및 상기 노듈들 중 적어도 하나의 표면 상에 위치하며 0.2㎛ 이하의 최장직경을 갖는 다수의 미세노듈들 - 여기서, 상기 최장직경은 상기 샤이니면에 평행한 방향의 최대 직경을 의미함 - 를 포함하는 것을 특징으로 하는, 전해동박이 제공된다.

[0019] 상기 미세노듈들은 Cu, Ni, Zn, Fe, Cr, 및 Mo 중 적어도 하나를 포함할 수 있다.

[0020] 상기 매트면의 R_z는 0.8 내지 3 ㎛일 수 있다.

[0021] 상기 미세노듈들은 구상 형태(spherical shape) 또는 침상 형태(needle shape)를 가질 수 있다.

[0022] 상기 전해동박의 두께는 1 내지 70 ㎛일 수 있다.

[0023] 상기 전해동박은, 메인 구리막(copper main film); 상기 메인 구리막 상의 구리 노듈층(copper nodule layer) - 상기 구리 노듈층은 상기 노듈들을 포함함 -; 상기 구리 노듈층 상의 미세노듈층(micro-nodule layer) - 상기 미세노듈층은 상기 미세노듈들을 포함함 -; 및 상기 미세노듈층 상의 베리어층(barrier layer)을 포함할 수 있다.

[0024] 상기 베리어층은, 상기 미세노듈층 상의 제1 서브 베리어층; 및 상기 제1 서브 베리어층 상의 제2 서브 베리어층을 포함할 수 있다.

[0025] 상기 제1 서브 베리어층은 아연 또는 아연합금을 포함할 수 있고, 상기 제2 서브 베리어층은 크롬을 포함할 수 있다.

[0026] 상기 제2 서브 베리어층의 표면은 실란 커플링제로 개질될 수 있다.

[0027] 본 발명의 다른 관점에 따라, 전해도금을 통해 메인 구리막을 형성하는 단계; 상기 메인 구리막 상에 구리 노듈층을 형성하는 단계; 및 0.2㎛ 이하의 최장직경을 갖는 다수의 미세노듈들을 포함하는 미세노듈층을 상기 구리 노듈층 상에 형성하는 단계 - 여기서, 상기 최장직경은 상기 샤이니면에 평행한 방향의 최대 직경을 의미함 - 를 포함하는 것을 특징으로 하는, 전해동박의 제조방법이 제공된다.

[0028] 상기 구리 노듈층 형성 단계는, 상기 메인 구리막 상에 노듈 핵을 생성하기 위한 파우더링(powdering) 공정을 수행하는 단계; 및 상기 노듈 핵을 안정화시키기 위한 캡슐링(capsuling) 공정을 수행하는 단계를 포함할 수 있다.

[0029] 상기 파우더링 공정은 20 내지 30 ℃로 유지되는 제1 도금액 내에서 20 내지 50 ASD의 전류밀도로 수행될 수 있고, 상기 제1 도금액은 15 내지 35 g/L의 구리 이온, 90 내지 210 g/L의 황산, 0.01 내지 5 g/L의 첨가제를 포함할 수 있으며, 상기 첨가제는 Ti, V, Cr, Fe, Co, Mo, W, Ni, 또는 이들 중 적어도 1종 또는 2종 이상의 혼합물일 수 있다.

[0030] 상기 캡슐링 공정은 40 내지 60 ℃로 유지되는 제2 도금액 내에서 5 내지 40 ASD의 전류밀도로 수행될 수 있고, 상기 제2 도금액은 40 내지 60 g/L의 구리 이온 및 90 내지 210 g/L의 황산을 포함할 수 있다.

[0031] 상기 파우더링 공정과 상기 캡슐링 공정을 번갈아 가면서 각각 2회 이상 수행할 수 있다.

[0032] 상기 미세노듈층 형성 단계는 20 내지 30 ℃로 유지되는 제3 도금액 내에서 5 내지 20 ASD의 전류밀도로 수행될 수 있고, 상기 제3 도금액은 7 내지 10 g/L의 구리 이온, 14 내지 16 g/L의 니켈 이온, 및 90 내지 210 g/L의 황산을 포함할 수 있다.

[0033] 본 발명의 방법은 상기 미세노듈층 상에 베리어층을 형성하는 단계를 더 포함할 수 있다.

[0034] 상기 베리어층을 형성하는 단계는, 상기 미세노듈층 상에 아연 또는 아연합금을 포함하는 제1 서브 베리어층을 형성하는 단계; 및 상기 제1 서브 베리어층 상에 크롬을 포함하는 제2 서브 베리어층을 형성하는 단계를 포함할 수 있다.

[0035] 본 발명의 방법은 상기 제2 서브 베리어층의 표면을 실란 커플링제로 개질하는 단계를 더 포함할 수 있다.

[0036] 본 발명의 또 다른 관점에 따라, 상술한 전해동박; 및 상기 전해동박의 매트면 상의 비전도성 고분자막을 포함하는 것을 특징으로 하는, 연성동박적층필름이 제공된다.

[0037] 본 발명의 또 다른 관점에 따라, 상술한 전해동박; 및 상기 전해동박의 매트면 상의 음극 활물질층을 포함하는 것을 특징으로 하는 음극이 제공된다.

[0038] 본 발명의 또 다른 관점에 따라, 상기 음극; 상기 양극과 음극 사이에서 리튬 이온이 이동할 수 있는 환경을 제공하는 전해질(electrolyte); 및 상기 양극과 상기 음극을 전기적으로 절연시켜 주는 분리막(separator)을 포함하는 것을 특징으로 하는, 이차전지가 제공된다.

[0039] 위와 같은 본 발명에 대한 일반적 서술은 본 발명을 예시하거나 설명하기 위한 것일 뿐으로서, 본 발명의 권리범위를 제한하지 않는다.

발명의 효과

[0040] 본 발명에 의하면, 전해동박의 표면조도를 낮게 유지하면서도 전해동박과 비전도성 고분자막 사이의 우수한 박리강도를 확보할 수 있다. 따라서, 본 발명은 전자기기의 소형화에 부응할 수 있을 뿐만 아니라 연성인쇄회로기판(FPCB) 및 그것이 적용된 전자기기의 수율, 내구성, 및 신뢰성이 회로 패턴 박리로 인해 저하되는 것을 방지할 수 있다.

[0041] 또한, 본 발명에 의하면, 회로 패턴 형성을 위하여 연성동박적층필름의 전해동박을 부분적으로 식각할 때 제거되어야 할 구리 부분이 완전히 제거되지 않고 잔동이 유발되는 것을 방지할 수 있다. 따라서, 회로의 단락으로 인한 전자기기의 수율 및 신뢰성 저하를 방지할 수 있다.

[0042] 또한, 본 발명의 전해동박은 음극 활물질과 강하게 접착됨으로써 이차전지의 충방전시 전해동박으로부터 활물질의 분리가 억제될 수 있고, 그 결과, 높은 충방전 용량 유지율을 갖는 이차전지가 제조될 수 있다.

도면의 간단한 설명

[0043] 첨부된 도면은 본 발명의 이해를 돕고 본 명세서의 일부를 구성하기 위한 것으로서, 본 발명의 실시예들을 예시하며, 발명의 상세한 설명과 함께 본 발명의 원리들을 설명한다.

도 1은 본 발명의 전해동박의 개략도이고,

도 2는 본 발명의 일 실시예에 따른 전해동박의 매트면의 SEM 사진이고,

도 3은 종래기술에 따른 전해동박의 매트면의 SEM 사진이고,

도 4는 본 발명의 일 실시예에 따른 전해동박의 단면도이고,

도 5는 본 발명의 일 실시예에 따른 전해동박의 제조장치를 개략적으로 보여주고,

도 6은 본 발명의 일 실시예에 따른 연성동박적층필름의 단면도이며,

도 7은 실시예들 및 비교예들로부터 얻어진 "미세노듈층 형성 공정 중에 가해진 전류밀도에 대한 전해동박의 표면조도(R_z)" 그래프이다.

발명을 실시하기 위한 구체적인 내용

[0044] 이하에서는 첨부된 도면을 참조하여 본 발명의 실시예들을 상세하게 설명한다.

[0045] 본 발명의 기술적 사상 및 범위를 벗어나지 않는 범위 내에서 본 발명의 다양한 변경 및 변형이 가능하다는 점은 당업자에게 자명할 것이다. 따라서, 본 발명은 특허청구범위에 기재된 발명 및 그 균등물의 범위 내에 드는 변경 및 변형을 모두 포함한다.

[0046] 도 1은 본 발명의 전해동박의 개략도이다.

[0047] 도 1에 도시된 바와 같이, 본 발명의 전해동박(100)은 매트면(M) 및 그 반대편의 샤이니면(S)을 갖는다.

[0048] 본 발명의 전해동박(100)의 매트면(M)은 상기 전해동박(100)이 소형 전자기기를 위한 얇은 비전도성 고분자막에 적용될 수 있을 정도로 낮은 표면조도(R_z)(예를 들어 0.8 내지 3.0 ㎛)를 가질 수 있다.

[0049] 본 발명의 일 실시예에 따른 전해동박(100)의 매트면(M)의 SEM 사진인 도 2에 예시된 바와 같이, 본 발명의 전해동박(100)은 상기 매트면(M)에 배치된 다수의 노듈들(N) 및 상기 노듈들(N) 중 적어도 하나의 표면 상에 위치하며 0.2㎛ 이하의 최장직경을 갖는 다수의 미세노듈들(MN)을 포함한다. 상기 미세노듈들(MN)의 최장직경은 상기 전해동박(100) 샤이니면(S)에 평행한 방향의 최대 직경을 의미한다.

[0050] 상기 미세노듈들(MN)의 직경이 0.2㎛를 초과할 경우, 소형 전자기기를 위한 얇은 비전도성 고분자막에 적용될 수 없을 정도로 상기 전해동박(100)의 매트면(M)의 표면조도(R_z)가 급격히 증가하여 3.0 ㎛를 초과하게 되고, 회로 패턴 형성을 위하여 연성동박적층필름의 전해동박(100)을 부분적으로 식각할 때 제거되어야 할 부분의 구리가 완전히 제거되지 않고 일부가 잔존하게 됨으로써(즉, 잔동이 존재하게 됨으로써) 연성인쇄회로기판(FPCB)의 회로 단락을 유발한다. 상기 "표면조도(R_z)"는 10점 평균조도(ten-point mean roughness)를 의미한다.

[0051] 또한, 상기 전해동박(100)이 이차전지의 제조에 이용될 경우, 상기 미세노듈들(MN)의 직경이 0.2㎛를 초과하면 상기 전해동박(100)의 높은 표면조도(R_z)로 인해 음극 활물질이 상기 전해동박(100) 상에 균일하게 코팅될 수 없다. 음극 활물질의 불균일한 코팅은 이차전지의 충방전시 전해동박(100)으로부터 상기 활물질의 부분적 탈리를 야기하여 이차전지의 용량 유지율을 급격히 저하시키고 이차전지의 수명을 단축시킨다.

[0052] 즉, 본 발명의 미세노듈들(MN)은 0.2㎛ 이하의 매우 작은 최장직경을 갖기 때문에 상기 전해동박(100)의 매트면(M)의 표면조도(R_z)에는 거의 영향을 미치지 않으면서도, 비전도성 고분자막/음극 활물질에 대한 상기 전해동박(100)의 접착력 및 박리강도를 현저히 증가시킬 수 있다.

[0053] 이에 반해, 도 3의 SEM 사진에 예시된 바와 같이, 종래기술의 전해동박의 매트면은 노듈들(N)만을 포함하고 본 발명의 미세노듈들(MN)은 포함하지 않기 때문에, 비전도성 고분자막/음극 활물질과 전해동박 사이의 접착력 및 박리강도가 불충분하며, 종래기술의 전해동박으로 제조되는 연성인쇄회로기판(FPCB)은 회로 패턴이 박리될 위험이 크고, 종래기술의 전해동박으로 제조되는 이차전지는 낮은 충방전 용량 유지율 및 짧은 수명을 갖게 된다.

[0054] 0.2㎛ 이하의 최장직경을 갖는 본 발명의 미세노듈들(MN)이 노듈들(N)의 표면 상에 형성될 경우, 미세노듈들을 갖지 않는 종래기술의 전해동박 대비 표면조도 증가량은 5% 이내에 불과한 반면 박리강도 증가량은 30% 이상임이 확인되었다.

[0055] 결과적으로, 본 발명에 의하면, 상기 노듈들(N)에 의해 실질적으로 결정되는 상기 전해동박(100)의 매트면(M)의 표면조도(R_z)는 0.8 내지 3.0 ㎛의 낮은 값으로 유지되면서도, 0.2㎛ 이하의 매우 작은 최장직경을 갖는 상기 미세노듈들(MN) 덕분에 비전도성 고분자막/음극 활물질에 대한 상기 전해동박(100)의 접착력 및 박리강도는 동일한 표면조도(R_z)를 갖는 종래기술의 전해동박 대비 현저히 향상될 수 있다. 본 발명의 일 실시예에 의하면, 상기 노듈들(N)은 불룩이고 상기 미세노듈들(MN)도 구상 형태(spherical shape) 또는 침상 형태(needle shape)를

가질 수 있다. 이러한 형상을 가짐으로써 조도를 높이지 않고 박리강도를 더욱 높일 수 있는 효과를 발휘한다.

[0056] 본 발명의 상기 미세노듈들(MN)은 Cu, Ni, Zn, Fe, Cr, 및 Mo 중 적어도 하나를 포함할 수 있다.

[0057] 본 발명의 일 실시예에 따른 전해동박(100)의 두께는 1 내지 70 ㎛일 수 있다. 상기 전해동박(100)의 두께가 1 ㎛ 미만이면, 상기 전해동박(100)을 이용하여 연성동박적층필름을 제조할 때 상기 연성동박적층필름에 주름이 발생한다. 반면, 상기 전해동박(100)의 두께가 70㎛를 초과하면, 회로 패턴 형성을 위한 에칭 공정을 수행할 때 구리가 선택적으로 제거되어야 할 부분에서 구리가 잔존하게 되는 문제가 발생한다.

[0058] 리튬 이차전지의 음극집전체로 사용되는 전해동박(100)가 두께가 얇을수록 음극 활물질을 두껍게 코팅함으로써 이차전지의 용량을 높일 수 있다. 따라서, 이차전지의 제조에 사용되는 전해동박(100)은 1 내지 20 ㎛의 두께를 갖는 것이 바람직하다. 전해동박(100)의 두께가 1㎛ 미만이면 작업 핸들링성이 좋지 못하여 롤투롤 공정에서 주름 및/또는 찢김이 빈번히 야기된다. 반면, 전해동박(100)의 두께가 20㎛를 초과하면 이차전지의 용량을 높이는데 한계가 있다.

[0059] 이하에서는, 도 4를 참조하여 본 발명의 일 실시예에 따른 전해동박(100)을 구체적으로 설명한다.

[0060] 도 4에 예시된 바와 같이, 본 발명의 일 실시예에 따른 전해동박(100)은 메인 구리막(copper main film)(110), 상기 메인 구리막(110) 상의 구리 노듈층(copper nodule layer)(120), 상기 구리 노듈층 상의 미세노듈층(micro-nodule layer)(130), 및 상기 미세노듈층(130) 상의 베리어층(barrier layer)(140)을 포함한다.

[0061] 상기 메인 구리막(110)은 전기도금을 통해 제조되며, 회전 음극 드럼과 접촉하였던 샤이나면과 그 반대 측의 매트면을 갖는다.

[0062] 상기 메인 구리막(110) 표면처리를 통해 상기 구리 노듈층(120), 미세노듈층(130), 및 베리어층(140)이 상기 메인 구리막(110)의 일면(예를 들어, 매트면) 또는 양면 상에 순차적으로 형성된다.

[0063] 상기 구리 노듈층(120)은 상기 노듈들(N)을 포함하고, 상기 미세노듈층(130)은 상기 미세노듈들(MN)을 포함한다.

[0064] 상기 베리어층(140)이 본 발명의 전해동박(100)의 매트면(M)의 물리적 특성들에 미치는 영향은 극히 미미하다. 따라서, 상기 구리 노듈층(120) 및 미세노듈층(130)을 어떻게 형성하느냐가 전해동박(100)의 최종 물성에 상당한 영향을 미치게 되는데, 상기 구리 노듈층(120) 및 미세노듈층(130)을 형성하는 본 발명의 구체적 방법은 후술한다.

[0065] 한편, 도 4에 예시된 바와 같이, 상기 베리어층(140)은, 상기 미세노듈층(130) 상의 제1 서브 베리어층(141) 및 상기 제1 서브 베리어층(141) 상의 제2 서브 베리어층(142)을 포함할 수 있다.

[0066] 상기 제1 서브 베리어층(141)은 전해동박(100)에 내산화성, 내열성, 및 내화학성을 부여하기 위한 것으로서, 아연(Zn), 아연합금, 니켈(Ni), 철(Fe), 코발트(Co), 바나듐(V), 및 몰리브덴(Mo) 중 적어도 하나를 포함하며, 바람직하게는 3 내지 20 ㎎/㎡의 아연(Zn) 또는 아연합금을 포함한다.

[0067] 상기 제1 서브 베리어층(141)은 0.05 중량% 이하의 불순물을 더 포함할 수 있다. 상기 불순물은 인(P), 황(S), 탄소(C), 산소(O), 및 질소(N) 중 적어도 하나일 수 있다.

[0068] 상기 제2 서브 베리어층(142)은 본 발명의 전해동박(100)을 수 개월 동안 장기 보관할 때 산화가 발생하는 것을 방지하기 위한 것으로서, 크롬(Cr)을 포함할 수 있다.

[0069] 상기 제2 서브 베리어층(142)의 표면은 실란 커플링제로 개질될 수 있다. 즉, 상기 제2 서브 베리어층(142)의 표면은 실란 커플링제와 결합되어 있을 수 있다.

[0070] 이하에서는, 도 5를 참조하여, 본 발명의 일 실시예에 따른 전해동박(100)의 제조방법을 구체적으로 설명한다.

[0071] 먼저, 전해조(10)에 담겨진 전해액(11) 내에 서로 이격되게 배치된 양극판(13) 및 회전 음극드럼(12)을 10 내지 80 ASD의 전류밀도로 통전시킴으로써 상기 회전 음극드럼(12) 상에 구리를 전착(electrodeposit)시켜 메인 구리막(110)을 형성한다. 상기 양극판(13)과 상기 회전 음극드럼(12) 사이의 간격은 8 내지 13 ㎜일 수 있다.

[0072] 상기 전해액(11)은 50 내지 100 g/L의 구리 이온, 50 내지 150 g/L의 황산, 17 내지 23 ppm의 염소 이온, 및 유기 첨가제를 포함한다. 상기 유기 첨가제는 젤리틴(gelatin), 하이드록시에틸 셀룰로오스(HEC), 유기 황화물(예를 들어, SPS), 유기 질화물, 티오요소(thiourea), 또는 이들 중 2 이상의 혼합물일 수 있다.

[0073] 상기 메인 구리막(110) 형성 단계 중에, 상기 전해액(11)은 40 내지 60 ℃로 유지될 수 있고, 상기 전해조(10)로 공급되는 상기 전해액(11)의 유량은 30 내지 50 mF/hour일 수 있다. 상기 전해조(10)로 공급되는 전해액(11)의 유량 편차는 2% 이내로 조절되는 것이 바람직하다.

[0074] 전류밀도, 전해액의 조성 및 조성비 등을 조절함으로써 메인 구리막(110)의 매트면의 조도를 제어할 수 있다.

[0075] 한편, 메인 구리막(110)의 샤이니면의 조도는 회전 음극드럼(12)의 표면의 연마 정도에 의존한다. 본 발명의 일 실시예에 의하면, #800 내지 #1500의 입도(Grit)를 갖는 연마 브러시로 상기 회전 음극드럼(12)의 표면이 연마된다.

[0076] 이어서, 전해도금을 통해 제조된 메인 구리막(110) 상에 구리 노듈층(120)과 미세노듈층(130)을 순차적으로 형성하기 위한 표면처리가 수행된다. 본 발명의 방법은 상기 미세노듈층(130) 상에 베리어층(140)을 형성하는 단계를 더 포함할 수 있다.

[0077] 상기 구리 노듈층(120)은 파우더링(powdering) 공정 및 캡슐링(capsuling) 공정을 순차적으로 수행함으로써 형성될 수 있다.

[0078] 상기 파우더링 공정은 비전도성 고분자막과의 밀착력 향상을 위하여 상기 메인 구리막(110) 상에 노듈 핵을 생성하기 위한 공정으로서, 20 내지 30 ℃로 유지되는 제1 도금액 내에서 20 내지 50 ASD의 전류밀도로 수행될 수 있다. 상기 제1 도금액은 15 내지 35 g/L의 구리 이온, 90 내지 210 g/L의 황산, 0.01 내지 5 g/L의 첨가제를 포함할 수 있으며, 상기 첨가제는 Ti, V, Cr, Fe, Co, Mo, W, Ni, 또는 이들 중 적어도 1종 또는 2종 이상의 혼합물일 수 있다.

[0079] 상기 캡슐링 공정은 상기 파우더링 공정을 통해 형성된 노듈 핵을 안정화시키기 위한 공정으로서, 40 내지 60 ℃로 유지되는 제2 도금액 내에서 5 내지 40 ASD의 전류밀도로 수행될 수 있다. 상기 제2 도금액은 40 내지 60 g/L의 구리 이온 및 90 내지 210 g/L의 황산을 포함할 수 있다. 상기 캡슐링 공정을 통해 구리가 균일하게 석출됨으로써 상기 노듈 핵이 더욱 성장하거나 상기 노듈 핵의 탈락이 방지될 수 있다.

[0080] 도 5에 예시된 바와 같이, 상기 파우더링 공정과 상기 캡슐링 공정은 메인 구리막(110)이 제1 및 제2 구리 도금조들(20, 30)을 순차적으로 통과함으로써 수행될 수 있다. 이때, 상기 제1 구리 도금조(20)에는 파우더링 공정을 위한 상기 제1 도금액이 들어 있고, 상기 제2 도금조(30)에는 캡슐링 공정을 위한 상기 제2 도금액이 들어 있다.

[0081] 선택적으로, 상기 파우더링 공정과 상기 캡슐링 공정을 번갈아 가면서 각각 2회 이상 수행할 수 있다.

[0082] 한편, 상기 메인 구리막(110) 상에 상기 구리 노듈층(120)을 형성하기 전에, 상기 메인 구리막(110)의 표면 상의 불순물(예를 들어, 수지 성분) 및 자연 산화막(natural oxide)을 제거하기 위한 산세(acid cleaning) 및 상기 산세에 사용된 산성 용액 제거를 위한 수세(water cleaning)를 순차적으로 수행할 수 있다. 산세 공정을 위한 산성 용액으로서, 염산 용액, 황산 용액, 황산-과산화수소 용액, 또는 이들 중 적어도 2 이상의 혼합물이 사용될 수 있다. 산성 용액의 농도 및 온도는 생산라인의 특성에 따라 조정될 수 있다.

[0083] 이어서, 상기 제1 및 제2 구리 도금조들(20, 30)을 순차적으로 통과한 상기 메인 구리막(110)이 제3 도금액이 담겨 있는 제3 구리 도금조(40)를 통과하도록 함으로써, 0.2㎛ 이하의 최장직경을 갖는 다수의 미세노듈들을 포함하는 미세노듈층(130)을 상기 구리 노듈층(120) 상에 형성한다. 전술한 바와 같이, 상기 최장직경은 상기 샤이니면에 평행한 방향의 최대 직경을 의미한다.

[0084] 상기 제3 도금액은 20 내지 30 ℃로 유지될 수 있으며, 7 내지 10 g/L의 구리 이온, 14 내지 16 g/L의 니켈 이온, 및 90 내지 210 g/L의 황산을 포함할 수 있다.

[0085] 상기 미세노듈층(130) 형성 단계는 5 내지 20 ASD의 전류밀도로 수행될 수 있다. 5 ASD 미만의 전류밀도가 가해지면 미세노듈들(MN)이 거의 생성되지 않기 때문에 비전도성 고분자막/음극 활물질과의 접착력 및 박리강도의 충분한 향상을 기대할 수 없다. 반면, 20 ASD를 초과하는 전류밀도가 가해지면 미세노듈들(MN)이 과도하게 성장하여 그 최장직경이 0.2㎛를 초과하게 된다.

[0086] 전술한 바와 같이, 미세노듈들(MN)의 직경이 0.2㎛를 초과할 경우, 소형 전자기기를 위한 얇은 비전도성 고분자막에 적용될 수 없을 정도로 상기 전해동박(100)의 표면조도(Rz)가 급격히 증가하여 3.0 ㎛를 초과하게 되고, 회로 패턴 형성을 위하여 전해동박(100)을 부분적으로 식각할 때 잔동이 유발되어 연성인쇄회로기판(FPCB)의 회로 단락이 야기된다. 또한, 이차전지의 경우, 상기 전해동박(100)에 음극 활물질이 불균일하게 코팅됨에 따라

이차전지의 충방전시 활물질이 상기 전해동박(100)으로부터 부분적으로 분리되어 이차전지의 용량 유지율이 급격히 떨어지게 되고 이차전지의 수명이 단축되게 된다.

[0087] 이어서, 상기 미세노듈층(130) 상에 베리어층(140)을 형성한다.

[0088] 본 발명의 일 실시예에 의하면, 상기 베리어층(140)을 형성하는 단계는, 상기 미세노듈층(130) 상에 아연(Zn) 또는 아연합금을 포함하는 제1 서브 베리어층(141)을 형성하는 단계 및 상기 제1 서브 베리어층(141) 상에 크롬(Cr)을 포함하는 제2 서브 베리어층(142)을 형성하는 단계를 포함할 수 있다.

[0089] 전술한 바와 같이, 상기 제1 서브 베리어층(141)은 전해동박(100)에 내산화성, 내열성, 및 내화학성을 부여하기 위한 것으로서, 본 발명의 일 실시예에 따른 제1 서브 베리어층(141)은 아연 또는 아연 합금을 포함하지만, 본 발명이 이에 한정되는 것은 아니며, 니켈(Ni), 철(Fe), 코발트(Co), 바나듐(V), 및 몰리브덴(Mo) 등을 포함할 수도 있다.

[0090] 상기 제2 서브 베리어층(142)은 전해동박(100)을 수 개월 동안 장기 보관할 때 부식이 발생하는 것을 방지하기 위한 것이다.

[0091] 도 5에 예시된 바와 같이, 상기 미세노듈층(130)이 형성되어 있는 메인 구리박(110)이 아연 도금조(50) 및 크롬 도금조(60)를 순차적으로 통과함으로써 상기 제1 및 제2 서브 베리어층들(141, 142)이 순차적으로 형성될 수 있다.

[0092] 상기 아연 도금조(50)의 도금액은 1 내지 5 g/L의 아연 이온을 포함하고, 30 내지 45℃로 유지될 수 있다. 선택적으로, 상기 아연 도금조(50)에 담겨 있는 도금액은 아연 외에 인(P), 황(S), 탄소(C), 산소(O), 및 질소(N) 중 적어도 하나를 불순물로서 더 포함할 수 있다. 상기 아연 도금조(50)에서의 도금은 1 내지 5 ASD의 전류밀도로 수행될 수 있다.

[0093] 상기 크롬 도금조(60)의 도금액은 1 내지 5 g/L의 크롬산을 포함하고, 10 내지 12의 pH를 가지며, 20 내지 40℃로 유지될 수 있다. 또한, 0.5 내지 4 ASD의 전류밀도로 도금이 수행될 수 있다.

[0094] 상기 제2 서브 베리어층(142)를 형성한 후, 건조 공정을 수행한 후 전해동박(100)를 와인더(WB)에 권취한다.

[0095] 한편, 비록 도 5에 도시되지는 않았지만, 본 발명의 전해동박의 제조방법은, 상기 건조 공정 후에, 상기 제2 서브 베리어층(142)의 표면(M)을 실란 커플링제로 개질하는 단계를 더 포함할 수 있다. 상기 실란 커플링제는 올레핀기, 에폭시기, 아미노기, 또는 메르캅토기(mercapto group)를 갖는 실란일 수 있다. 상기 실란 커플링제를 이용한 표면 개질은 침지법, 샤워링법, 분무법 등의 방법을 통해 수행될 수 있다. 실란 커플링제를 이용한 표면 개질은, 연성동박적층필름을 제조할 때, 상기 전해동박(100)과 비전도성 고분자막 사이의 접착력을 강화시킨다.

[0096] 한편, 이차전지용 전해동박을 위한 표면처리 공정은 연성동박적층필름용 전해동박과는 다를 수 있다. 일반적으로 이차전지용 전해동박으로 사용하기 위해서는 제박 후에 크로메이트 또는 전해크롬 또는 실란커플링 또는 BTA(벤탠트리아졸) 중에 한 가지로 방청처리를 행하지만, 본 발명을 통해 기존 이차전지용 전해동박보다 더 우수한 성능을 가지는 전해동박으로 만들기 위해서는 제박 후에 미세노듈 처리를 해주게 되는데 연성동박적층필름용 전해동박과 달리 제박 후에 파우더링 공정과 캡슐링 공정은 전류를 흘리지 않고 도금조 내에서 전해동박을 통과만 시킨후 미세노듈 처리시에만 전류를 흘려서 미세노듈을 만들어 준다. 이때 매트면 뿐만 아니라 샤이니면도 미세노듈 처리를 위해 도금조내에 전극을 설치하여 전류를 인가해줌으로써 매트과 샤이니면 모두 동시에 미세노듈을 만들어 주는 것이 가능하다. 즉 생산성 측면에서도 이차전지용과 연성동박적층필름용 중에 어떤 용도로든 전류인가 여부만으로도 쉽게 제작이 가능하다. 또한 이차전지용의 경우 미세노듈 처리 후에 제2 서브 베리어 처리를 해줌으로써 방청성을 부여해준다.

[0097] 이하에서는, 도 6을 참조하여 본 발명의 연성동박적층필름(FCCL)을 구체적으로 설명한다.

[0098] 도 6에 예시된 바와 같이, 본 발명의 연성동박적층필름은 매트면 및 그 반대편의 샤이니면을 갖는 전해동박(100) 및 상기 전해동박(100)의 매트면 상의 비전도성 고분자막(200)을 포함한다.

[0099] 전술한 바와 같이, 상기 전해동박(100)은 상기 매트면에 배치된 다수의 노듈들(N) 및 상기 노듈들(N) 중 적어도 하나의 표면 상에 위치하며 0.2㎛ 이하의 최장직경을 갖는 다수의 미세노듈들(MN)을 포함한다. 상기 매트면의 R_z는 0.8 내지 3 ㎛일 수 있다.

[0100] 본 발명의 일 실시예에 의하면, 상기 전해동박(100)의 두께는 1 내지 70 ㎛일 수 있다.

[0101] 도 6에 예시된 바와 같이, 상기 전해동박(100)은 메인 구리막(110), 상기 메인 구리막(110) 상의 구리 노듈층(120), 상기 구리 노듈층(120) 상의 미세노듈층(130), 및 상기 미세노듈층(130) 상의 베리어층 (140)을 포함한다.

[0102] 상기 베리어층(140)은, 상기 미세노듈층(130) 상의 제1 서브 베리어층(141) 및 상기 제1 서브 베리어층(141) 상의 제2 서브 베리어층(142)을 포함할 수 있다. 상기 제1 서브 베리어층(141)은 전해동박(100)에 내산화성, 내열성, 및 내화학성을 부여하기 위한 것으로서, 아연(Zn), 아연합금, 니켈(Ni), 철(Fe), 코발트(Co), 바나듐(V), 및 몰리브덴(Mo) 중 적어도 하나를 포함하며, 바람직하게는 3 내지 20 ㎎/㎡의 아연(Zn) 또는 아연합금을 포함한다. 상기 제2 서브 베리어층(142)은 본 발명의 전해동박(100)을 수 개월 등안 장기 보관할 때 부식이 발생하는 것을 방지하기 위한 것으로서, 크롬(Cr)을 포함할 수 있다. 상기 비전도성 고분자막(200)과 접촉하는 상기 제2 서브 베리어층(142)의 표면은 실란 커플링제로 개질될 수 있다.

[0103] 본 발명의 바람직한 실시예에 의하면, 상기 비전도성 고분자막(200)은 폴리이미드를 포함할 수 있으며, 롤 프레스(Roll Press)를 통해 폴리이미드 필름을 상기 전해동박(100) 상에 라미네이팅함으로써 형성되거나, 폴리이미드 전구체 용액을 예를 들어 나이프 코팅법을 이용하여 상기 전해동박(100) 상에 코팅한 후 열처리를 수행함으로써 형성될 수 있다.

[0105] 이하에서는, 실시예들 및 비교예들을 통해 본 발명을 구체적으로 설명한다. 다만, 하기의 실시예들은 본 발명의 이해를 돕가 위한 것일 뿐으로, 본 발명의 권리범위가 이들 실시예들로 제한되지 않는다.

[0107] 실시예 1

[0108] 전해조에 담겨진 전해액(주성분: 황산구리, 첨가제: 젤라틴, HEC, SPS) 내에 10㎜의 간격을 두고 이격되게 배치된 양극판 및 회전 음극드럼을 50 ASD의 전류밀도로 통전시킴으로써 상기 회전 음극드럼 상에 구리를 전착(electrodeposit)시켰고, 그 결과, 메인 구리막이 형성되었다.

[0109] 이어서, 상기 메인 구리막이 제1 및 제2 구리 도금조들을 순차적으로 통과함으로써 상기 메인 구리막 상에 다수의 노듈들이 형성되었다.

[0110] 상기 제1 구리 도금조에는 파우더링 공정을 위한 제1 도금액이 담겨 있었다. 상기 제1 도금액은 25℃로 유지되었고, 20 g/L의 구리 이온, 150 g/L의 황산, 및 첨가제로서 300ppm의 몰리브덴(Mo)을 포함하였다. 상기 파우더링 공정을 위해 적용된 전류밀도는 30 ASD이었다.

[0111] 상기 제2 구리 도금조에는 캡슐링 공정을 위한 제2 도금액이 담겨 있었다. 상기 제2 도금액은 40 g/L의 구리 이온 및 100 g/L의 황산을 포함하였고, 40℃로 유지되었다. 상기 캡슐링 공정을 위해 적용된 전류밀도는 10 ASD이었다.

[0112] 이어서, 노듈들이 형성된 메인 구리막이 제3 구리 도금조 내의 제3 도금액을 통과함으로써 상기 노듈들의 표면 상에 다수의 미세노듈들을 형성하였다. 상기 제3 도금액은 8 g/L의 구리 이온, 15 g/L의 니켈 이온, 및 150 g/L의 황산을 포함하였고, 25 ℃로 유지되었다. 미세노듈 형성을 위해 적용된 전류밀도는 5 ASD이었다.

[0113] 이어서, 상기 미세노듈들이 형성된 메인 구리막이 제1 서브 베리어층 형성을 위한 아연 도금조, 및 제2 서브 베리어층 형성을 위한 크롬 도금조를 순차적으로 통과함으로써 18㎛ 두께의 전해동박이 완성되었다.

[0114] 실시예 2

[0115] 미세노듈 형성을 위해 적용된 전류밀도가 10 ASD이었다는 것을 제외하고는 상기 실시예 1과 동일한 방법으로 전해동박을 제조하였다.

[0116] 실시예 3

[0117] 미세노듈 형성을 위해 적용된 전류밀도가 15 ASD이었다는 것을 제외하고는 상기 실시예 1과 동일한 방법으로 전해동박을 제조하였다.

[0118] 실시예 4

[0119] 미세노듈 형성을 위해 적용된 전류밀도가 20 ASD이었다는 것을 제외하고는 상기 실시예 1과 동일한 방법으로 전

해동박을 제조하였다.

[0120] 비교예 1

[0121] 미세노듈 형성 공정을 생략하였다는 것을 제외하고는 상기 실시예 1과 동일한 방법으로 전해동박을 제조하였다.

[0122] 비교예 2

[0123] 미세노듈 형성을 위해 적용된 전류밀도가 3 ASD이었다는 것을 제외하고는 상기 실시예 1과 동일한 방법으로 전해동박을 제조하였다.

[0124] 비교예 3

[0125] 미세노듈 형성을 위해 적용된 전류밀도가 25 ASD이었다는 것을 제외하고는 상기 실시예 1과 동일한 방법으로 전해동박을 제조하였다.

[0127] 위와 같이 제조된 실시예들 및 비교예들의 전해동박들의 (i) 미세노듈 여부 및 그 직경, (ii) 표면조도(R_z), (iii) 폴리이미드 필름에 대한 박리강도, (iv) 잔동 유무, 및 (v) 실시예들과 비교예들의 전해동박들로 제조된 음극을 포함하는 이차전지의 용량 유지율을 아래의 방법들에 의해 각각 측정하였고, 그 결과를 표 1에 나타내었다.

[0128] * 미세노듈 존재 여부 및 그 최장직경

[0129] 주사전자현미경으로 45° 틸트(tilt)한 후 20,000×의 배율에서 전해동박의 매트면을 관찰함으로써 미세노듈들의 존재 여부를 확인하고 및 그 최장직경을 측정하였다.

[0130] * 표면조도(R_z)

[0131] JIS B 0601-1994 규격에 따라 접촉식 표면조도 측정기(미쯔도요社의 SJ-210)를 사용하여 전해동박의 매트면의 R_z를 측정하였다.

[0132] * 박리강도 및 잔동 유무

[0133] 전해동박의 매트면 상에 폴리아믹산 용액(polyamic acid solution)을 코팅한 후 열경화를 통한 이미드화를 수행함으로써 전해동박과 폴리이미드 필름의 적층체 샘플을 제작하였다. 이 샘플에 대하여 JIS C 6481 규격에 따라 전해동박과 폴리이미드 필름 사이의 박리강도를 측정하였다. 이어서, 박리강도 측정 후 폴리이미드 필름 표면에 노듈이 남아있는 지의 여부를 광학현미경으로 관찰함으로써 잔동 유무를 확인하였다.

[0134] * 이차전지의 용량 유지율(%)

[0135] 먼저, 실시예 1-4 및 비교예 1-3의 전해동박들로 음극을 제조하였다. 구체적으로, 음극 활물질용으로 시판되는 카본 100 중량부에 SBR(스티렌부타디엔 고무) 2 중량부 및 CMC(카르복시메틸 셀룰로오스) 2 중량부를 혼합하였다. 이어서, 이 혼합물에 용제인 증류수를 첨가함으로써 슬러리를 제조하였다. 닥터 블레이드를 이용해 상기 슬러리를 약 60㎛ 두께로 전해동박(폭: 10cm) 표면 상에 도포하고 120℃에서 건조시킨 후 롤프레싱 공정(압력: 1 ton/cm²)을 수행함으로써 음극을 제조하였다.

[0136] 리튬망간산화물($Li_{1.2}Mn_{1.8}Al_{0.2}O_4$)과 orthorhombic 결정구조의 리튬망간산화물(o-$LiMnO_2$)을 90:10의 중량비로 혼합하여 양극 활물질을 제조하였다. 상기 양극 활물질, 카본블랙, 및 폴리비닐리덴플루오라이드(PVDF)를 85:10:5의 중량비로 유기용매인 NMP와 혼합하여 슬러리를 제조하였다. 상기 슬러리를 두께 20㎛의 알루미늄 호일의 양면에 도포한 후 건조시킴으로써 양극을 제조하였다.

[0137] 또한, 에틸렌카보네이트(EC) 및 에틸메틸카보네이트(EMC)를 1:2의 중량비로 혼합한 비수성 유기용매에 용질로서 $LiPF_6$를 1M 용해시킨 것을 기본 전해액으로 하고, 이 기본 전해액 99.5 중량%와 숙신산 무수물(succinic anhydride) 0.5 중량%를 혼합하여 전해액을 제조하였다.

[0138] 이와 같이 제조된 음극, 양극, 및 전해액으로 이차전지를 제조하였다.

[0139] 이어서, 이와 같이 제조된 이차전지에 대하여, 4.3V의 충전작동전압 및 3.4V의 방전작동전압으로 양극의 g당 용량을 측정하였고, 50 ℃에서 0.2 C의 충/방전 속도로 50회의 충/방전 실험을 수행하였으며, 이차전지의 용량 유지율을 아래의 식 1에 따라 산출하였다. (참고로, 업계에서 요구되는 이차전지의 50회 충방전 후 용량 유지율은

90% 이상이다.)

[0140] [식 1]

[0141] 용량 유지율(%) = (50회 충방전 후 용량/1회 충방전 후 용량)×100

표 1

[0142]

	미세노듈 형성 공정 수행 여부	미세노듈 형성시 가해진 전류밀도(ASD)	미세노듈 존재 여부	최대 미세노듈 최장직경 (㎛)	R_a (㎛)	박리강도 (kgf/cm)	잔동 유무	용량 유지율 (%)
실시예1	○	5	○	0.11	2.65	0.80	×	91
실시예2	○	10	○	0.14	2.66	0.79	×	91
실시예3	○	15	○	0.16	2.68	0.81	×	93
실시예4	○	20	○	0.18	2.69	0.82	×	92
비교예1	×	-	×	-	2.60	0.50	×	82
비교예2	○	3	×	-	2.61	0.51	×	85
비교예3	○	25	○	0.25	3.10	0.82	○	91

[0143] 위 표 1로부터 알 수 있는 바와 같이, 미세노듈이 형성된 실시예 1-4의 전해동박들은 미세노듈 형성 공정이 수행되지 않은 경우(비교예 1)에 비해 표면조도(R_a) 상승이 미미하였던 반면, 폴리이미드 필름에 대한 박리강도는 월등히 향상되었음을 알 수 있다.한편, 미세노듈 형성 공정시 가해진 전류밀도가 5 ASD 미만이었던 비교예 2의 경우에는 미세노듈이 형성되지 않아 전해동박의 폴리이미드 필름에 대한 박리강도 상승이 거의 관찰되지 않았다.

[0144] 반면, 미세노듈 형성 공정시 가해진 전류밀도가 25 ASD 미만이었던 비교예 3의 경우에는 미세노듈들이 과도하게 성장하여 최장직경이 0.2㎛를 초과하는 미세노듈들이 관찰되었고, 전해동박의 표면조도(R_a)가 3.0 ㎛를 초과할 정도로 급격히 증가하여 소형 전자기기를 위한 얇은 비전도성 고분자막에 적용될 수 없을 정도에 이르렀다. 또한, 비교예 3의 경우 박리강도 실험 후 잔동이 관찰되었는데, 이러한 잔동은 전술한 바와 같이 연성인쇄회로기판(FPCB)의 회로 단락을 야기한다.

[0145] 한편, 미세노듈이 형성된 실시예 1-4 및 비교예 3의 전해동박들로 제조된 리튬 이차전지는 50회 충방전 후 90% 이상의 우수한 용량 유지율을 나타낸 반면, 미세노듈이 형성되지 않은 비교예 1 및 2의 전해동박들로 제조된 리튬 이차전지는 50회 충방전 후 90% 미만의 낮은 용량 유지율을 나타내었다. 따라서, 미세노듈이 전해동박과 음극 활물질의 밀착력을 향상시킴으로써 이차전지의 충방전시 활물질의 탈리가 억제됨을 알 수 있다.

[0146] 도 7은 실시예 1-4 및 비교예 2-3로부터 얻어진 "미세노듈층 형성 공정 중에 가해진 전류밀도에 대한 전해동박의 표면조도(R_a)" 그래프이다. 도 7의 그래프로부터, 미세노듈 형성 공정시 가해지는 전류밀도가 20 ASD를 초과할 때 전해동박의 표면조도(R_a)가 급격히 증가함을 알 수 있다.

부호의 설명

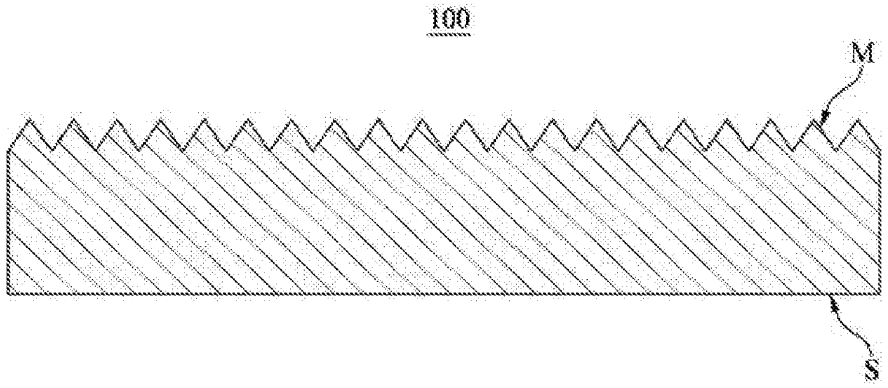
[0147] 100: 전해동박 110: 메인 구리막

120: 구리 노듈층 130: 미세노듈층

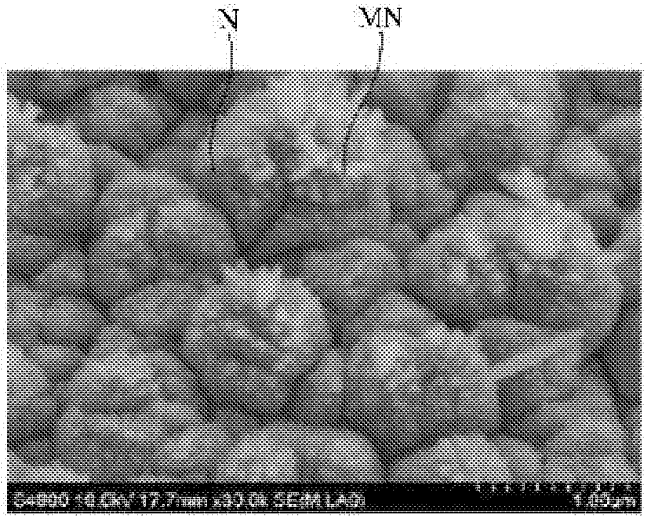
140: 베리어층 200: 비전도성 고분자막

도면

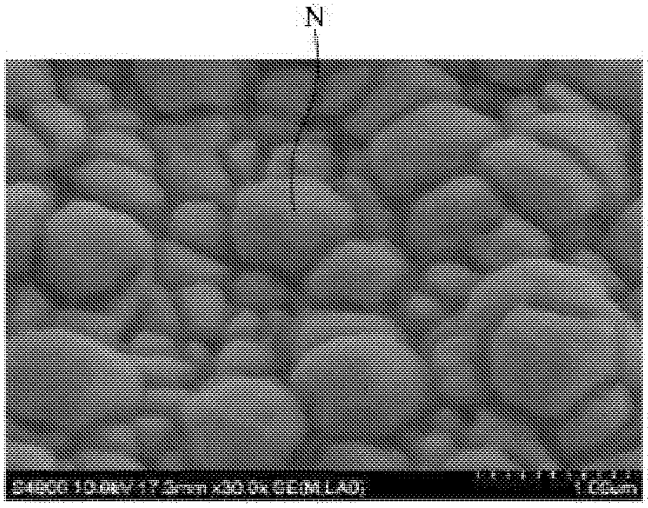
도면1



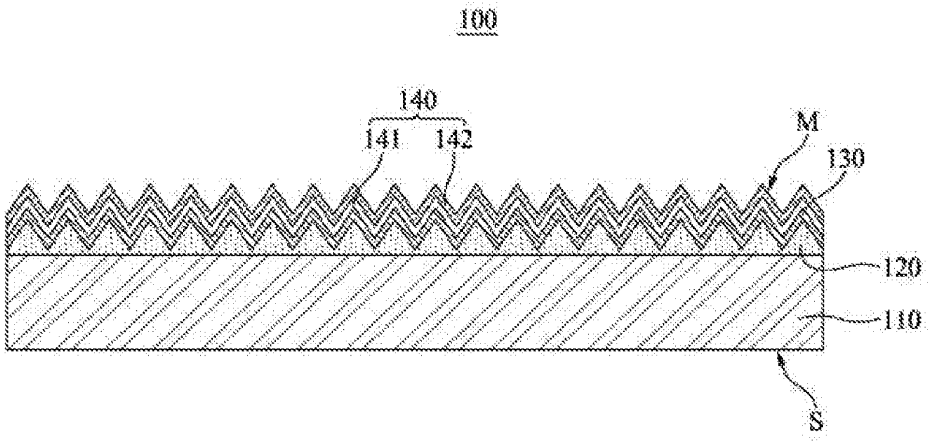
도면2



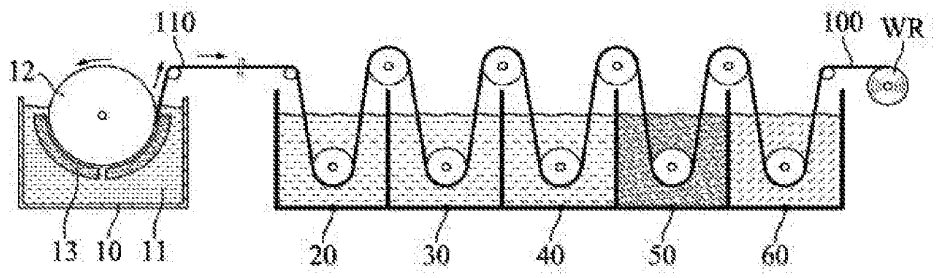
도면3



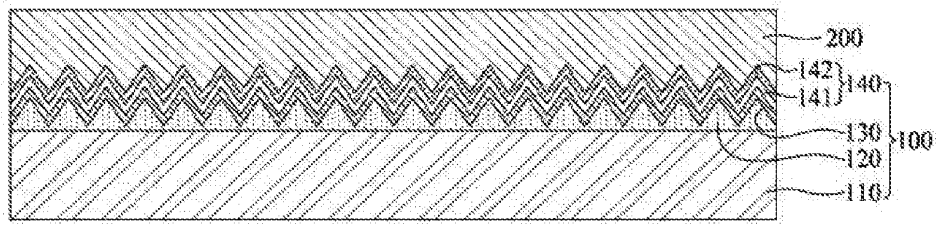
도면4



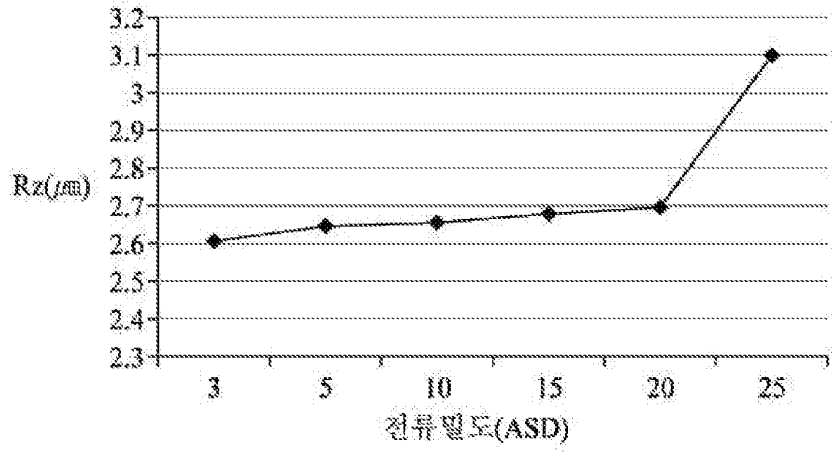
도면5


110
12
100
WR
13
10
11
20
30
40
50
60

도면6


200
142
141
140
130
120
110
100

도면7


3.2
3.1
3
2.9
2.8
2.7
2.6
2.5
2.4
2.3
Rz(㎛)
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전류밀도(ASD)

Espacenet

Bibliographic data: TWI533496 (B) — 2016-05-11

Electrolytic copper foil

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Applicant(s): CHANG CHUN PETROCHEMICAL CO [TW] ± (CHANG CHUN PETROCHEMICAL CO., LTD)

Classification: - international: *H01M4/64*
- cooperative: C25C1/12 (KR); C25D3/38 (EP, US); C25D7/0614 (EP, US); H01M10/0525 (EP, KR, US); H01M10/0562 (EP, US); H01M4/661 (KR); H01M4/745 (KR); Y10T428/12431 (EP, US)

Application number: TW20130140840 20131111

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Abstract of TW201505243 (A)

An electrolytic copper foil has an opposed luster surface and a rough surface with a surface roughness below 2 [mu]m. Also, use the total sum of the texture coefficient of the (111), (200), (220) and (311) surface of the electrolytic copper foil as a reference, the sum of the texture coefficient of the (220) and the (311) surface is 60% or above, so it is particularly suitable for the applications of the lithium ion secondary battery.

I533496

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(56)參考文獻：

TW 200403358A CN 101364645A

審查人員：李明達

申請專利範圍項數：10 項 圖式數：0 共 19 頁

(54)名稱

電解銅箔

(57)摘要

一種電解銅箔，係具有相對的光澤面及粗糙度為 2μm 以下的粗糙面，且以該電解銅箔之(111)面、(200)面、(220)面以及(311)面的織構係數之總合為基準，該電解銅箔在(220)面與(311)面的織構係數之和係佔 60%以上，特別適用於鋰離子二次電池之應用。

I533496

公告本

發明摘要

※申請案號：102140840

※申請日：102. 11. 11　　※IPC分類：

H01M 4/64 (2006.01)

【發明名稱】(中文/英文)

電解銅箔

【中文】

一種電解銅箔，係具有相對的光澤面及粗糙度爲 2 μm 以下的粗糙面，且以該電解銅箔之(111)面、(200)面、(220)面以及(311)面的織構係數之總合爲基準，該電解銅箔在(220)面與(311)面的織構係數之和係佔 60%以上，特別適用於鋰離子二次電池之應用。

【英文】無。

【代表圖】

【本案指定代表圖】：無。

【本代表圖之符號簡單說明】：無。

本案無圖式。

【本案若有化學式時，請揭示最能顯示發明特徵的化學式】：

無。

發明專利說明書

（本說明書格式、順序，請勿任意更動）

【發明名稱】（中文/英文）

電解銅箔

【技術領域】

本發明係關於一種電解銅箔，更詳而言，係關於一種適用於充放電電池之電解銅箔。

【先前技術】

近年環保意識抬頭，用完即丟的一次電池漸漸爲高性能二次電池所取代，並廣泛的運用於消費性電子產品、儲能系統等產業。

隨著汽車工業的發展，對於鋰離子二次電池的需求亦與日俱增，除了鋰離子二次電池必須有良好充放電性能外，更顧及安全性及電池壽命。而未來鋰離子二次電池的發展趨勢係朝向電能儲存系統用之儲能電池，爲了使鋰離子二次電池達到系統規模的要求以符合儲能技術的發展趨勢，不僅該鋰離子二次電池的電容量要求需要達到MW/MWh級規模能力，手機規格的鋰離子二次電池循環壽命應達到2000次級以上，系統規格的鋰離子二次電池的循環壽命應達到6000次級以上。

鋰離子二次電池之結構，係將正極極片、隔離膜及負極極片捲繞在一起，將其置入容器，注入電解液並密封成電池。其中，負極極片係由以銅箔構成之負極集電體與塗佈於其表面之以碳材等作爲材料之負極活性物質所構成，

第 102140840 號專利申請案
104 年 4 月 13 日修正替換頁

銅箔可以是壓延銅箔或電解銅箔。又，電解銅箔是以硫酸及硫酸銅所組成之水溶液作爲電解液，以鈦元素或其氧化物被覆的鈦板做爲陽極(dimensionally stable anode, DSA)，以鈦製輥筒做爲陰極輪(Drum)，於兩極間通以直流電，使電解液中的銅離子電解析出在鈦製輥筒上，接著將析出的電解銅自鈦製輥筒表面剝離並連續收捲進行製造，其中，電解銅箔與鈦製輥筒表面接觸的面稱做「光澤面(S 面)」，而將其反面稱做「粗糙面(M 面)」。通常，電解銅箔 S 面的粗糙度取決於鈦製輥筒表面的粗糙度，因此 S 面之粗糙度較爲固定，而 M 面的粗糙度則可藉由硫酸銅電解液條件的調整來加以控制。

因此，爲了降低電解銅箔 M 面的粗糙度，習知電解銅箔係於硫酸銅電解液中加入小分子量膠(如動物膠(gelatin))、羥乙基纖維素(hydroxyethyl cellulose，HEC)或聚乙二醇(polyethylene glycol，PEG)等有機添加劑及添加具有細晶化效果的 3-巯基-1-丙烷磺酸鈉(sodium 3-mercaptopropane Sulphonate，MPS)、聚二硫丙烷磺酸鈉(bis-(3-soldiumsulfopropyl disulfide，SPS)等含硫的化合物，藉此改變電解銅箔的晶相。

習知方法，例如第 10-2010-0125044 號韓國專利製得之電解銅箔之晶相，係以所得之電解銅箔之(111)面、(200)面以及(220)面的織構係數(texture coefficient，TC)之總合爲基準，該電解銅箔在(111)面及(200)面的織構係數之和係佔 60 至 85%，且該電解銅箔在(111)面及(200)面的織構係數分別係

佔 18 至 38%及 28 至 62%，以得到 M 面粗糙度較低之細晶粒結構之電解銅箔，俾適用於鋰離子二次電池。

因此，傳統上係認爲當電解銅箔之(111)面及(200)面之織構係數較高時，則該電解銅箔之晶粒較小，M面粗糙度較低，且該電解銅箔之抗張強度會較高，伸長率則會較低。反之，當電解銅箔之(111)面及(200)面之織構係數較低時，及/或電解銅箔之(220)面及(311)面之織構係數較高時，則該電解銅箔之晶粒較大，M面粗糙度較高。

由前可知，以習知方法所製得之電解銅箔，期望電解銅箔的(111)面及(200)面的織構係數較高，使 M 面粗糙度較低，提升電容量。但相對地，電解銅箔就容易因膨脹收縮而斷裂，而犧牲電池的壽命。

因此，亟需開發一種保有較低的 M 面粗糙度，且可提升電池循環壽命之適用於鋰離子二次電池之電解銅箔。

【發明內容】

本發明提供一種電解銅箔，其具有相對之光澤面及粗糙度爲 2 μm 以下之粗糙面，且以該電解銅箔之(111)面、(200)面、(220)面以及(311)面的織構係數之總合爲基準，該電解銅箔在(220)面與(311)面的織構係數之和係佔 60%以上。

於一具體實施例中，以該電解銅箔之(111)面、(200)面、(220)面以及(311)面的織構係數之總合爲基準，該電解銅箔在(220)面與(311)面的織構係數之和係佔 70%以上。

於一具體實施例中，前述電解銅箔在(311)面之織構係

數係大於 1。

於一具體實施例中，前述電解銅箔具有相對之光澤面及粗糙面，且該光澤面之粗糙度爲 2 μm 以下。

於一具體實施例中，前述電解銅箔具有相對之光澤面及粗糙面，且該光澤面及粗糙面之粗糙度差爲 0.5 μm 以下。於前述具體實施例中，該光澤面及粗糙面之粗糙度差爲 0.4 μm 以下。

此外，前述電解銅箔之重量電阻率係小於 0.2 Ω g/m^2。

於又一具體實施例中，前述電解銅箔在(111)面之織構係數係小於 1，且該電解銅箔在(200)面之織構係數係小於 1。

在一具體實施例中，前述電解銅箔具有 9%以上的伸長率，更佳係具有 14%以上的伸長率。

再者，本發明之電解銅箔在(220)面與(311)面具有較突出之晶相特徵，不僅使電解銅箔之伸長率可達 14%以上，更發現具有此晶相特徵之電解銅箔，改變傳統產品粗糙度過高而不適合用於鋰離子二次電池之問題，本發明之電解銅箔粗糙面粗糙度係 2 μm 以下，俾使光澤面與粗糙面之粗糙度差較小，特別適合做爲鋰離子二次電池用之電解銅箔。

此外，本發明之電解銅箔之重量電阻率係小於 0.2 Ω g/m^2，具有較佳之充放電效能。

由此可知，本發明之電解銅箔具有完全不同的晶相結構，在雙面之粗糙度皆低且兩面之粗糙度相差極小之情況

下，因而在循環充放電時就不易產生裂紋或斷裂，進而延長電池的壽命。

【圖式簡單說明】

無。

【實施方式】

以下係藉由特定之具體實施例進一步說明本發明之實施方式，熟習此技藝之人士可由本說明書所揭示之內容瞭解本發明之其他優點與功效。本發明以厚度爲 6 至 10 μm 的電解銅箔作爲實施例，如下所示，但本發明並不限於這些實施例。

同時，本說明書中所述之「不含」係意指含量低於 1.2 ppm 或 0。

本發明電解銅箔之製備，是以硫酸及硫酸銅所組成之水溶液作爲電解液，以鈦製輥筒做爲陰極輪(Drum)，於陽極和陰極之間通以直流電，使電解液中的銅離子電解析出在陰極輪上，以形成電解銅箔，接著將析出的電解銅箔自陰極輪表面剝離並連續收捲進行製造。在本發明中，電解銅箔與陰極輪表面接觸的面稱做「光澤面(S 面)」，而將其反面稱做「粗糙面(M 面)」。

雖然，傳統上，習慣於硫酸銅電解液中加入小分子量膠(如動物膠(gelatin))、羥乙基纖維素(hydroxyethyl cellulose，HEC)或聚乙二醇(polyethylene glycol，PEG)等有機添加劑及 3-巰基-1-丙烷磺酸鈉(sodium 3-mercaptopropane Sulphonate，MPS)、聚二硫丙烷磺酸鈉

(bis-(3-soldiumsulfopropyl disulfide，SPS)等含硫的化合物。但本發明發現在硫酸銅電解液中加入酸變性聚乙烯醇，例如羧酸變性聚乙烯醇、磺酸變性聚乙烯醇、磷酸變性聚乙烯醇，得到意料不到的結果。所得之電解銅箔以該電解銅箔之(111)面、(200)面、(220)面以及(311)面的織構係數之總合爲基準，該電解銅箔在(220)面與(311)面的織構係數之和係佔 60%以上。在非限制性的實施例中，所得電解銅箔以該電解銅箔的(111)面、(200)面、(220)面以及(311)面的織構係數的總合爲基準，該電解銅箔在(220)面與(311)面的織構係數的和占 60%至 90%。此外，伸長率可獲大幅提升，例如大於 14%，甚至 15%，電解銅箔之粗糙面粗糙度爲 2 μm以下。

再者，電解銅箔在(311)面之織構係數係大於 1，甚至大於 2，或高達 2.5。並可同時令該光澤面及粗糙面之粗糙度差爲 0.5μm以下，較佳地爲 0.4 μm以下，甚至達 0.14μm。

此外，本發明可簡化電解液之組成，可在不添加羥乙基纖維素及/或聚乙二醇的情況下，得到優異結果，又本發明之電解銅箔於製造過程中，電解液不含乙烯硫脲。

實施例

實施例 1　本發明之電解銅箔的製備

將銅線以 50 wt%之硫酸水溶液溶解，製得包含 320 g/l之硫酸銅($CuSO_4.5H_2O$)與 100 g/l 之硫酸之硫酸銅電解液，並於每升硫酸銅電解液添加 5 毫克(mg)之磺酸變性聚乙烯

醇(TA-02F；長春石油化學公司)及 1.2 毫克之 3-巯基-1-丙烷磺酸鈉(MPS；HOPAX 公司)。

接著於液溫 50℃，電流密度爲 50 A/dm^2 製備厚度爲 10μm 之電解銅箔。並測量本發明之電解銅箔之粗糙度、抗張強度、伸長率及重量電阻率，並以 X-ray 繞射測量實施例 1 製得之電解銅箔之晶相結構，計算其織構係數，並將結果記錄於表 3。

實施例 2 至 4　本發明之電解銅箔的製備

重複實施例 1 之步驟，但實施例 2 至 4 中添加的磺酸變性聚乙烯醇及小分子量膠(DV；Nippi 公司)的添加量係如表 1 所示。

電解銅箔之測試結果記錄於表 3。

實施例 5 及 6　本發明的電解銅箔的製備

重複實施例 1 的步驟，但實施例 5 及 6 製備的電解銅箔是適用於手機的厚度爲 6μm，且實施例 5 及 6 中添加的磺酸變性聚乙烯醇及小分子量膠(DV；Nippi 公司)的添加量如表 1 所示。

電解銅箔的測試結果記錄於表 4。

表 1

	實施例 2	實施例 3	實施例 4	實施例 5	實施例 6
酸變性聚乙烯醇	1.5 mg	3 mg	5 mg	1.5 mg	3 mg
小分子量膠	3.5 mg	1.5 mg	0.8 mg	3.5 mg	1.5 mg

比較例

比較例 1　電解銅箔的製備

將銅線以 50 wt%之硫酸水溶液溶解製得，包含 320 g/l 之硫酸銅($CuSO_4.5H_2O$)與 100 g/l 之硫酸之硫酸銅電解液，並於每升硫酸銅電解液添加 1.5 毫克(mg)之羥乙基纖維素(LC-400；DAICEL 公司)、3.5 毫克之小分子量膠(DV；Nippi 公司)及 1.2 毫克之 3-巰基-1-丙烷磺酸鈉(MPS；HOPAX 公司)。

接著於液溫 50℃，電流密度爲 50 A/dm^2 製備厚度爲 10μm 之電解銅箔。並測量電解銅箔之粗糙度、抗張強度、伸長率及重量電阻率，並以 X-ray 繞射測量電解銅箔之晶相結構，計算其織構係數，並將結果記錄於表 3。

比較例 2　電解銅箔的製備

重複比較例 1 之步驟，但改於每升硫酸銅電解液添加 1.5mg 之聚乙二醇(PEG2000；東聯化學公司)，以取代羥乙基纖維素。

電解銅箔之測試結果記錄於表 3

比較例 3　電解銅箔的製備

重複比較例 1 之步驟，但羥乙基纖維素之添加量改爲於每升硫酸銅電解液添加 5 mg。

電解銅箔之測試結果記錄於表 3

比較例 4　電解銅箔的製備

重複比較例 1 之步驟，但不添加羥乙基纖維素，且小分子量膠之添加量改爲於每升硫酸銅電解液添加 10 mg 且 3-巯基-1-丙烷磺酸鈉之添加量改爲 3.2 mg。

電解銅箔之測試結果記錄於表 3

比較例 5　電解銅箔的製備

重複比較例 1 之步驟，但不添加羥乙基纖維素及 3-巯基-1-丙烷磺酸鈉，且小分子量膠之添加量改爲於每升硫酸銅電解液添加 0.5 mg。

電解銅箔之測試結果記錄於表 3

比較例 6　電解銅箔的製備

重複比較例 1 的步驟，但比較例 6 製備的電解銅箔的厚度爲 6μm。

電解銅箔的測試結果記錄於表 4。

測試例

分別將上述實施例 1 至 6 及比較例 1 至 6 所製得之電解銅箔裁取成合適大小之測試樣片，進行抗張強度、伸長率、粗糙度及重量電阻率之量測，並以 X-ray 繞射測量實施例 1 至 6 及比較例 1 至 6 製得之電解銅箔之晶相結構，並計算其織構係數。測試例所使用之檢測方法詳述如下：

抗張強度：

依據 IPC-TM-650 方法，使用 SHIMADZU CORPORATION 公司製造之 AG-I 型拉力試驗機，於室溫(約 25℃)下，將電解銅箔裁取爲長 100mm×寬 12.7mm 之試片，以夾頭(chuck)距離爲 50mm，拉伸速度(crosshead speed)爲 50 mm/min 條件下進行測量。

伸長率：

係於室溫(約 25℃)下，依據 IPC-TM-650 方法，使用 SHIMADZU CORPORATION 公司製造之 AG-I 型拉力試驗機，將電解銅箔裁取爲長 100mm×寬 12.7mm 之試片，以夾頭距離爲 50mm，拉伸速度爲 50 mm/min 條件下進行測量。

粗糙度(十點平均粗糙度，Rz)測試：

使用 α 型表面粗糙度計(Kosaka Laboratory 公司；型號 SE1700)以 IPC-TM-650 方法進行量測。

重量電阻率之測試：

依據 IPC-TM-650 2.5.14 方法，將電解銅箔裁取爲長 70cm×寬 3cm 之試片，以夾頭距離爲 50cm 條件下，以惠司同電橋(Wheatstone bridge)進行測量。

織構係數(texture coefficient，TC)：

使用 PANalytical 公司製造的 PW3040 型 X 光粉末繞射分析儀，於 45kV 的外加電壓下、電流爲 40mA、掃描解析度爲 0.04°且掃描範圍(2θ)爲 40°至 95°之條件下進行分析。並以下式(I)計算各試片的織構係數。

$$TC(hkl) = \frac{I(hkl) / I_0(hkl)}{(1/n)\Sigma I(hkl) / I_0(hkl)}$$

式(I)

其中，式(I)中，TC(hkl)爲(hkl)晶面的織構係數，TC 值越大，表明該晶面擇優取向(preferred orientation)程度越高；I(hkl)係表示所分析的試片之(hkl)晶面繞射強度，I_0(hkl)係美國材料試驗協會(American Society of Testing Materials，ASTM)之標準銅粉末(hkl)晶面的繞射強度(PDF#040836)；以及 n 爲特定繞射角度(2θ)範圍內繞射峰的數量。

電池充放電之測試：

鋰離子二次電池之製備

將如表 2 所述之正極材料以 N-甲基吡咯烷酮(1-Methyl-2-pyrrolidone；NMP)做爲溶劑，固液比爲 195 wt%(100 克正極材料：195 克 NMP)製得正極漿料。將如表 2 所述之負極材料以水做爲溶劑，固液比爲 73 wt%(100 克負極材料：73 克水) 製得負極漿料。

接著，將正極漿料塗佈於鋁箔；並分別將該負極漿料塗佈於前述實施例 1 至 6 及比較例 1 至 6 所製得之電解銅箔上，將溶劑蒸發後，做成正極及負極極片。

在組裝成電池前，先將負極極片使用 140℃的烘箱烘 5 小時，可以將碳材表面的水份去除，之後將正極極片、隔離膜(Celgard 公司)及負極極片捲繞在一起，將其置入容器，注入電解液並密封成電池，電池之規格，係使用一般圓筒型之 18650 型。

電解液，係於體積比爲 1：2 的碳酸乙烯酯(ethylene carbonate；EC)及碳酸甲乙酯(ethyl methyl carbonate)混合液中添加 1M 之六氟磷酸鋰($LiPF_6$)及 2wt% 之碳酸亞乙烯酯(vinylene carbonate；VC)，並對利用實施例 1 至 6 及比較例 1 至 6 之電解銅箔所製得之鋰離子二次電池進行充放電之測試。

表 2

正極材料配方：	以正極材料總重計
正極活性物質($LiFePO_4$)	83 wt%
助導劑(片狀石墨；KS6)	5 wt%
助導劑(導電碳粉；Super P)	2 wt%
油性黏著劑(PVDF1300)	10 wt%
負極材料配方：	以負極材料總重計
負極活性物質(MGPA)	95 wt%
助導劑(導電碳粉；Super P)	1 wt%
增黏劑(CMC)	1.6 wt%
水性黏著劑(SBR)	2.4 wt%

充放電測試：

將利用實施例1至4及比較例1至5之電解銅箔所製得之鋰離子二次電池反覆充放電實施6000次，然後將鋰離子二次電池拆解，觀察銅箔是否有產生裂痕。將利用實施例5至6及比較例6的電解銅箔所製得的鋰離子二次電池反覆充放電實施2000次，然後將鋰離子二次電池拆解，觀察銅箔是否有產生裂痕。其中，充電係以CCCV(定電流定電壓)模式，充電電壓爲3.75V，充電電流爲1C來進行。放電則以CC(定電流)模式，放電電壓爲2.8V，放電電流爲1C來進行，電池充放電測試於室溫(25℃)下進行。

表 3：電解銅箔特性量測結果

	實施例 1	實施例 2	實施例 3	實施例 4	比較例 1	比較例 2	比較例 3	比較例 4	比較例 5
抗張強度 (kg/mm^2)	31.9	31.6	31.4	31.6	33.4	32.3	31.3	31.1	38.6
伸長率 (%)	15.4	14.2	15.1	15.6	9.5	9.8	10.1	8.2	10.6
S 面粗糙度 Rz (μ m)	1.73	1.86	1.75	1.68	1.72	1.76	1.72	1.70	1.76
M 面粗糙度 Rz (μ m)	1.56	1.50	1.49	1.54	1.56	1.62	1.58	1.49	2.42
S 面與 M 面粗糙度 Rz 差(μ m)	0.17	0.36	0.26	0.14	0.16	0.14	0.14	0.21	0.66
重量電阻率(Ω g/m^2)	0.154	0.156	0.154	0.155	0.163	0.162	0.160	0.161	0.155
TC(111)	0.23	0.62	0.33	0.32	1.03	0.98	0.91	1.01	0.30
TC(200)	0.23	0.58	0.30	0.33	1.85	1.51	1.66	1.63	0.18
TC(220)	1.04	1.08	1.07	1.06	0.82	0.72	0.77	0.70	3.20
TC(311)	2.50	1.72	2.30	2.29	0.30	0.79	0.66	0.66	0.32
TC(220)+TC(311)佔 TC(total)%	89	70	84	84	28	38	36	34	88
充放電測試後銅箔是否產生裂痕	無	無	無	無	有	有	有	有	有

表 4：電解銅箔特性量測結果

	實施例 5	實施例 6	比較例 6
抗張強度(kg/mm^2)	33.7	33.5	34.5
伸長率(%)	9.4	9.7	6.2
S 面粗糙度 Rz(μm)	1.85	1.77	1.74
M 面粗糙度 Rz(μm)	1.55	1.54	1.58
S 面與 M 面粗糙度 Rz 差(μm)	0.30	0.23	0.16
重量電阻率(Ω g/m^2)	0.157	0.156	0.163
TC(111)	0.84	0.71	1.04
TC(200)	0.71	0.66	1.87
TC(220)	1.09	1.09	0.80
TC(311)	1.36	1.54	0.29
TC(220)+TC(311)占 TC(total)%	61	66	27
充放電測試後銅箔是否產生裂痕	無	無	有

傳統上係認爲電解銅箔之(220)面及(311)面之織構係數較高，則該電解銅箔之晶粒較大，M 面粗糙度較高，如比較例 5 所示。但由表 3 及表 4 結果所示，本發明之電解銅箔在(220)面及(311)面所佔的織構係數較高的情況下，卻可使 M 面粗糙度變小，在粗糙度差異小之情況下，兩面的

碳材塗佈均勻，可以提升電池的循環充放電壽命。

此外，如表 3 及 4 所示，本發明的電解銅箔具有相對較高的伸長率及較低的重量電阻率，對於 6μm 厚的電解銅箔應滿足的 2000 次的電池的充放電，經過 2000 次的電池的充放電測試後，仍不會產生裂痕的優點，對於 10μm 厚的電解銅箔應滿足的 6000 次的電池的充放電，可經過 6000 次的電池的充放電測試後亦不會產生裂痕的優點，如表 3 所示。

綜上可知，本發明之電解銅箔具有完全不同的晶相結構，在雙面之粗糙度皆低且兩面之粗糙度相差極小之情況下，因而在循環充放電時就不易產生裂紋或斷裂，進而延長電池的壽命。

上述實施例僅例示說明本發明之原理及其功效，而非用於限制本發明。任何熟習此項技藝之人士均可在不違背本發明之精神及範疇下，對上述實施例進行修飾與改變。因此，本發明之權利保護範圍，應如後述之申請專利範圍所列，在不影響本發明所能產生之功效及所能達成之目的下，均應仍落在本發明所揭示之技術內容得能涵蓋之範圍內。

【符號說明】

無。

申請專利範圍

1. 一種電解銅箔，其具有相對之光澤面及粗糙度爲 2 μm 以下之粗糙面，且以該電解銅箔之(111)面、(200)面、(220)面以及(311)面的織構係數之總合爲基準，該電解銅箔在(220)面與(311)面的織構係數之和係佔 60%以上。
2. 如申請專利範圍第 1 項所述之電解銅箔，其中，該電解銅箔在(311)面之織構係數係大於 1。
3. 如申請專利範圍第 1 項所述之電解銅箔，其中，該光澤面之粗糙度爲 2 μm 以下。
4. 如申請專利範圍第 1 項所述之電解銅箔，其中，該光澤面及粗糙面之粗糙度差爲 0.5 μm 以下。
5. 如申請專利範圍第 4 項所述之電解銅箔，其中，該光澤面及粗糙面之粗糙度差爲 0.4 μm 以下。
6. 如申請專利範圍第 1 項所述之電解銅箔，其中，該電解銅箔之重量電阻率係小於 0.2 $\Omega g/m^2$。
7. 如申請專利範圍第 1 項所述之電解銅箔，其中，該電解銅箔在(111)面之織構係數係小於 1。
8. 如申請專利範圍第 1 或 7 項所述之電解銅箔，其中，該電解銅箔在(200)面之織構係數係小於 1。
9. 如申請專利範圍第 1 項所述之電解銅箔，其中，該電解銅箔具有 9%以上的伸長率。
10. 如申請專利範圍第 1 項所述之電解銅箔，其中，該電解銅箔具有 14%以上的伸長率。

FIG. 1

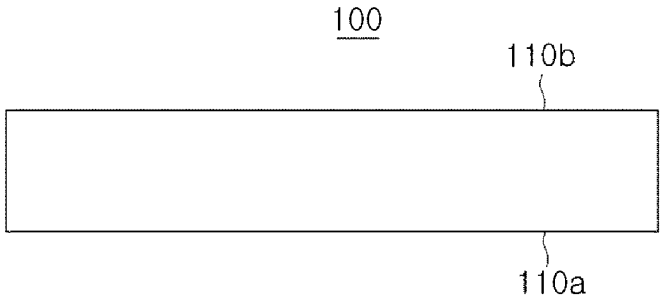


FIG. 2

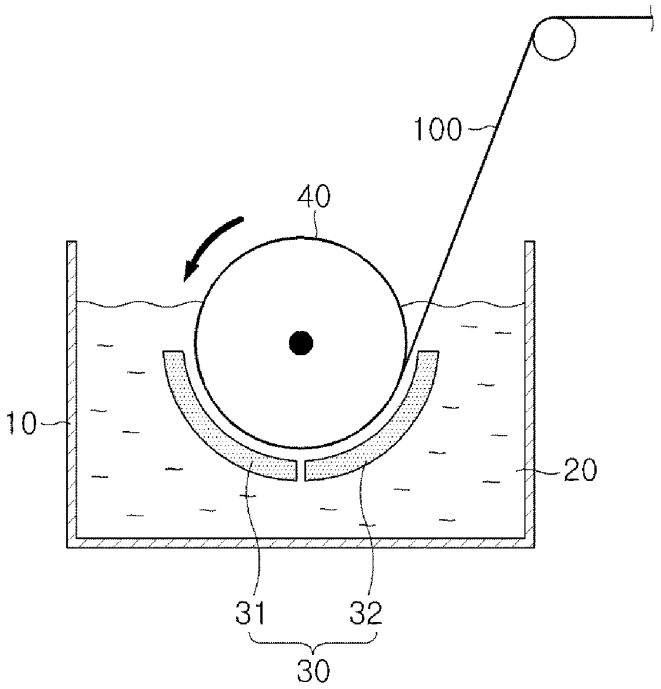


FIG. 3

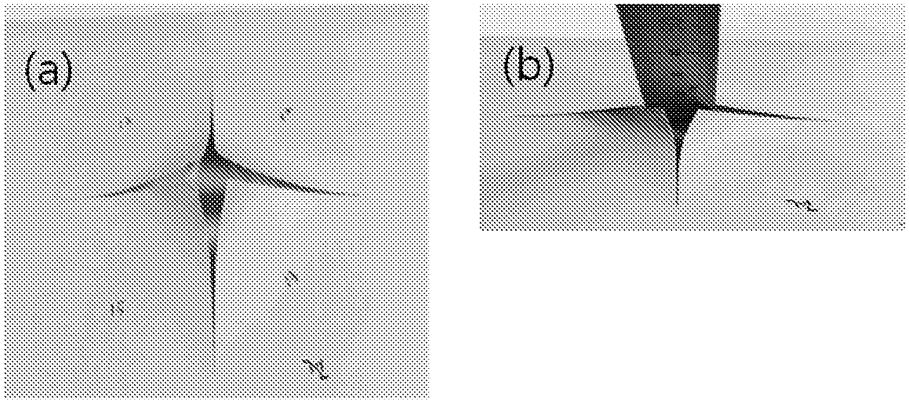
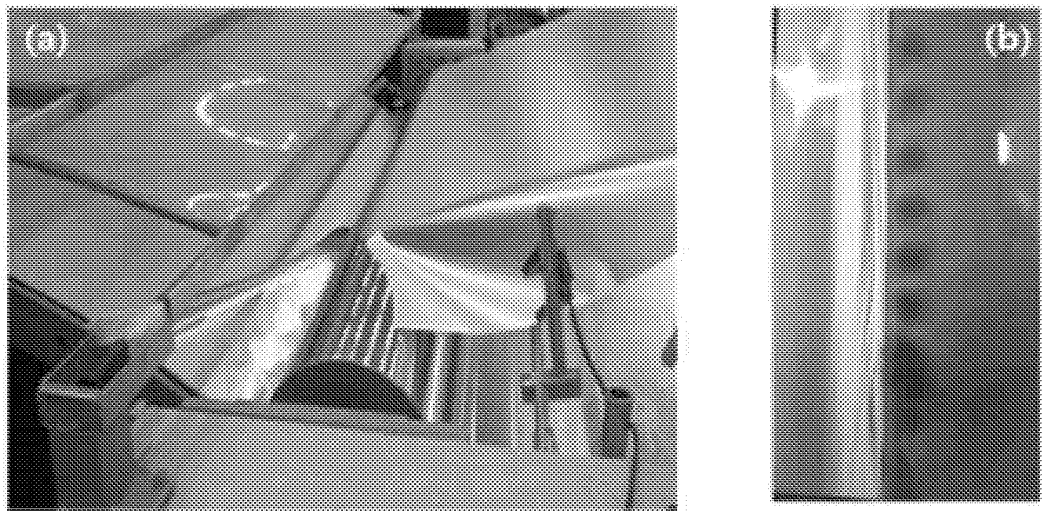


FIG. 4



ABSTRACT OF THE DISCLOSURE

The present invention relates to an electrolytic copper foil having excellent handling characteristics in the manufacture of copper foil and in post-processing for manufacturing a secondary battery. The present invention provides an electrolytic copper foil having a first surface and a second surface, wherein the texture coefficient of the (220) plane of the electrolytic copper foil is 0.4-1.32, the difference (|Δ(Rz/Ra)|) between Rz/Ra on the first surface and Rz/Ra on the second surface, of the electrolytic copper foil, is less than 2.42, and the difference (|ΔPD|) in peak density (PD) between the first surface and the second surface, of the electrolytic copper foil, is 96 ea or less.

WHAT IS CLAIMED IS:

1. An electrolytic copper foil having a first surface and a second surface, wherein

a texture coefficient of (220) plane of the electrolytic copper foil defined by Equation 1 below is 0.4 to 1.32,

(Equation 1)

$$TC(220) = \frac{\frac{I(220)}{I_0(220)}}{\frac{1}{n}\sum\frac{I(hkl)}{I_0(hkl)}}$$

a difference (|Δ(Rz/Ra)|) between Rz/Ra at the first surface of the electrolytic copper foil and Rz/Ra at the second surface of the electrolytic copper foil is less than 2.42, and

a difference (|ΔPD|) between a peak density (PD) at the first surface of the electrolytic copper foil and a peak density (PD) at the second surface of the electrolytic copper foil is 96 ea or less.

2. The electrolytic copper foil according to claim 1, wherein

the second surface is an M surface, and

Rz/Ra at the second surface is 4.2 to 9.0.

3. The electrolytic copper foil according to claim 2, wherein

the first surface is an S surface, and

Rz/Ra at the S surface of the electrolytic copper foil is 5.1 to 6.8.

4. The electrolytic copper foil according to claim 1, wherein the electrolytic copper foil has a tensile strength, measured at room temperature, of 30 to 65 kgf/mm^2.

5. The electrolytic copper foil according to claim 1, wherein the electrolytic copper foil has an elongation, measured at room temperature, of 3 % or more.

6. The electrolytic copper foil according to claim 1, wherein the electrolytic copper foil has a lateral weight deviation of 5 % or less.

7. The electrolytic copper foil according to claim 1, wherein an arithmetic mean of measured heights of corners of four protruding incision portions of the electrolytic copper foil, formed by incising electrolytic copper foil in a form of a cross having a size of 8 cm x 8 cm so as to be vertically divided into two parts, is less than 10 mm.

8. A method of manufacturing an electrolytic copper foil by applying electric current between a positive electrode plate and a rotary negative electrode drum, disposed in an electrolytic solution in an electrolytic bath so as to be spaced apart from each other, in order to electroplate a copper film on the rotary negative electrode drum, the method comprising:

buffing a surface of the rotary negative electrode drum using a brush having a grit of 500# to 3000#;

electrodepositing a copper film on the buffed rotary negative electrode drum; and

winding the electrodeposited copper film, wherein

the electrolytic solution comprises 70 to 90 g/L of copper ions, 80 to 120 g/L of sulfuric acid, 10 to 20 ppm of chlorine ions, 3 to 12 ppm of a sulfide-based compound, 25 to 50 ppm of molybdenum (Mo), and 5 to 25 ppm of polyethylene glycol (PEG).

9. The method according to claim 8, wherein the sulfide-based compound is selected from a group consisting of bis-(sodium sulfopropyl) disulfide (SPS), 3-mercapto 1-propane sulfonate (MPS), and 3-(benzothiazolyl-2-mercapto)-propyl-sulfonate (ZPS).

10. The method according to claim 8, wherein the sulfide-based compound is SPS.

ELECTROLYTIC COPPER FOIL HAVING EXCELLENT HANDLING CHARACTERISTICS IN POSTPROCESSING, AND MANUFACTURING METHOD THEREFOR

BACKGROUND

Technical Field

[1] The present disclosure relates to an electrolytic copper foil, and more particularly to an electrolytic copper foil exhibiting excellent handling characteristics in a process of manufacturing a copper foil and a subsequent process of manufacturing a secondary battery.

Description of the Related Art

[2] With increased use of portable electronic devices, such as mobile phones and laptop computers, and the propagation of hybrid electric vehicles, the demand for lithium secondary batteries has abruptly increased.

[3] In a lithium secondary battery, an electrolytic copper foil is mainly used for the material of a negative electrode current collector. The electrolytic copper foil is manufactured through a foil manufacturing process using an electroplating method. In the case in which production conditions are not precisely controlled at the time of manufacturing the electrolytic copper foil, a large number of curls, wrinkles, or tears, which are caused when a thin film is manufactured, may occur. Such defects of copper

foil products are a prime cause of increased manufacturing costs at the time of producing copper foils. In addition, curls and wrinkles are a prime cause of the deterioration of the quality of lithium secondary batteries and of the increase in total quality-control expenses.

[4] Conventionally, the range of roughness of a copper foil is controlled to be uniform in order to reduce the incidence of defects of the copper foil products. As a copper foil having a thickness of 10 μm or less is increasingly used as a negative electrode current collector for a lithium secondary battery in order to increase the capacity of the lithium secondary battery, however, curls, wrinkles, or tears still occur even though the roughness of the copper foil is precisely controlled.

[5] [Related art document]

[6] 1. Korean Patent Application No. 10-2015-62228

BRIEF SUMMARY

[7] Therefore, the present disclosure relates to an electrolytic copper foil that is capable of preventing problems resulting from limitations and shortcomings of the related art described above and a method of manufacturing the same.

[8] It is an object of the present disclosure to provide an electrolytic copper foil configured such that

the possibility of the electrolytic copper foil being curled, wrinkled, and/or torn is reduced in a process of manufacturing the electrolytic copper foil and/or a subsequent process of manufacturing a secondary battery.

[9] It is another object of the present disclosure to provide a method of manufacturing an electrolytic copper foil configured such that the possibility of the electrolytic copper foil being curled, wrinkled, and/or torn is reduced in a process of manufacturing the electrolytic copper foil and/or a subsequent process of manufacturing a secondary battery.

[10] In accordance with an aspect of the present disclosure, the above and other objects can be accomplished by the provision of an electrolytic copper foil having a first surface and a second surface, wherein the texture coefficient of (220) plane of the electrolytic copper foil defined by Equation 1 below is 0.4 to 1.32,

(Equation 1)

$$TC(220) = \frac{\frac{I(220)}{I_0(220)}}{\frac{1}{n}\sum\frac{I(hkl)}{I_0(hkl)}}$$

the difference (|Δ(Rz/Ra)|) between Rz/Ra at the first surface of the electrolytic copper foil and Rz/Ra at the second surface of the electrolytic copper foil is less than 2.42, and the difference (|ΔPD|) between the peak

density (PD) at the first surface of the electrolytic copper foil and the peak density (PD) at the second surface of the electrolytic copper foil is 96 ea or less.

[11] The second surface may be an M surface, and Rz/Ra at the second surface may be 4.2 to 9.0. In addition, the first surface may be an S surface, and Rz/Ra at the S surface of the electrolytic copper foil may be 5.1 to 6.8.

[12] In accordance with another aspect of the present disclosure, there is provided a method of manufacturing an electrolytic copper foil by applying electric current between a positive electrode plate and a rotary negative electrode drum, disposed in an electrolytic solution in an electrolytic bath so as to be spaced apart from each other, in order to electroplate a copper film on the rotary negative electrode drum, the method including buffing the surface of the rotary negative electrode drum using a brush having a grit of 500# to 3000#, electrodepositing a copper film on the buffed rotary negative electrode drum, and winding the electrodeposited copper film, wherein the electrolytic solution includes 70 to 90 g/L of copper ions, 80 to 120 g/L of sulfuric acid, 10 to 20 ppm of chlorine ions, 3 to 12 ppm of a sulfide-based compound, 25 to 50 ppm of molybdenum (Mo), and 5 to 25 ppm of polyethylene glycol (PEG).

[13] The sulfide-based compound may be selected from

the group consisting of bis-(sodium sulfopropyl) disulfide (SPS), 3-mercapto 1-propane sulfonate (MPS), and 3-(benzothiazolyl-2-mercapto)-propyl-sulfonate (ZPS). The sulfide-based compound may be SPS.

BRIEF DESCRIPTION OF THE SEVERAL VIEWS OF THE DRAWINGS

[14] The above and other objects, features and other advantages of the present disclosure will be more clearly understood from the following detailed description taken in conjunction with the accompanying drawings, in which:

[15] FIG. 1 is a sectional view schematically showing an electrolytic copper foil according to an embodiment of the present disclosure;

[16] FIG. 2 is a view schematically showing an apparatus for manufacturing the electrolytic copper foil according to the present disclosure;

[17] FIG. 3 is a photograph showing a method of measuring the value of a curl in an embodiment of the present disclosure; and

[18] FIGS. 4(a) and 4(b) are photographs illustrating a tear-occurrence state and a wrinkle-occurrence state, respectively.

DETAILED DESCRIPTION OF THE DISCLOSURE

[19] Reference will now be made in detail to the

preferred embodiments of the present disclosure, examples of which are illustrated in the accompanying drawings.

[20] FIG. 1 is a sectional view schematically showing an electrolytic copper foil according to an embodiment of the present disclosure.

[21] Referring to FIG. 1, the electrolytic copper foil, denoted by reference numeral 100, has a first surface 110a and a second surface 110b.

[22] In the present disclosure, the electrolytic copper foil 100 has a predetermined thickness, for example, a thickness of 4 to 30 μm. In the case in which the thickness of the copper foil is less than 4 μm, workability in a battery manufacturing process is deteriorated. In the case in which the thickness of the copper foil is greater than 30 μm, it is difficult to realize high capacity of a lithium secondary battery at the time of manufacturing the lithium secondary battery due to the great thickness of the copper foil.

[23] The electrolytic copper foil 100 is formed on a rotary negative electrode drum by electroplating. The electrolytic copper foil 100 has a shiny surface (an S surface), which is the surface that is in direct contact with the rotary negative electrode drum during electroplating, and a matte surface (an M surface), which is opposite the shiny surface. For example, in the present

disclosure, the first surface may be the S surface, and the second surface may be the M surface.

[24] In order to inhibit the occurrence of wrinkles, curls, and tears, the electrolytic copper foil 100 according to the present disclosure has a controlled surface texture factor and a controlled surface shape factor.

[25] As the surface texture factor, it is preferable for the electrolytic copper foil to have a crystalline structure that is controlled such that a texture coefficient TC of (220) plane is within a specific range. In the present disclosure, the texture coefficient TC of (220) plane is expressed by Equation 1 below.

[26] Equation 1

$$TC(220) = \frac{\frac{I(220)}{I_0(220)}}{\frac{1}{n}\sum\frac{I(hkl)}{I_0(hkl)}}$$

[27] In Equation 1 above, I(hkl) indicates the XRD diffraction intensity of (hkl) crystal plane of a sample, and I_0(hkl) indicates the diffraction intensity of (hkl) crystal plane of standard copper powder, set forth by the Joint Committee on Powder Diffraction Standards (JCPDS) (X-ray light source: Cu K_{a1}). Also, in Equation 1, 1 to n indicate the number of diffraction peaks within a specific range of diffraction angle 2θ. In the present disclosure,

the texture coefficient is obtained from an X-ray diffraction pattern within a range of diffraction angle 2θ between 30 degrees and 95 degrees, and remarkable crystal planes that are considered are (111), (200), (220), and (311) planes (that is, n=4). Consequently, the texture coefficient of (220) plane indicates the ratio of the peak intensity of (220) plane normalized with the peak intensity of standard Cu to the average peak intensity of (111), (200), (220), and (311) planes normalized with the peak intensity of standard Cu in the X-ray diffraction pattern of the sample.

[28] In the present disclosure, it is preferable for the electrolytic copper foil 100 to have a (220) texture coefficient of 0.40 to 1.32 on both the first surface 110a and the second surface 110b. In the case in which the (220) texture coefficient is less than 0.40, as will be described below, the crystal texture of the copper foil is not dense. As a result, the texture of the copper foil is deformed by stress and heat applied thereto in a battery manufacturing process, whereby wrinkles are formed in the copper foil. Also, in the case in which the (220) texture coefficient is greater than 1.32, the texture of the copper foil is excessively dense. As a result, the copper foil is brittle, whereby the copper foil is torn during the battery manufacturing process.

[29] In the present disclosure, it is preferable for the difference between Rz/Ra at the first surface of the electrolytic copper foil 100 and Rz/Ra at the second surface of the electrolytic copper foil 100, i.e. |Δ(Rz/Ra)|, which is the surface shape factor, to be less than 2.42. Here, Rz indicates ten-point average roughness, and Ra indicates arithmetical average roughness. Also, in the present disclosure, it is preferable for the difference between the peak density PD at the first surface of the electrolytic copper foil and the peak density PD at the second surface of the electrolytic copper foil, i.e. |ΔPD|, to be 96 ea or less.

[30] In the present disclosure, Rz and Ra may be measured according to JIS B 0601(2001) standards, and PD may be measured according to ASME B46.1 standards.

[31] In the present disclosure, in the case in which |Δ(Rz/Ra)| and |ΔPD| at the opposite surfaces of the electrolytic copper foil deviate from the above numerical ranges, curls are formed in the electrolytic copper foil due to the difference in the surface properties between the opposite surfaces of the electrolytic copper foil.

[32] In addition, it is preferable for Rz/Ra at the M surface of the electrolytic copper foil to be within the range from 4.2 to 9.0. In the case in which Rz/Ra is less than 4.2, the specific surface area of the copper foil that

is capable of contacting a negative electrode active material is small, whereby it is difficult to realize sufficient force of coupling with a negative electrode active material. In the case in which Rz/Ra is greater than 9.0, the surface of the electrolytic copper foil is nonuniform, whereby the negative electrode active material may not be uniformly attached to the surface of the copper foil.

[33] In the present disclosure, it is preferable for the electrolytic copper foil to have a tensile strength, measured at room temperature (25±15 °C), of 30 to 65 kgf/mm^2. In the case in which the tensile strength is less than 30 kgf/mm^2, the electrolytic copper foil may be easily deformed by the force applied thereto during the manufacturing process. Also, in the case in which the tensile strength is greater than 65 kgf/mm^2, the electrolytic copper foil is highly brittle. As a result, the electrolytic copper foil may be torn by pressure locally applied thereto in a subsequent process of manufacturing a lithium secondary battery, whereby workability is deteriorated. In the present disclosure, the tensile strength of an electrolytic copper foil may be measured using a universal testing machine (UTM) according to the guidelines set forth in the IPC-TM-650 Test Method Manual. In an embodiment of the present disclosure, the

tensile strength of an electrolytic copper foil is measured using a universal testing machine from Instron Company. The tensile strength of an electrolytic copper foil is measured under the conditions in which the width of the sample is 12.7 mm, the distance between grips is 50 mm, and the measurement speed is 50 mm/min. For evaluation, the tensile strength of an electrolytic copper foil may be repeatedly measured three times, and the average of the measured tensile strengths may be taken as the tensile strength of the electrolytic copper foil.

[34] Also, in the present disclosure, it is preferable for the electrolytic copper foil to have an elongation, measured at room temperature (25±15 °C), of 3 % or more. In the case in which the elongation is less than 3 %, the electrolytic copper foil may not extend but may rupture due to volumetric expansion of the electrolytic copper foil during charging and discharging of the cylindrical battery in the case in which the electrolytic copper foil is applied to the cylindrical battery. Here, the room-temperature elongation is the elongation when the test sample ruptures under the above-described tensile strength measurement conditions.

[35] In addition, it is preferable for the electrolytic copper foil according to the present disclosure to have a lateral weight deviation of 5 % or less. In the case in

which the lateral weight deviation of the electrolytic copper foil is greater than 5 %, the electrolytic copper foil may locally extend due to weight overlap between the copper foil and a bobbin when the electrolytic copper foil is wound around the bobbin, whereby the electrolytic copper foil may be wrinkled. In the present disclosure, the lateral weight deviation of the electrolytic copper foil is realized by cutting a copper foil into an area of 5 cm x 5 cm in order to manufacture a sample, measuring the weight of the sample, converting the measured weight of the sample into a weight value of the copper foil per unit area, repeatedly performing the sample cutting process in the lateral direction of the copper foil, measuring the copper foil weight value of each sample, and calculating the standard deviation.

[36] FIG. 2 is a view schematically showing an apparatus for manufacturing the electrolytic copper foil according to the present disclosure.

[37] As shown in FIG. 2, a positive electrode plate 30 and a rotary negative electrode drum 40 are disposed in an electrolytic solution 20 in an electrolytic bath 10 so as to be spaced apart from each other. In the case in which electric power is applied between the rotary negative electrode drum 40 and the positive electrode plate 30 while the rotary negative electrode drum 40 is rotated in

a predetermined direction, plating is performed through electric conduction via the electrolytic solution 20. A copper film 100 plated on the surface of the rotary negative electrode drum 40 is wound while being guided by a guide roll.

[38] A copper sulfate electrolytic solution, a copper pyrophosphate electrolytic solution, or a copper sulfamate electrolytic solution may be used as the electrolytic solution 20, which deposits the electrolytic copper foil. In the present disclosure, a copper sulfate electrolytic solution is very suitable as the electrolytic solution, and this is preferably used.

[39] The positive electrode plate 30 may include a first positive electrode plate 31 and a second positive electrode plate 32, which are electrically insulated from each other. The density of the electric current that is supplied by the positive electrode plate 30, i.e. the first positive electrode plate 31 and the second positive electrode plate 32, may be 40 to 80 A/dm^2.

[40] In an embodiment of the present disclosure, the electrolytic solution 20 may include 70 to 90 g/L of copper ions, 80 to 120 g/L of sulfuric acid, and 10 to 30 ppm of chlorine ions.

[41] In addition, the electrolytic solution 20 may further include an additive, such as a brightener or a

leveling agent. In the present disclosure, the additive may include at least one sulfide-based compound selected from the group consisting of bis-(sodium sulfopropyl) disulfide (SPS), 3-mercapto 1-propane sulfonate (MPS), and 3-(benzothiazolyl-2-mercapto)-propyl-sulfonate (ZPS). Preferably, SPS is used. In the present disclosure, in the case in which the concentration of the sulfide-based compound is greater than 12 ppm, plating is minute, and the (220) texture coefficient deviates from the preferable upper limit. In the case in which the concentration of the sulfide-based compound is less than 32 ppm, on the other hand, the size of plated crystal particles is large, and the (111) texture is developed while the (220) texture is less developed, whereby the texture coefficient deviates from the preferable lower limit.

[42] In the present disclosure, the rotary negative electrode drum 40 has a surface profile that is suitable for controlling the surface profile of the S surface of the electrolytic copper foil. Since the S surface of the electrolytic copper foil contacts the drum, the profile of the S surface of the electrolytic copper foil is affected by the surface structure of the drum. Specifically, in the present disclosure, the surface structure of the drum may be controlled by buffing the surface of the drum. For example, in the case in which the surface of the drum is

buffed using a brush having a grit of 500# to 3000#, the range of Rz/Ra of the S surface of the electrodeposited electrolytic copper foil is 5.1 to 6.8, which indicates a value having little fluctuation. In the case in which the surface of the drum is buffed using a brush having a grit of greater than 3000#, on the other hand, the surface profile of the drum is lowered, which causes uniform electrodeposition of copper. Consequently, the Rz value of the S surface converges to the Ra value. As a result, the difference in Rz/Ra between the M surface and the S surface increases.

[43] In addition, the buffing of the surface of the drum may affect the peak density PD. In the case in which the surface of the drum is buffed using a brush having a grit of 500# to 3000#, however, it is possible to obtain an electrolytic copper foil, the peak density of the S surface of which is a relatively uniform value of 10 to 20 ea.

[44] In the present disclosure, the surface profile of the M surface of the electrolytic copper foil may be further controlled as follows.

[45] First, in the present disclosure, the concentration of Mo in the electrolytic solution is maintained at 25 to 50 ppm. In the case in which the concentration of Mo in the electrolytic solution is greater than 50 ppm, copper is nonuniformly plated, whereby Rz of the M surface of the

copper foil abruptly increases. As a result, the Rz/Ra value becomes higher than in the case of the S surface, and the difference in the Rz/Ra value between the opposite surfaces of the copper foil deviates from the preferable upper limit. In the case in which the concentration of Mo in the electrolytic solution is less than 25 ppm, on the other hand, Mo does not serve as a uniform additive over the entire surface of the drum, which causes locally nonuniform plating. As a result, the M surface of the copper foil is stained or nonuniformly electroplated. As the result of such stains or nonuniform plating, a negative electrode material is nonuniformly applied in a subsequent process of manufacturing a lithium secondary battery, whereby the capacity of the lithium secondary battery is reduced.

[46] Also, in the present disclosure, the concentration of polyethylene glycol (PEG), which is used as the leveling agent, may be controlled in order to maintain the surface profile of the M surface within a preferable range. In the present disclosure, the concentration of polyethylene glycol in the electrolytic solution may be adjusted to fall within the range of 5 to 25 ppm. In the case in which the concentration of PEG is less than 5 ppm, copper is not levelly electrodeposited at the time of plating, whereby the copper foil has a surface structure with developed

micro-scale irregularities. As a result, the PD value of the M surface of the copper foil becomes high, whereby the difference in the PD value between the M surface and the S surface increases. In the case in which the concentration of PEG is greater than 25 ppm, on the other hand, copper plating is levelly electrodeposited in the electrolytic solution, whereby Rz/Ra has a value of less than 4.2

[47] In the present disclosure, it is preferable for the electrolytic solution 20 to be maintained at 45 to 65 °C and for the flow rate of the electrolytic solution 20 that is supplied into the electrolytic bath 10 to be maintained at 35 to 46 m^3/hour. In the case in which the flow rate of the electrolytic solution 20 is less than 35 m^3/hour, copper ions are not sufficiently supplied to the surface of the rotary negative electrode drum 40, whereby a plated thin film is nonuniformly formed. In the case in which the flow rate of the electrolytic solution 20 is greater than 46 m^3/hour, on the other hand, the flow speed of the electrolytic solution 20, which also passes through a filter, is excessively fast, which abruptly reduces the lifespan of the filter.

[48] Hereinafter, preferred examples of the present disclosure will be described in detail.

[49] <Manufacture of electrolytic copper foil>

[50] A positive electrode plate and a rotary negative

electrode drum, disposed in an electrolytic solution in an electrolytic bath so as to be spaced apart from each other, were electrically conducted using an apparatus identical to that shown in FIG. 2 in order to form a copper film on the rotary negative electrode drum.

[51] SPS, Mo, and PEG were added to a solution including 75 g/L of copper ions, 100 g/L of sulfuric acid, and 20 ppm of chlorine ions in order to prepare an electrolytic solution. The copper film was electrodeposited while the content of SPS, Mo, and PEG in the electrolytic solution was changed. At this time, the temperature of the electrolytic solution was maintained at about 55 °C, the current density of the electrolytic solution was 60 A/dm^2, and the flow rate of the electrolytic solution was 40 m^3/hr. Also, in order to obtain different surface profiles at the S surface of the copper foil before the manufacture of the copper foil, the surface of the rotary negative electrode drum was buffed using brushes having different grits (different degrees of roughness), and then experiments were carried out.

[52] The manufacturing conditions of the manufactured copper foil are shown in Table 1 below.

[53] [Table 1]

	SPS (ppm)	Mo (ppm)	PEG (ppm)	Brush (#)
Example 1	3	25	15	2000
Example 2	12	25	15	2000

Example 3	7	49	15	2000
Example 4	7	25	5	2000
Comparative Example 1	2	25	15	2000
Comparative Example 2	13	25	26	2000
Comparative Example 3	7	51	15	2000
Comparative Example 4	7	25	4	2000
Comparative Example 5	7	25	15	4000

[54] Subsequently, the properties of the manufactured electrolytic copper foil samples (Examples 1 to 4 and Comparative Examples 1 to 5) were measured. The respective properties of the electrolytic copper foil samples were measured as follows.

[55] Texture coefficient

[56] The X-ray diffraction pattern of the M surface of each of the manufactured electrolytic copper foil samples was obtained within a range of diffraction angle 2θ between 30 degrees and 95 degrees, and the ratio of the peak intensity of (220) plane normalized with the peak intensity of standard Cu to the average peak intensity of (111), (200), (220), and (311) planes, which were crystal planes, normalized with the peak intensity of standard Cu was obtained as the texture coefficient of (220) plane.

[57] Surface profile of copper foil

[58] Rz and Ra were measured according to JIS B 0601 (2001) standards using a stylus tip from Mitutoyo Company,

the model name of which was SJ-310 and which had a radius of 2 μm, under a condition of a measurement pressure of 0.75 mN. At this time, the measurement length, excluding the cut-off length, was 4 mm, the cut-off length was 0.8 mm at the first stage and the last stage, and the average of the values obtained by performing the measurement three times was taken.

[59] The peak density PD was measured according to ASME B46.1 standards, and the peak density was measured using a roughness tester from Mahr Company (Model name: Marsurf M300) and a stylus tip having a radius of 2 μm. The peak count level was ±0.5 μm from the center line of the profile, the measurement length, excluding the cut-off length, was 4 mm, and the cut-off length was 0.8 mm at the first stage and the last stage. The measurement pressure was 0.7 mN. The average of the values obtained by performing the measurement three times was taken as the peak density.

[60] Curls

[61] An incision was made in the shape of a cross having a size of 8 cm x 8 cm at an arbitrary point on the M surface of each of the electrolytic copper foils manufactured according to Examples and Comparative Examples so as to be vertically divided into two parts in order to form four incision portions. After incision, the heights of the corners of the four incision portions that protruded

sharply were measured, and the arithmetic mean of the measured heights was taken as the curl.

[62] Wrinkles and tears

[63] Whether each of the electrolytic copper foils was wrinkled and torn during a roll-to-roll process was observed with the naked eye. FIGS. 4(a) and 4(b) are photographs illustrating a tear-occurrence state and a wrinkle-occurrence state, respectively.

[64] <Manufacture of negative electrode>

[65] A current collector having a width of 10 cm was prepared using each of the electrolytic copper foils manufactured according to Examples and Comparative Examples. On the current collector, 2 wt% of styrene butadiene rubber (SBR) and 2 wt% of carboxymethyl cellulose (CMC) were mixed with 100 wt% of artificial graphite and SiO2, marketed as a negative electrode active material, using distilled water as a solvent in order to manufacture a slurry.

[66] Subsequently, a sample of each of the electrolytic copper foils to be measured was placed on a glass plate having a clean surface and was spread so as to remove any wrinkle or crumple. A negative electrode material was coated on the copper foil using a bar coater such that the amount of the negative electrode material that was loaded was 9.0±0.5 mg/cm^2. At this time, the coating speed of the bar coater was 10 to 15 mm/s. The copper foil having the

negative electrode material coated thereon was placed in a dry oven heated to 100 °C, and was dried for 15 minutes. The dried copper foil sample was pressed in four stages using a roll press such that the density of an electrode was 1.55±0.05 g/cc in order to manufacture a negative electrode. The adhesion force of the manufactured negative electrode was measured using the following method.

[67] The manufactured electrode was cut to obtain a sample having a size of 10 mm (width) x 100 mm (length), and the active material portion of the sample was adhered to a reinforcement plate using a double-sided tape. At this time, all of the samples that were manufactured were attached using uniform force. The adhesive force (adhesion force) of the manufactured samples was measured using an UTM apparatus.

[68] - Crosshead speed: 50.0 mm/min

[69] - Measurement length: 20 to 50 mm

[70] - 90° peeling test

[71] <Manufacture of Lithium secondary battery>

[72] 1 M of $LiPF_6$, serving as a solute, was dissolved in a non-aqueous organic solvent, obtained by mixing ethylene carbonate (EC) and ethyl methyl carbonate (EMC) with each other at a ratio of 1:2, in order to prepare a basic electrolytic solution, and 99.5 wt% of the basic electrolytic solution and 0.5 wt% of succinic anhydride

were mixed with each other in order to manufacture a non-aqueous electrolytic solution.

[73] A lithium manganese oxide, such as $Li_{1.1}Mn_{1.8}5Al_{0.05}O_4$, and a lithium manganese oxide having an orthorhombic crystalline structure, such as o-$LiMnO_2$, were mixed with each other at a weight ratio of 90:10 in order to manufacture a positive electrode active material. The positive electrode active material, carbon black, and polyvinylidene fluoride (PVDF), serving as a binder, were mixed with each other at a weight ratio of 85:10:5 in NMP, serving as an organic solvent, in order to manufacture a slurry. The manufactured slurry was applied to opposite surfaces of an Al foil having a thickness of 20 μm and was dried in order to manufacture a positive electrode. A lithium secondary battery was obtained using the manufactured positive electrode, negative electrode, and electrolytic solution.

[74] Table 2 below shows the results of measurement of the physical properties of the electrolytic copper foil samples manufactured according to Examples of the present disclosure and the results of measurement of the adhesion forces of the negative electrodes manufactured using the electrolytic copper foils.

[75] [Table 2]

	Example 1	Example 2	Example 3	Example 4	Comparative	Comparative	Comparative	Comparative	Comparative

					Example 1	Example 2	Example 3	Example 4	Example 5
Texture coefficient	0.4	1.32	0.78	0.78	0.32	1.41	0.78	0.78	0.78
|Δ(Rz/Ra)|	0.85	0.85	2.42	0.85	0.85	0.85	2.43	0.85	2.43
Rz/Ra (M surface)	4.22	4.21	9.00	4.21	4.21	4.08	9.13	4.22	4.22
Rz/Ra (S surface)	3.37	3.36	6.58	3.36	3.36	3.23	6.70	3.37	1.79
|ΔPD| (ea/cm)	38	38	38	96	38	38	38	97	38
M surface PD (ea/cm)	48	48	48	105	48	48	48	107	48
S surface PD (ea/cm)	10	10	10	9	10	10	10	10	10
Curl (mm)	5.6	5.5	8.7	8.6	5.2	5.4	11.5	11.6	11.6
Wrinkle	no	no	no	no	yes	no	no	no	no
Tear	no	no	no	no	no	yes	no	no	no
Adhesion force (N/m)	26.4	26.4	28.4	26.4	26.8	15.5	15.4	26.7	26.3

[76] Referring to Table 2, all of the electrolytic copper foil samples manufactured according to Examples 1 to 4 had excellent curl values of 10 mm or less. An electrolytic copper foil having a curl value in this range is not folded in a process of manufacturing a copper foil or a subsequent process of manufacturing a battery. Meanwhile, in the case of Comparative Example 1 and Comparative Example 2, |Δ(Rz/Ra)| and |ΔPD| of the electrolytic copper foil samples were similar to those of the electrolytic copper foil samples manufactured according to Examples; however, the electrolytic copper foil samples were wrinkled or torn during a roll-to-roll process. The reason for this is that the (220) texture coefficient of each of the electrolytic copper foil samples manufactured according to Comparative Example 1 and Comparative Example 2 had a value of less than 0.40, whereby the crystal

texture of the copper foil was not dense, and therefore the texture of the copper foil was deformed by stress and heat during a battery manufacturing process, with the result that wrinkles were formed in the copper foil or that the (220) texture coefficient of each of the electrolytic copper foil samples was greater than 1.32, whereby the texture of the copper foil was excessively dense, with the result that the copper foil was brittle.

[77] Meanwhile, it can be seen that Rz/Ra of the M surface of the electrolytic copper foil manufactured according to Comparative Example 3 had a very high value (9.13), whereby |Δ(Rz/Ra)| was greater than 2.42, which was a high curl value. In addition, in the case of Comparative Example 4, it can be seen that the content of PEG was small, whereby the electrolytic copper foil had a surface structure with developed micro-scale irregularities, and therefore the PD value of the M surface of the copper foil increased (97 ea), with the result that the curl value increased. Meanwhile, Rz/Ra of the S surface of the electrolytic copper foil manufactured according to Comparative Example 5 had a very low value, and |Δ(Rz/Ra)| was greater than 2.42, which were caused by the surface profile of the rotary negative electrode drum.

[78] Meanwhile, in the case of Comparative Examples 2 and 3, each of the manufactured negative electrodes had a

low value of adhesion force. In the case in which the adhesion force is less than 20 N/m, the negative electrode material may be separated from the surface of the copper foil at the time of charging and discharging a lithium secondary battery after the manufacture of the lithium secondary battery, whereby the charge capacity of the lithium secondary battery may be abruptly reduced. In the case of Comparative Examples 2 and 3, the (220) texture coefficient of each of the electrolytic copper foil samples was low, or Rz/Ra of the M surface of each of the electrolytic copper foil samples was low, whereby the force of coupling with the negative electrode material was insufficient. The reason for this is that the crystal texture of the copper foil was not dense or that the specific surface area of the copper foil was low.

[79] As is apparent from the above description, according to the present disclosure, it is possible to provide an electrolytic copper foil configured such that the possibility of the electrolytic copper foil being curled, wrinkled, and/or torn is reduced in a process of manufacturing the electrolytic copper foil and/or a subsequent process of manufacturing a secondary battery by controlling the surface profile of a rotary negative electrode drum, the surface texture structure of a copper foil, and the surface profile of the copper foil.

[80] It will be apparent to those skilled in the art that the present disclosure described above is not limited by the above-described embodiments and the accompanying drawings and that various substitutions, modifications, and variations can be made in the present disclosure without departing from the spirit or scope of the disclosures. Consequently, the scope of the present disclosure is defined by the accompanying claims, and it is intended that all variations or modifications derived from the meaning, scope, and equivalent concept of the claims fall within the scope of the present disclosure.

IN THE UNITED STATES ELECTED/DESIGNATED OFFICE
OF THE UNITED STATES PATENT AND TRADEMARK OFFICE
UNDER THE PATENT COOPERATION TREATY

Applicant(s):	Seung Min KIM
Intnl. Appl. No.:	PCT/KR2019/001069
Intnl. Filing Date:	January 25, 2019
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Docket No.:	0313221.00022

Mail Stop PCT
Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

PRELIMINARY AMENDMENT

Sir:

Please amend the above-identified International Application before entry into the National stage before the U.S. Patent and Trademark Office under 35 U.S.C. §371 as follows:

Amendments to the Specification begin on page 2 of this paper.

Amendments to the Claims begin on page 3 of this paper.

Remarks begin on page 6 of this paper.

Amendments to the Specification:

On page 1, immediately after the title, please add the following heading and paragraph:

CROSS-REFERENCE TO RELATED APPLICATIONS

[0001] The present application is a National Stage of International Application No. PCT/KR2019/001069, filed January 25, 2019, which claims priority to Korean Application No. 10-2018-0012179, filed on January 31, 2018, the disclosure of which are incorporated herein by reference.

On page 1, before paragraph [0001], please amend the heading as follows:

~~**BACKGROUND**~~

~~**TECHNICAL**~~ **FIELD OF THE INVENTION**

On page 1, before paragraph [0002], please amend the heading as follows:

~~**DESCRIPTION OF THE RELATED ART**~~ **BACKGROUND OF THE INVENTION**

On page 2, before paragraph [0007], please amend the heading as follows:

BRIEF ~~SUMMARY~~ DESCRIPTION OF THE INVENTION

On page 5, before paragraph [0014], please amend the heading as follows:

BRIEF DESCRIPTION OF THE ~~SEVERAL VIEWS OF THE~~ DRAWINGS

On page 5, before paragraph [0019], please amend the heading as follows:

DETAILED DESCRIPTION OF THE ~~DISCLOSURE~~ INVENTION

Amendments to the Claims:

Please replace the claims beginning at page 28 of the English language translation of the application as filed with the following listing of reformatted claims:

1. (Original) An electrolytic copper foil having a first surface and a second surface, wherein

a texture coefficient of (220) plane of the electrolytic copper foil defined by Equation 1 below is 0.4 to 1.32,

(Equation 1)

$$TC(220) = \frac{\frac{I(220)}{I_0(220)}}{\frac{1}{n}\sum\frac{I(hkl)}{I_0(hkl)}}$$

a difference ($|\Delta(Rz/Ra)|$) between Rz/Ra at the first surface of the electrolytic copper foil and Rz/Ra at the second surface of the electrolytic copper foil is less than 2.42, and

a difference ($|\Delta PD|$) between a peak density (PD) at the first surface of the electrolytic copper foil and a peak density (PD) at the second surface of the electrolytic copper foil is 96 ea or less.

2. (Original) The electrolytic copper foil according to claim 1, wherein

the second surface is an M surface, and

Rz/Ra at the second surface is 4.2 to 9.0.

3. (Original) The electrolytic copper foil according to claim 2, wherein

the first surface is an S surface, and

Rz/Ra at the S surface of the electrolytic copper foil is 5.1 to 6.8.

4. (Original) The electrolytic copper foil according to claim 1, wherein the electrolytic copper foil has a tensile strength, measured at room temperature, of 30 to 65 kgf/mm^2.

5. (Original) The electrolytic copper foil according to claim 1, wherein the electrolytic copper foil has an elongation, measured at room temperature, of 3 % or more.

6. (Original) The electrolytic copper foil according to claim 1, wherein the electrolytic copper foil has a lateral weight deviation of 5 % or less.

7. (Original) The electrolytic copper foil according to claim 1, wherein an arithmetic mean of measured heights of corners of four protruding incision portions of the electrolytic copper foil, formed by incising electrolytic copper foil in a form of a cross having a size of 8 cm x 8 cm so as to be vertically divided into two parts, is less than 10 mm.

8. (Original) A method of manufacturing an electrolytic copper foil by applying electric current between a positive electrode plate and a rotary negative electrode drum, disposed in an electrolytic solution in an electrolytic bath so as to be spaced apart from each other, in order to electroplate a copper film on the rotary negative electrode drum, the method comprising:

buffing a surface of the rotary negative electrode drum using a brush having a grit of 500# to 3000#;

electrodepositing a copper film on the buffed rotary negative electrode drum; and

winding the electrodeposited copper film, wherein

the electrolytic solution comprises 70 to 90 g/L of copper ions, 80 to 120 g/L of sulfuric

acid, 10 to 20 ppm of chlorine ions, 3 to 12 ppm of a sulfide-based compound, 25 to 50 ppm of molybdenum (Mo), and 5 to 25 ppm of polyethylene glycol (PEG).

9. (Original) The method according to claim 8, wherein the sulfide-based compound is selected from a group consisting of bis-(sodium sulfopropyl) disulfide (SPS), 3-mercapto 1-propane sulfonate (MPS), and 3-(benzothiazolyl-2-mercapto)-propyl-sulfonate (ZPS).

10. (Original) The method according to claim 8, wherein the sulfide-based compound is SPS.

REMARKS

In this Preliminary Amendment, Applicant has added a Cross-Reference to Related Applications section to the specification to conform the present application to the requirements of United States Patent Office. Furthermore, Applicant has amended the claims to update the format of the claims to provide appropriate identifiers. No new matter is added thereby.

Early and favorable consideration on the merits is respectfully requested.

Respectfully submitted,

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(81) 지정국 (별도의 표시가 없는 한, 가능한 모든 종류의 국내 권리의 보호를 위하여): AE, AG, AL, AM, AO, AT, AU, AZ, BA, BB, BG, BH, BN, BR, BW, BY, BZ, CA, CH, CL, CN, CO, CR, CU, CZ, DE, DJ, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IR, IS, JO, JP, KE, KG, KH, KN, KP, KW, KZ, LA, LC, LK, LR, LS, LU, LY, MA, MD, ME, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PA, PE, PG, PH, PL, PT, QA, RO, RS, RU, RW, SA, SC, SD, SE, SG, SK, SL, SM, ST, SV, SY, TH, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW.

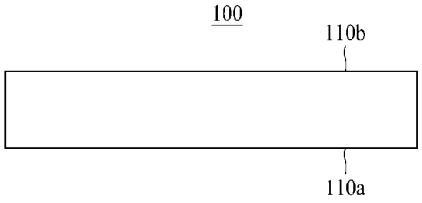
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— 국제조사보고서와 함께 (조약 제21조(3))

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(54) Title: ELECTROLYTIC COPPER FOIL HAVING EXCELLENT HANDLING CHARACTERISTICS IN POST-PROCESSING, AND MANUFACTURING METHOD THEREFOR

(54) 발명의 명칭: 후속 공정에서 핸들링 특성이 우수한 전해동박 및 그 제조방법



(57) Abstract: The present invention relates to an electrolytic copper foil having excellent handling characteristics in the manufacture of copper foil and in post-processing for manufacturing a secondary battery. The present invention provides an electrolytic copper foil having a first surface and a second surface, wherein the texture coefficient of the (220) plane of the electrolytic copper foil is 0.4-1.32, the difference (|Δ(Rz/Ra)|) between Rz/Ra on the first surface and Rz/Ra on the second surface, of the electrolytic copper foil, is less than 2.42, and the difference (|ΔPD|) in peak density (PD) between the first surface and the second surface, of the electrolytic copper foil, is 96 ea or less.

(57) 요약서: 본 발명은 동박 제조 및 후속 이차전지의 제조 공정에서 우수한 핸들링 특성을 갖는 전해동박에 관한 것이다. 본 발명은 제1 표면 및 상기 제2 표면을 갖는 전해동박에 있어서, 상기 전해동박은 (220)면의 집합조직 계수가 0.4~1.32 이고, 상기 전해동박의 제1 표면에서의 Rz/Ra 와 제2 표면에서의 Rz/Ra 차이(|Δ(Rz/Ra)|)가 2.42 미만이며, 상기 전해동박의 제1 표면 및 제2 표면에서의 피크 밀도(PD) 차이(|ΔPD|) 가 96ea 이하인 것을 특징으로 하는 전해동박을 제공한다.

명세서

발명의 명칭: 후속 공정에서 핸들링 특성이 우수한 전해동박 및 그 제조방법

기술분야

[1] 본 발명은 전해동박에 관한 것으로, 보다 상세하게는 동박 제조 및 후속 이차전지의 제조 공정에서 우수한 핸들링 특성을 갖는 전해동박에 관한 것이다.

배경기술

[2] 휴대폰, 노트북 등 휴대용 가전의 사용 증가와 하이브리드 자동차의 보급과 더불어 Li 이차전지의 수요는 급격히 증가하고 있다.

[3] 리튬 이차전지에 있어서 음극 집전체의 소재로는 주로 전해동박이 사용된다. 전해동박은 전기 도금법에 의한 제박공정을 통해 제조되는데, 전해동박 제조시 생산 조건을 정밀하게 제어하지 않으며, 얇은 박막을 제조할 때 생길 수 있는 컬(Curl), 주름 또는 찢김 불량이 다량 발생하게 된다. 이러한 동박 제품의 불량은 동박 생산시 제조 원가를 상승시키는 주요한 원인이 되며, 컬 및 주름은 Li 이차전지의 품질을 저하시키는 주 요인으로 전체적인 품질 비용을 높이는 원인이 되기도 한다.

[4] 종래에는 이러한 동박 제품의 불량을 저감할 수 있는 방법으로 동박의 조도 범위를 일정하게 제어하는 것이 알려져 있다. 그러나, Li 이차전지의 용량 증대를 위해 10㎛ 이하의 동박을 Li 이차전지용 음극 집전체로 사용하는 비율이 증가함에 따라 동박의 조도를 정밀하게 제어를 함에도 불구하고 여전히 컬, 찢김 및 주름 불량이 발생하고 있는 실정이다.

[5] [선행기술문헌]

[6] 1. 한국특허공개 제10-2015-62228호

발명의 상세한 설명

기술적 과제

[7] 따라서, 본 발명은 위와 같은 관련 기술의 제한 및 단점들에 기인한 문제점들을 방지할 수 있는 전해동박 및 그 제조방법에 관한 것이다.

[8] 본 발명의 일 관점은, 전해동박의 제조 중 및/또는 후속 이차전지 제조 공정에서 컬, 주름 및/또는 찢김 발생 가능성을 감소시키는 전해동박을 제공하는 것이다.

[9] 본 발명의 다른 관점은, 전해동박의 제조 중 및/또는 후속 이차전지 제조 공정에서 컬, 주름 및/또는 찢김 발생 가능성을 감소시키는 전해동박을 제조하는 방법을 제공하는 것이다.

과제 해결 수단

[10] 위와 같은 본 발명의 일 관점에 따라, 제1 표면 및 상기 제2 표면을 갖는 전해동박에 있어서, 상기 전해동박은 다음의 수학식 1에 의해 정의되는

(220)면의 집합조직 계수가 0.4~1.32이고,

[11] (수학식 1)

[12]

$$TC(220) = \frac{\frac{I(220)}{I_0(220)}}{\frac{1}{n}\Sigma\frac{I(hkl)}{I_0(hkl)}}$$

[13] 상기 전해동박의 제1 표면에서의 Rz/Ra와 제2 표면에서의 Rz/Ra 차이(|Δ(Rz/Ra)|)가 2.42 미만이며, 상기 전해동박의 제1 표면 및 제2 표면에서의 피크 밀도(PD) 차이(|ΔPD|)가 96ea 이하인 것을 특징으로 하는 전해동박을 제공한다.

[14] 상기 제2 표면은 M면이고, 상기 제2 표면에서의 Rz/Ra가 4.2 ~ 9.0 인 것이 바람직하다. 또한, 상기 제1 표면은 S면이고, 상기 전해동박은 S면의 Rz/Ra가 5.1 ~ 6.8인 것이 바람직하다.

[15] 본 발명의 다른 관점에 따라, 전해조의 전해액 내에 서로 이격되게 배치된 양극판 및 회전 음극드럼 사이에 전류를 인가하여 상기 회전 음극드럼 상에 구리막을 전기 도금하여 전해동박을 제조하는 방법에 있어서, 상기 회전 음극드럼의 표면을 500# 내지 3000# 입도를 가지는 브러쉬로 버핑하는 단계; 상기 버핑된 회전 음극드럼 상에 구리막을 전착하는 단계; 및 도금된 상기 구리막을 권취하는 단계를 포함하되, 상기 전해액은 70 내지 90 g/L의 구리 이온, 80 내지 120 g/L의 황산, 10 내지 20 ppm의 염소 이온, 3 내지 12 ppm의 황화물계 화합물, 25 내지 50 ppm의 Mo, 및 5 내지 25 ppm의 PEG를 포함하는 것을 특징으로 하는 전해동박의 제조 방법을 제공한다.

[16] 상기 황화물계 화합물은 SPS, MPS 및 ZPS로 이루어진 그룹 중에서 선택될 수 있다. 바람직하게는 상기 황화물계 화합물은 SPS일 수 있다.

발명의 효과

[17] 본 발명에 따르면, 회전 음극드럼의 표면 프로파일, 동박 표면의 표면 조직 구조 및 표면 프로파일을 제어하여 전해동박 제조 공정 및/또는 후속 이차전지 제조 공정에서 컬, 주름 및/또는 찢김 발생 가능성을 감소시키는 전해동박을 제공할 수 있게 된다.

도면의 간단한 설명

[18] 도 1은 본 발명의 실시예에 따른 전해동박의 단면을 나타낸 모식도이다.

[19] 도 2는 본 발명의 전해동박 제박장치를 모식적으로 도시한 도면이다.

[20] 도 3은 본 발명의 일실시예에서 컬 값의 측정 방법을 보여주는 사진이다.

[21] 도 4의 (a) 및 (b)는 각각 찢김 및 주름 발생 상태를 예시하는 사진이다.

발명의 실시를 위한 형태

[22] 이하 도면을 참조하여 본 발명의 바람직한 실시예를 설명한다.

[23] 도 1은 본 발명의 실시예에 따른 전해동박의 단면을 나타낸 모식도이다.

[24] 도 1을 참조하면, 전해동박(100)은 제1 표면(110a) 및 제2 표면(110b)을 구비한다.

[25] 본 발명에서 상기 전해동박(100)은 소정 두께 예컨대 4 내지 30 ㎛의 두께를 갖는다. 동박 두께가 4㎛ 미만인 경우 전지 제조공정에서의 작업성 저하를 초래하고, 30㎛ 이상인 경우 Li 이차전지 제조시 동박의 두꺼운 두께로 인해 고용량 구현이 어렵게 된다.

[26] 상기 전해동박(100)은 회전 음극드럼에서 전기도금에 의해 형성되는데, 전기도금 과정에서 상기 회전 음극 드럼과 직접 접촉하는 표면은 샤이니 면(S면)과 그 반대 편의 매트 면(M면)을 갖는다. 예컨대, 본 발명에서 상기 제1 표면은 S면이고, 상기 제2 표면을 M면일 수 있다.

[27] 주름, 컬 및 찢김의 발생을 억제하기 위하여, 본 발명의 상기 전해동박(100)은 제어된 표면조직 인자 및 표면형상 인자를 갖는다.

[28] 표면조직 인자로서, 상기 전해동박은 (220)면의 집합조직 계수가 특정 범위에 있도록 제어된 결정 구조를 갖는 것이 바람직하다. 본 발명에서 (220)면의 집합조직 계수(Texture Coefficient; TC)는 다음의 수학식 1에 의해 표현된다.

[29] (수학식 1)

[30]
$$TC(220) = \frac{\frac{I(220)}{I_0(220)}}{\frac{1}{n}\sum\frac{I(hkl)}{I_0(hkl)}}$$

[31] 위 수학식 1에서 I(hkl)은 시편의 (hkl) 결정면의 XRD 회절 강도를 의미하고, I_0(hkl)은 JCPDS(Joint Committee on Powder Diffraction Standards)에 규정된 표준 구리 분말의 (hkl) 결정면의 회절 강도를 의미한다(X선 광원 : Cu $K_{\alpha 1}$) . 또한, 수학식 1에서 n은 특정 범위의 회절각(2θ) 내에서 회절 피크의 수를 나타낸다. 본 발명에서 집합조직 계수는 회절각(2θ) 30°에서 95° 범위에서 X선 회절 패턴으로부터 구하는데, 고려되는 현저한 결정면은 (111), (200), (220) 및 (311)면이다(즉, n=4). 따라서, (220)면의 집합조직계수는 시편의 X선 회절 패턴에서 (111), (200), (220) 및 (311)면에 대하여 표준 Cu의 피크 강도로 정규화 된 평균 피크 강도에 대하여 (220)면의 정규화 된 피크 강도의 비율을 나타낸다.

[32] 본 발명에서 상기 전해동박(100)은 제1 표면(110a) 및 제2 표면(110b) 모두에서 0.40 내지 1.32의 (220) 집합조직계수를 갖는 것이 바람직하다. 후술하는 바와 같이, (220) 집합조직 계수가 0.40 미만이면 동박의 결정 조직이 치밀하지 못하여 전지 제조 공정에서 겪는 응력 및 열에 의해 조직이 변형되어 주름을 발생시킨다. 또한, (220) 집합조직 계수가 1.32를 초과하면 동박의 조직이 너무 치밀하여 취성을 가지며 전지 제조 공정에서 찢김이 발생한다.

[33] 본 발명에서 상기 표면 형상 인자로서, 상기 전해동박(100)의 제1 표면에서의 Rz/Ra와 제2 표면에서의 Rz/Ra 차이, 즉 |Δ(Rz/Ra)|이 2.42 미만인 것이

바람직하다. 여기서, Rz는 십점평균조도, Ra는 산술평균조도이다. 또한, 본 발명에서 상기 전해동박은 제1 표면 및 제2 표면에서의 피크 밀도(Peak density, PD) 차이, 즉 |ΔPD|가 96ea 이하인 것이 바람직하다.

[34] 본 발명에서 전술한 Rz 및 Ra 는 JIS B 0601(2001) 규격에 따라 측정될 수 있고, PD는 ASME B46.1 규격에 따라 측정될 수 있다.

[35] 본 발명에서 전해동박 양면에서의 |Δ(Rz/Ra)| 및 |ΔPD|가 전술한 수치 범위를 벗어나면 전해동박 양면에서의 표면 특성 차이로 인해 컬이 발생하게 된다.

[36] 또한, 전해동박의 M면에서의 Rz/Ra는 4.2 내지 9.0 범위에 있는 것이 바람직하다. Rz/Ra가 4.2 미만인 경우 음극활물질과 접촉할 수 있는 동박의 비표면적이 작아 음극재와 충분한 결합력을 형성하기가 어렵고, 9.0을 초과하는 경우 전해동박의 표면이 불균일하여 음극활물질이 동박 표면에 균일하게 접착될 수 없다.

[37] 본 발명에서 상기 전해동박은 상온(25±15℃)에서 측정한 인장강도가 30 ~ 65kgf/mm^{2}인 전해동박인 것이 바람직하다. 인장강도가 30 미만인 경우 제조 공정 중에 가해 지는 힘에 의해 변형이 발생되기 쉽다. 또한, 인장강도가 65를 초과하는 경우 높은 취성을 가져 후속 Li 이차전지 제조 공정에서 가해지는 국부적인 압력에 의해 찢김이 발생될 수 있어, 작업성이 저하된다. 본 발명에서 시편의 인장강도는 IPC-TM-650 Test Method Manual의 규정에 준하여, 만능시험기(UTM)에 의해 측정될 수 있다. 본 발명의 일 실시예에 따르면, 인스트론사(Instron)의 만능시험기에 의해 인장강도가 측정되는데, 측정용 샘플의 폭은 12.7 mm이고, 그립(grip)간 거리는 50 mm이며, 측정 속도는 50 mm/min에서 측정된다. 평가를 위해 샘플의 인장강도는 3회에 걸쳐 반복 측정하여, 그 평균값을 전해동박의 인장강도로 할 수 있다.

[38] 또한, 본 발명에서 전해동박은 상온(25±15℃)에서 측정한 연신율이 3% 이상인 것이 바람직하다. 연신율이 3% 미만인 경우 원통형 전지에 적용될 경우 충방전시 가해지는 부피 팽창에 의해 동박이 신장되지 못하고 파단이 발생할 수 있다. 여기서 상온 연신율은 전술한 인장강도 측정 조건에서 시험 샘플의 파단시의 연신율로 한다.

[39] 또한, 본 발명의 전해동박은 폭방향 중량 편차가 5% 이하인 것이 바람직하다. 폭방향 중량 편차가 5%를 초과하는 경우 전해동박을 보빈에 권취할 때 동박과의 중량 중첩으로 국부적으로 늘어나는 현상이 발생되어 울음 불량이 발생할 수 있다. 본 발명에서 전해동박의 폭방향 중량 편차는 동박을 5㎝ x 5㎝의 면적으로 절개하여 시편을 만든 후 그 중량을 측정하여 단위면적당 동박 중량값을 환산하고, 동박의 폭 방향을 따라 상기 시편을 절개하는 과정을 반복적으로 수행하여 각 시편에 대한 동박 중량값들을 측정한 후 표준편차를 계산함으로써 산출된다.

[40] 도 2는 본 발명의 전해동박 제박장치를 모식적으로 도시한 도면이다.

[41] 도 2에 도시된 바와 같이, 전해조(10) 내의 전해액(20) 내에 서로 이격되게

배치된 양극판(30) 및 회전 음극드럼(40)이 구비된다. 회전 음극드럼(40)을 소정 방향으로 회전시키면서 상기 회전 음극드럼(40)과 양극판(30) 사이에 전원을 인가하면 전해액(20)을 매개로 하여 통전에 의해 도금이 수행된다. 회전 음극드럼(40) 표면에 도금된 구리박(100)은 가이드 롤(50)에 의해 권취된다.

[42] 상기 전해동박을 석출시키는 전해액(20)으로서는 황산 구리 전해액, 피로린산 구리 전해액 또는 슬파민산 구리 전해액 등이 사용될 수 있다. 바람직하게는 본 발명에서 전해액으로는 황산 구리 전해액이 매우 적합하다.

[43] 이 때, 상기 양극판(30)은 서로 전기적으로 절연된 제1 양극판(31) 및 제2 양극판(32)을 포함할 수 있다. 이 때, 상기 양극판(30), 즉 상기 제1 및 제2 양극판들(31, 32)에 의해 각각 제공되는 전류밀도는 40 내지 80 A/dm^2 일 수 있다.

[44] 본 발명의 일 실시예에서, 상기 전해액(20)은 70 내지 90 g/L의 구리 이온, 80 내지 120 g/L의 황산, 10 내지 30 ppm의 염소 이온을 포함할 수 있다.

[45] 또한, 상기 전해액(20)은 광택제나 평활제와 같은 첨가제를 더 포함할 수 있다. 본 발명에서 상기 첨가제는 SPS(비스-(소듐 술포프로필) 디설파이드), MPS(3-메르캅토 1-프로판 술폰산 나트륨) 및 ZPS(3-(벤조티아졸릴-2-메르캅톤)-프로필-술폰산 나트륨)로 이루어지는 그룹 중에서 선택되는 최소한 1종의 황화물계 화합물을 포함할 수 있다. 이 때, 바람직하게는 SPS가 사용되는 것이 좋다. 본 발명에서 상기 황화물계 화합물의 농도가 12ppm을 초과하면 도금이 미세하게 되고, (220) 집합조직 계수가 바람직한 상한을 초과하게 된다. 이와 달리, 전해액 내의 황화물계 화합물의 농도가 3ppm 미만이면 도금된 결정립의 사이즈가 크고 (111) 집합조직이 발달하여, 상대적으로 (220) 집합조직은 덜 발달하게 되어 집합조직계수가 바람직한 하한을 이탈하게 된다.

[46] 본 발명에서 상기 회전 음극드럼(40)은 전해동박의 S면의 표면 프로파일의 제어에 적합한 표면 프로파일을 가진다. 전해동박의 S면은 동박의 드럼과 접촉하며 그 프로파일은 드럼의 표면 구조에 영향을 받는다. 구체적으로 본 발명에서 드럼의 표면 구조는 드럼 표면의 버핑에 의해 제어될 수 있다. 예컨대, 500# 내지 3000# 입도를 가지는 브러쉬를 사용하여 드럼 표면을 버핑하게 되면 전착된 전해동박 S면의 Rz/Ra의 범위는 5.1~6.8 수준으로 변동성이 작은 값을 나타낸다. 이와 달리, 3000#이 넘는 브러쉬에 의한 드럼 표면 버핑은 드럼에 낮은 표면 프로파일을 초래하고, 구리의 균일한 전착을 유발한다. 이에 따라, S면의 Rz 값이 Ra 값에 수렴하게 되며, 결과적으로 M면과 S면의 Rz/Ra 차이가 큰 값을 나타내게 된다.

[47] 또한, 드럼 표면의 버핑은 피크밀도(PD)에 영향을 미칠 수 있다. 다만, 500# 내지 3000# 입도를 가지는 브러쉬를 사용하여 드럼 표면을 버핑하게 되면 전착된 전해동박 S면의 피크밀도는 10~20ea 수준의 비교적 균일한 값을 갖는 전해동박이 얻어질 수 있다.

[48] 본 발명에서 전해동박 M면의 표면 프로파일은 다음의 방식으로 추가적으로

제어될 수 있다.

[49] 먼저, 본 발명에서 전해액 내의 Mo 농도는 25 내지 50ppm으로 유지된다. 전해액 내의 Mo 농도가 50ppm을 초과하면 구리가 불균일하게 도금되어 동박 M면의 Rz가 급격하게 증가하게 된다. 이에 따라 Rz/Ra 값이 S면 대비 매우 높아지며, 동박 양면의 Rz/Ra 값의 차이는 바람직한 상한을 이탈하게 된다. 또한, Mo 농도가 25ppm 미만이면 Mo가 드럼의 전체 표면에 걸쳐 균일한 첨가제로서의 역할을 하지 못하여 국부적으로 불균일한 도금을 야기한다. 그 결과 동박의 M면에 얼룩 혹은 불균일 전착을 발생시키는데, 이러한 얼룩이나 불균일 도금은 후속 Li 이차전지 제조공정에서 음극재가 불균일하게 도포되게 되어 Li 이차전지 용량을 저하시키는 원인이 된다.

[50] 또한, 본 발명에서는 평활제로 사용되는 PEG의 농도를 제어함으로써 M면의 표면 프로파일을 바람직한 범위 내에서 유지되도록 할 수 있다. 본 발명에서 전해액 내의 폴리에틸렌글리콜(Polyethyleneglycol)의 농도는 5 내지 25 ppm 범위 내로 조정된다. PEG의 농도가 5ppm 미만이면 도금시 구리가 평활하게 전착되지 못하고 미세 요철이 발달된 표면 구조를 갖는다. 이로 인해 동박 M면의 PD 값이 높아지게 되고, M면과 S면의 PD 값 차이는 커지게 된다. 한편, PEG의 농도가 25ppm을 넘으면 전해액 내에 구리 도금이 평활하게 전착되어 Rz/Ra가 4.2 미만의 값을 가진다.

[51] 본 발명에서 상기 전해액(60)은 45 내지 65 ℃로 유지되고, 상기 전해조(10) 내로 공급되는 상기 전해액(20)의 유량은 35 내지 46 m^3/hour 범위로 유지되는 것이 바람직하다. 상기 전해액(20)의 유량이 35 m^3/hour 이하인 경우 회전 음극드럼(40) 표면에 구리 이온이 원활히 공급되지 못해 도금 박막이 불균일하게 형성되며, 상기 전해액(20)의 유량이 46 m^3/hour를 초과할 경우 필터를 통과하는 전해액(20)의 유속이 너무 빨라서 필터의 수명이 급격히 단축되는 원인이 된다.

[52]

[53] 이하 본 발명의 바람직한 실시예를 상술한다.

[54] <전해동박의 제조>

[55] 도 2에 도시된 것과 같은 장치를 사용하여 전해조 내의 전해액 내에 서로 이격되게 배치된 양극판 및 회전 음극드럼을 통전시킴으로써 상기 회전 음극드럼상에 구리막을 형성하였다.

[56] 전해액은 75g/L의 구리 이온, 100 g/L의 황산, 및 20 ppm의 염소 이온을 포함하는 용액에 SPS, Mo 및 PEG를 첨가함으로써 준비되었다. 전해액의 SPS, Mo 및 PEG 함량을 달리하여 상이한 함량 조건에서 구리막을 전착하였다. 이 때, 전해액의 온도는 약 55℃로 유지하고, 전류밀도는 60 A/dm^2, 유량은 40m^3/hr로 하였다. 또한, 동박 제조 전 동박 S면에서 상이한 표면 프로파일을 얻기 위하여 회전 음극드럼의 표면을 상이한 입도(거칠기)의 브러쉬로 버핑하여 실험을 수행하였다.

[57] 제조된 동박의 제박 조건을 아래 표 1에 나타내었다.

[58] [표1]

	SPS (ppm)	Mo (ppm)	PEG (ppm)	Brush (#)
실시예1	3	25	15	2000
실시예2	12	25	15	2000
실시예3	7	49	15	2000
실시예4	7	25	5	2000
비교예1	2	25	15	2000
비교예2	13	25	26	2000
비교예3	7	51	15	2000
비교예4	7	25	4	2000
비교예5	7	25	15	4000

[59] 이어서, 제조된 전해동박 시편(실시예 1 내지 4 및 비교예 1 내지 5)의 특성을 측정하였다. 각 특성에 대한 측정 방법은 다음과 같이 하였다.

[60] **집합조직 계수**

[61] 제작된 전해동박 시편의 M면에 대하여 회절각(2θ) 30°에서 95° 범위에서 X선 회절 패턴을 구하고, 결정면 (111), (200), (220) 및 (311)면을 기준으로 표준 Cu의 피크 강도로 정규화 된 평균 피크 강도에 대하여 (220)면의 정규화 된 피크 강도의 비율을 구하여 (220)면의 집합조직 계수로 하였다.

[62] **동박 표면 프로파일**

[63] 미투토요사 SJ-310 모델, 반경 2㎛인 스타일러스 팁을 사용하고, 측정 압력을 0.75mN으로 하여, JIS B 0601 (2001) 규격에 따라 Rz 및 Ra를 측정하였다. 이 때 컷 오프(Cut off) 길이를 제외한 측정 길이는 4mm이며, 컷 오프 길이는 초기와 말기 각각 0.8mm로 하였고, 각각 3회 측정값의 평균을 취하였다.

[64] 피크밀도(PD)는 ASME B46.1 규격에 따라 측정하며, 마흐(Mahr)사의 조도계(Marsurf M300 모델)와 반경 2㎛인 스타일러스 팁을 이용하여 피크 밀도를 측정하였다. 피크 카운트 레벨(Peak Count Level)은 프로파일의 중심선을 기준으로 ±0.5㎛로 하였고, 컷 오프 길이를 제외한 측정 길이는 4mm, 컷 오프 길이는 초기와 말기 각각 0.8mm로 하였다. 측정 압력은 0.7mN으로 하였다. 피크 밀도는 3회 측정값의 평균을 취하였다.

[65] **컬(curl)**

[66] 도 3과 같이, 실시예 및 비교예에서 제조된 전해동박의 M면 상의 임의의 지점에서 8cm X 8cm로 열십자 형태로 수직 이등분하도록 절개하여 4개의 절개부를 형성하였다. 절개 후 뾰족하게 튀어나온 4개의 절개부 모서리 높이를 측정하여 그 높이 측정값의 산술 평균값을 컬로 정의하였다.

[67] **주름 및 찢김**

[68] 롤투롤 공정에서 전해동박의 주름과 찢김이 발생하는지를 육안으로 관찰하였다. 도 4의 (a) 및 (b)는 각각 찢김 및 주름 발생 상태를 예시하는 사진이다.

[69] <음극의 제조>

[70] 전술한 실시예 및 비교예에서 제조된 전해동박으로 10cm 폭의 집전체를 준비하였다. 집전체 상에 음극활물질용으로 시판되는 인조 흑연 및 SiO_2 100 중량부에 대해 SBR(스티렌부타디엔고무) 2 중량부 및 CMC(카르복시메틸 셀룰로오스) 2 중량부를 혼합하고 증류수를 용제로 하여 슬러리를 제조하였다.

[71]

[72] 이어서, 표면이 깨끗한 유리판 위에 측정하고자 하는 전해동박 시편을 올려 놓은 후 주름, 구겨짐 등이 없도록 펼쳐 놓고, 동박 위에 바코터(Bar coater)를 사용하여 음극재 로딩(Loading)양이 9.0±0.5mg/㎠가 되도록 코팅하였다. 이 때, 바코터의 속도는 10~15mm/s의 속도로 실시하였다. 음극재가 코팅 된 동박을 100℃로 가열된 건조 오븐 에 넣어 15분 동안 건조하고, 건조된 동박 시편을 롤 프레스를 사용하여 전극 밀도 1.55±0.05g/cc가 되도록 4단 프레스하여 음극을 제조하였다. 제조된 음극으로 다음의 방법으로 밀착력을 측정하였다.

[73] 제조된 전극을 절단하여 10mm(폭) x 100mm(길이)의 시료를 얻고, 이 시료의 활물질 부분과 보강판을 양면 테이프로로 접착하였다. 이때 제작 되는 모든 시료는 균일한 힘으로 부착 될 수 있도록 하였다. UTM 장치를 이용하여 제작된 시편의 접착력(밀착력)을 측정하였다.

[74] -. Crosshead speed : 50.0mm/min.

[75] -. 측정 길이 : 20~50mm

[76] -. 90° Peeling 테스트

[77]

[78] <Li 이차전지의 제조>

[79] 에틸렌카보네이트(EC) 및 에틸메틸카보네이트(EMC)를 1:2의 비율로 혼합한 비수성 유기용매에 용질로서 $LiPF_6$을 1M 용해시킨 것을 기본 전해액으로 하고, 이 기본 전해액 99.5중량%와 숙신산 무수물(Succinic anhydride) 0.5중량%를 혼합하여 비수전해액을 제조하였다.

[80] $Li_{1.1}Mn_{1.8}5Al_{0.05}O_4$인 리튬 망간 산화물과 o-$LiMnO_2$인 사방정(orthorhombic) 결정구조의 리튬 망간 산화물을 중량비 90:10으로 혼합하여, 양극 활물질을 제조하였다. 상기 양극 활물질과 카본 블랙을 결착제인 PVDF[Poly(vinylidenefluoride)]와 85:10:5의 중량비로 유기 용매인 NMP와 혼합하여 슬러리를 제조하였다. 제조된 슬러리를 두께 20 ㎛인 Al 박(foil) 양면에 도포한 후 건조하여 양극을 제작하였다. 제조된 양극, 음극 및 전해액으로 Li 이차전지 셀을 제조하였다.

[81] 아래 표 2는 본 발명의 실시예에 따라 제조된 전해동박 시편의 물성 측정 결과 및 그 전해동박으로 제조된 음극의 밀착력 측정 결과를 나타낸 표이다.

[82] [표2]

	실시예1	실시예2	실시예3	실시예4	비교예1	비교예2	비교예3	비교예4	비교예5
집합조직계수	0.4	1.32	0.78	0.78	0.32	1.41	0.78	0.78	0.78
|Δ(Rz/Ra)|	0.85	0.85	2.42	0.85	0.85	0.85	2.43	0.85	2.43
Rz/Ra (M면)	4.22	4.21	9.00	4.21	4.21	4.08	9.13	4.22	4.22
Rz/Ra (S면)	3.37	3.36	6.58	3.36	3.36	3.23	6.70	3.37	1.79
|ΔPD|(ea/cm)	38	38	38	96	38	38	38	97	38
M면 PD(ea/cm)	48	48	48	105	48	48	48	107	48
S면 PD(ea/cm)	10	10	10	9	10	10	10	10	10
컬 (mm)	5.6	5.5	8.7	8.6	5.2	5.4	11.5	11.6	11.6
주름	no	no	no	no	yes	no	no	no	no
찢김	no	no	no	no	no	yes	no	no	no
밀착력 (N/m)	26.4	26.4	28.4	26.4	26.8	15.5	15.4	26.7	26.3

[83] 표 2를 참조하면, 실시예 1 내지 4에 따라 제조된 전해동박 샘플은 모두 10mm 이하의 양호한 컬 값을 나타내었다. 이와 같은 컬 값 범위를 갖는 전해동박 은 동박 제조공정이나 후속 전지 제조 공정에서 접힘을 발생하지 않게 된다. 한편, 비교예 1 및 비교예 2의 경우 실시예와 유사한 수준의 |Δ(Rz/Ra)| 및 |ΔPD|을 나타내고 있지만, 롤투롤 공정에서 주름 또는 찢김 현상이 관찰되었다. 이것은 각각 (220) 집합계수가 0.40 미만의 값을 가져 동박의 결정 조직이 치밀하지 못하여 전지 제조 공정에서 겪는 응력 및 열에 의해 조직이 변형되어 주름을 발생시키거나 (220) 집합조직 계수가 1.32를 초과하여 동박의 조직이 너무 치밀하여 취성을 가진 것에 기인한다.

[84] 한편, 비교예 3의 경우 M면의 Rz/Ra가 매우 높은 값(9.13)을 나타내며 그로 인해 |Δ(Rz/Ra)|가 2.42를 초과하여 높은 컬 값을 나타냄을 알 수 있다. 또한, 비교예 4의 경우 PEG의 함량이 작아 미세 요철이 발달된 표면 구조를 나타내어 동박 M면의 PD 값(97ea)이 높아지고 이로 인해 컬 값이 증가하게 됨을 알 수

있다. 한편, 비교예 5의 경우 S면의 Rz/Ra 값이 매우 낮은 값을 가지며 |Δ(Rz/Ra)|가 2.42를 초과하고 있는데, 이것은 회전 음극드럼의 표면 프로파일에 기인하는 것이다.

[85] 한편, 비교예 2 및 3의 경우, 제조된 음극이 낮은 밀착력 값을 나타내고 있다. 이와 같이 밀착력이 20 N/m 미만인 경우에는 Li 이차전지 제조후 충반전시 동박 표면에서 음극재가 탈리되어 충전 용량이 급격히 저하될 수 있다. 비교예 2 및 3은 각각 (220) 집합조직 계수가 낮거나 M면의 Rz/Ra가 낮은 값을 나타내어 음극재와 충분한 결합력을 형성할 수 없다. 그 이유는 동의 결정 조직이 치밀하지 못하거나 또는 비표면적이 낮은 것에 기인한다.

[86] 이상, 본 발명의 실시예를 통해 본 발명을 상술하였지만, 전술한 실시예는 본 발명의 기술 사상을 예시적으로 설명한 것에 불과한 것으로서, 본 발명이 속하는 기술 분야에서 통상의 지식을 가진 자라면 본 발명의 본질적인 특성에서 벗어나지 않는 범위에서 다양한 수정 및 변형이 가능함을 알 수 있을 것이다. 따라서, 본 발명에 개시된 실시 예는 본 발명의 기술 사상을 한정하기 위한 것이 아니라 설명하기 위한 것이고, 이러한 실시 예에 의하여 본 발명의 기술 사상의 범위가 한정되는 것은 아니다. 본 발명의 보호 범위는 아래의 청구범위에 의하여 해석되고, 그와 동등한 범위 내에 있는 모든 기술 사상은 본 발명의 권리범위에 포함되는 것으로 해석되어야 할 것이다.

청구범위

[청구항 1] 제1 표면 및 상기 제2 표면을 갖는 전해동박에 있어서,
상기 전해동박은 다음의 수학식 1에 의해 정의되는 (220)면의 집합조직 계수가 0.4~1.32이고,
(수학식 1)

$$TC(220) = \frac{\frac{I(220)}{I_0(220)}}{\frac{1}{n}\Sigma\frac{I(hkl)}{I_0(hkl)}}$$

상기 전해동박의 제1 표면에서의 Rz/Ra와 제2 표면에서의 Rz/Ra 차이(|Δ(Rz/Ra)|)가 2.42 미만이며,
상기 전해동박의 제1 표면 및 제2 표면에서의 피크 밀도(PD) 차이(|ΔPD|)가 96ea 이하인 것을 특징으로 하는 전해동박.

[청구항 2] 제1항에 있어서,
상기 제2 표면은 M면이고,
상기 제2 표면에서의 Rz/Ra가 4.2 ~ 9.0 인 것을 특징으로 하는 전해동박.

[청구항 3] 제2항에 있어서,
상기 제1 표면은 S면이고,
상기 전해동박은 S면의 Rz/Ra가 5.1 ~ 6.8인 것을 특징으로 하는 전해동박.

[청구항 4] 제1항에 있어서,
상기 전해동박은 상온에서의 인장강도가 30~65 kg/mm^{2}인 것을 특징으로 하는 전해동박.

[청구항 5] 제1항에 있어서,
상기 전해동박은 상온에서의 연신율이 3% 이상인 것을 특징으로 하는 전해동박.

[청구항 6] 제1항에 있어서,
상기 전해동박은 폭 방향 중량편차가 5% 이하인 것을 특징으로 하는 전해동박.

[청구항 7] 제1항에 있어서,
상기 전해동박은,
8cm X 8cm로 열십자 형태로 수직 이등분하도록 절개하여 4개의 절개부를 형성한 후 돌출된 4개의 절개부 모서리 높이를 측정한 평균값이 10 mm 미만인 것을 특징으로 하는 전해동박.

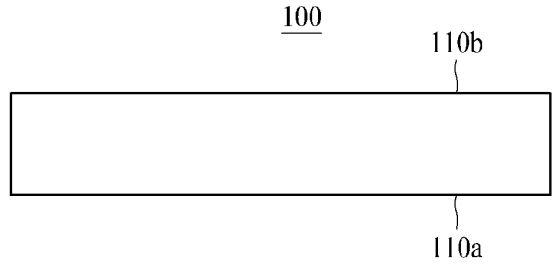
[청구항 8] 전해조의 전해액 내에 서로 이격되게 배치된 양극판 및 회전 음극드럼 사이에 전류를 인가하여 상기 회전 음극드럼 상에 구리막을 전기 도금하여 전해동박을 제조하는 방법에 있어서;
상기 회전 음극드럼의 표면을 500# 내지 3000# 입도를 가지는 브러쉬로

버핑하는 단계;
상기 버핑된 회전 음극드럼 상에 구리막을 전착하는 단계; 및
도금된 상기 구리막을 권취하는 단계를 포함하되,
상기 전해액은 70 내지 90 g/L의 구리 이온, 80 내지 120 g/L의 황산, 10 내지 20 ppm의 염소 이온, 3 내지 12 ppm의 황화물계 화합물, 25 내지 50 ppm의 Mo, 및 5 내지 25 ppm의 PEG를 포함하는 것을 특징으로 하는 전해동박의 제조 방법.

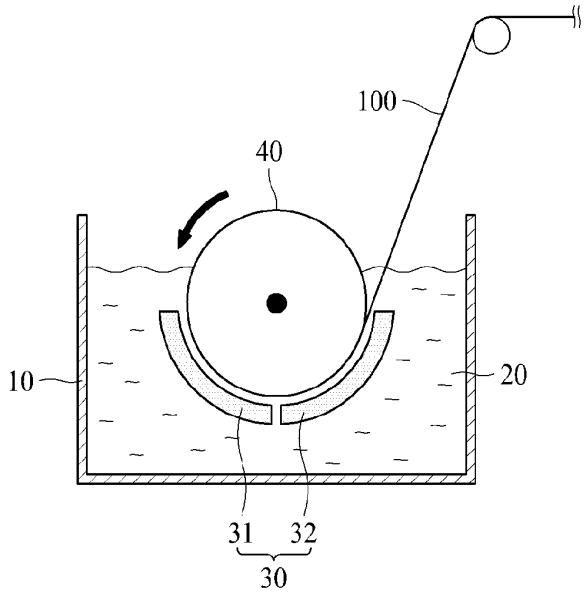
[청구항 9] 제8항에 있어서,
상기 황화물계 화합물은 SPS, MPS 및 ZPS로 이루어진 그룹 중에서 선택되는 것을 특징으로 하는 전해동박의 제조 방법.

[청구항 10] 제8항에 있어서,
상기 황화물계 화합물은 SPS인 것을 특징으로 하는 전해동박의 제조 방법.

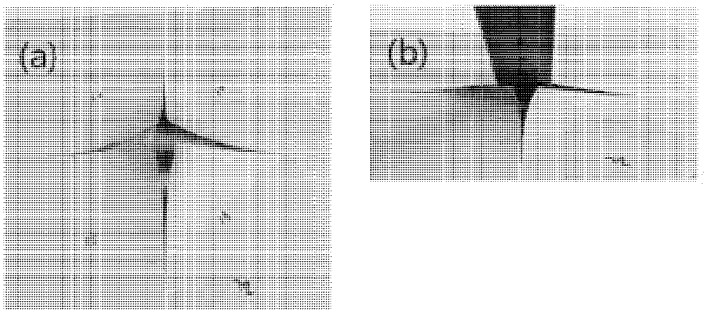
[도1]



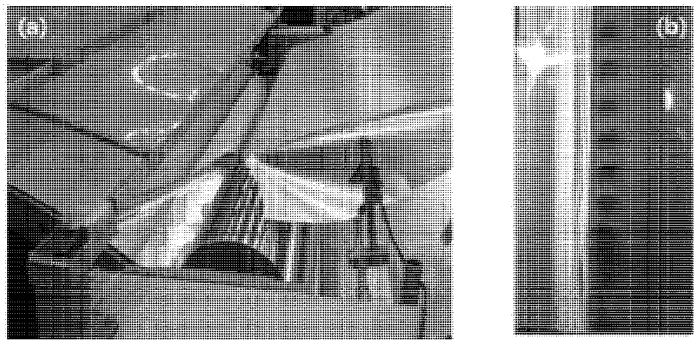
[도2]



[도3]



[도4]



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U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE
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TRANSMITTAL LETTER TO THE UNITED STATES DESIGNATED/ELECTED OFFICE (DO/EO/US) CONCERNING A SUBMISSION UNDER 35 U.S.C. 371

Attorney Docket No.	
0313221.00022	
U.S. Application No. (if known, see 37 CFR 1.5)	

International Application No.	International Filing Date	Priority Date Claimed
PCT/KR2019/001069	January 25, 2019	January 31, 2018

Title of Invention
ELECTROLYTIC COPPER FOIL HAVING EXCELLENT HANDLING CHARACTERISTICS IN POSTPROCESSING, AND MANUFACTURING METHOD THEREFOR

First Named Inventor
Seung Min KIM

Applicant herewith submits to the United States Designated/Elected Office (DO/EO/US) the following items and other information.

1. ☒ This is an express request to begin national examination procedures (35 U.S.C. 371(f)). NOTE: The express request under 35 U.S.C. 371(f) will not be effective unless the requirements under 35 U.S.C. 371(c)(1), (2), and (4) for payment of the basic national fee, copy of the International Application and English translation thereof (if required), and the oath or declaration of the inventor(s) have been received.
2. ☒ A copy of the International Application (35 U.S.C. 371(c)(2)) is attached hereto (not required if the International Application was previously communicated by the International Bureau or was filed in the United States Receiving Office (RO/US)).
3. An English language translation of the International Application (35 U.S.C. 371(c)(2))
   a. ☒ is attached hereto.
   b. ☐ has been previously submitted under 35 U.S.C. 154(d)(4).
4. An oath or declaration of the inventor(s) (35 U.S.C. 371(c)(4))
   a. ☐ is attached.
   b. ☐ was previously filed in the international phase under PCT Rule 4.17(iv).

Items 5 to 8 below concern amendments made in the international phase.

PCT Article 19 and 34 amendments

5. ☐ Amendments to the claims under PCT Article 19 are attached (not required if communicated by the International Bureau) (35 U.S.C. 371(c)(3)).
6. ☐ English translation of the PCT Article 19 amendment is attached (35 U.S.C. 371(c)(3)).
7. ☐ English translation of annexes (Article 19 and/or 34 amendments only) of the International Preliminary Examination Report is attached (35 U.S.C. 371(c)(5)).

Cancellation of amendments made in the international phase

8a. ☐ Do not enter the amendment made in the international phase under PCT Article 19.

8b. ☐ Do not enter the amendment made in the international phase under PCT Article 34.

NOTE: A proper amendment made in English under Article 19 or 34 will be entered in the U.S. national phase application absent a clear instruction from applicant not to enter the amendment(s).

The following items 9 to 17 concern a document(s) or information included.

9. ☒ An Information Disclosure Statement under 37 CFR 1.97 and 1.98.
10. ☒ A preliminary amendment.
11. ☒ An Application Data Sheet under 37 CFR 1.76.
12. ☐ A substitute specification. NOTE: A substitute specification cannot include claims. See 37 CFR 1.125(b).
13. ☒ A power of attorney and/or change of address letter.
14. ☐ A computer-readable form of the sequence listing in accordance with PCT Rule 13*ter*.3 and 37 CFR 1.821-1.825 (not required if sequence listing in text format was indicated on the PCT Request as part of the International Application and the sequence listing was published as part of the international application).
15. ☐ Assignment papers *(cover sheet and document(s))*. Name of Assignee: _____
16. ☐ 37 CFR 3.73(c) Statement *(when there is an Assignee)*.

This collection of information is required by 37 CFR 1.414 and 1.491-1.492. The information is required to obtain or retain a benefit by the public, which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.11 and 1.14. This collection is estimated to take 15 minutes to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. SEND TO: Mail Stop PCT, Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.

U.S. APPLN. No. (if known – see 37 CFR 1.5)	INTERNATIONAL APPLICATION No.	ATTORNEY DOCKET No.
	PCT/KR2019/001069	0313221.00022

17. ☐ Other items or information:

The following fees have been submitted.	CALCULATIONS
18. ■ Basic national fee (37 CFR 1.492(a)) **$300**	$ 300.00
19. ■ Examination fee (37 CFR 1.492(c)) • If the written opinion prepared by ISA/US or the international preliminary examination report prepared by IPEA/US indicates all claims satisfy provisions of PCT Article 33(1)-(4)..... **$0** • All other situations **$760**	$ 760.00
20. ■ Search fee (37 CFR 1.492(b)) • If the written opinion prepared by ISA/US or the international preliminary examination report prepared by IPEA/US indicates all claims satisfy provisions of PCT Article 33(1)-(4)..... **$0** • Search fee (37 CFR 1.445(a)(2)) has been paid on the international application to the USPTO as an International Searching Authority ..... **$140** • International Search Report prepared by an ISA other than the US and provided to the Office or previously communicated to the US by the IB..... **$520** • All other situations **$660**	520.00 $
TOTAL OF 18, 19, and 20 =	$ 1580.00

☐ Additional fee for specification and drawings filed in paper over 100 sheets (excluding sequence listing in compliance with 37 CFR 1.821(c) or (e) in an electronic medium or computer program listing in an electronic medium) (37 CFR 1.492(j)).

Fee for each additional 50 sheets of paper or fraction thereof **$400**

Total Sheets	Extra Sheets	Number of each additional 50 or fraction thereof (round **up** to a whole number)	RATE
- 100 =	/ 50 =		x **$400**

$

Surcharge for furnishing any of the search fee, examination fee, or the oath or declaration after the date of commencement of the national stage (37 CFR 1.492(h))..... **$140** $

CLAIMS	NUMBER FILED	NUMBER EXTRA	RATE	
Total claims	10 - 20 =		x **$100**	$
Independent claims	2 - 3 =		x **$460**	$
MULTIPLE DEPENDENT CLAIM(S) (if applicable)			**+ $820**	$

Fee for submission of Sequence Listing text file of 300 MB to 800 MB (37 CFR 1.21(o)(1))..... **$1,000**	$
Fee for submission of Sequence Listing text file of more than 800 MB (37 CFR 1.21(o)(2))..... **$10,000**	$
Processing fee for furnishing the English translation later than 30 months from the earliest claimed priority date (37 CFR 1.492(i))..... **$140** +	$
TOTAL OF ABOVE CALCULATIONS =	$ 1580.00
☐ **Applicant asserts small entity status.** See 37 CFR 1.27. Fees above are reduced by ½.	
☐ **Applicant certifies micro entity status.** See 37 CFR 1.29. Fees above are reduced by ¾. Applicant must attach form PTO/SB/15A or B or equivalent.	
TOTAL NATIONAL FEE =	$ 1580.00
Fee for recording the enclosed assignment (37 CFR 1.21(h)). The assignment must be accompanied by an appropriate cover sheet (37 CFR 3.28, 3.31)..... **$50.00** per property +	$
TOTAL FEES ENCLOSED =	$ 1580.00

a. ☐ A check in the amount of $_____ to cover the above fees is enclosed.

b. ☒ Please charge my Deposit Account No. 02-1818 in the amount of $1580.00 to cover the above fees.

c. ☒ The Director is hereby authorized to charge additional fees which may be required, or credit any overpayment, to Deposit Account No. 02-1818 as follows:

i. ☐ any required fee.

ii. ☒ any required fee except for excess claims fees required under 37 CFR 1.492(d) and (e) and multiple dependent claim fee required under 37 CFR 1.492(f).

d. ☐ Fees are to be charged to a credit card. **WARNING:** Information on this form may become public. Credit card information should not be included on this form. Provide credit card information and authorization on PTO-2038. The PTO-2038 should only be mailed or faxed to the USPTO. However, when paying the basic national fee, the PTO-2038 may NOT be faxed to the USPTO.

ADVISORY: If filing by EFS-Web, do **NOT** attach the PTO-2038 form as a PDF along with your EFS-Web submission. Please be advised that this is **not** recommended and by doing so your **credit card information may be displayed via PAIR**. To protect your information, it is recommended to pay fees online by using the electronic payment method.

NOTE: Where an appropriate time limit under 37 CFR 1.495 has not been met, a petition to revive (37 CFR 1.137(a) or (b)) must be filed and granted to restore the International Application to pending status.

Statement under 37 CFR 1.55 or 1.78 for AIA (First Inventor to File) Transition Applications

☐ This application (1) claims priority to or the benefit of an application filed before March 16, 2013, and (2) also contains, or contained at any time, a claim to a claimed invention that has an effective filing date on or after March 16, 2013.

NOTE 1: By providing this statement under 37 CFR 1.55 or 1.78, **this application, with a filing date on or after March 16, 2013, will be examined under the first inventor to file provisions of the AIA**.

NOTE 2: A U.S. national stage application may not claim priority to the international application of which it is the national phase. The filing date of a U.S. national stage application is the international filing date. See 35 U.S.C. 363.

Correspondence Address

☒ The address associated with Customer Number: 24573 **OR** ☐ Correspondence address below

Name					
Address					
City		State		Zip Code	
Country			Telephone		
Email					

Signature	/Matthew S. Dicke/	Date	2020-06-30
Name (Print/Type)	Matthew S. Dicke	Registration No. (Attorney/Agent)	58819

Privacy Act Statement

The **Privacy Act of 1974 (P.L. 93-579)** requires that you be given certain information in connection with your submission of the attached form related to a patent application or patent. Accordingly, pursuant to the requirements of the Act, please be advised that: (1) the general authority for the collection of this information is 35 U.S.C. 2(b)(2); (2) furnishing of the information solicited is voluntary; and (3) the principal purpose for which the information is used by the U.S. Patent and Trademark Office is to process and/or examine your submission related to a patent application or patent. If you do not furnish the requested information, the U.S. Patent and Trademark Office may not be able to process and/or examine your submission, which may result in termination of proceedings or abandonment of the application or expiration of the patent.

The information provided by you in this form will be subject to the following routine uses:

1. The information on this form will be treated confidentially to the extent allowed under the Freedom of Information Act (5 U.S.C. 552) and the Privacy Act (5 U.S.C 552a). Records from this system of records may be disclosed to the Department of Justice to determine whether disclosure of these records is required by the Freedom of Information Act.
2. A record from this system of records may be disclosed, as a routine use, in the course of presenting evidence to a court, magistrate, or administrative tribunal, including disclosures to opposing counsel in the course of settlement negotiations.
3. A record in this system of records may be disclosed, as a routine use, to a Member of Congress submitting a request involving an individual, to whom the record pertains, when the individual has requested assistance from the Member with respect to the subject matter of the record.
4. A record in this system of records may be disclosed, as a routine use, to a contractor of the Agency having need for the information in order to perform a contract. Recipients of information shall be required to comply with the requirements of the Privacy Act of 1974, as amended, pursuant to 5 U.S.C. 552a(m).
5. A record related to an International Application filed under the Patent Cooperation Treaty in this system of records may be disclosed, as a routine use, to the International Bureau of the World Intellectual Property Organization, pursuant to the Patent Cooperation Treaty.
6. A record in this system of records may be disclosed, as a routine use, to another federal agency for purposes of National Security review (35 U.S.C. 181) and for review pursuant to the Atomic Energy Act (42 U.S.C. 218(c)).
7. A record from this system of records may be disclosed, as a routine use, to the Administrator, General Services, or his/her designee, during an inspection of records conducted by GSA as part of that agency's responsibility to recommend improvements in records management practices and programs, under authority of 44 U.S.C. 2904 and 2906. Such disclosure shall be made in accordance with the GSA regulations governing inspection of records for this purpose, and any other relevant (*i.e.*, GSA or Commerce) directive. Such disclosure shall not be used to make determinations about individuals.
8. A record from this system of records may be disclosed, as a routine use, to the public after either publication of the application pursuant to 35 U.S.C. 122(b) or issuance of a patent pursuant to 35 U.S.C. 151. Further, a record may be disclosed, subject to the limitations of 37 CFR 1.14, as a routine use, to the public if the record was filed in an application which became abandoned or in which the proceedings were terminated and which application is referenced by either a published application, an application open to public inspection or an issued patent.
9. A record from this system of records may be disclosed, as a routine use, to a Federal, State, or local law enforcement agency, if the USPTO becomes aware of a violation or potential violation of law or regulation.

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Application Data Sheet 37 CFR 1.76	Attorney Docket Number	0313221.00022
	Application Number	
Title of Invention	ELECTROLYTIC COPPER FOIL HAVING EXCELLENT HANDLING CHARACTERISTICS IN POSTPROCESSING, AND MANUFACTURING METHOD THEREFOR	

The application data sheet is part of the provisional or nonprovisional application for which it is being submitted. The following form contains the bibliographic data arranged in a format specified by the United States Patent and Trademark Office as outlined in 37 CFR 1.76.
This document may be completed electronically and submitted to the Office in electronic format using the Electronic Filing System (EFS) or the document may be printed and included in a paper filed application.

Secrecy Order 37 CFR 5.2:

☐ Portions or all of the application associated with this Application Data Sheet may fall under a Secrecy Order pursuant to 37 CFR 5.2 (Paper filers only. Applications that fall under Secrecy Order may not be filed electronically.)

Inventor Information:

Inventor 1 Remove

Legal Name

Prefix	Given Name	Middle Name	Family Name	Suffix
	Seung	Min	KIM	

Residence Information (Select One) US Residency ● Non US Residency Active US Military Service

City	Anyang-si, Gyeonggi-do	Country of Residence [i]	KR

Mailing Address of Inventor:

Address 1	4F., 39, LS-ro 116beon-gil, Dongan-gu
Address 2	

City	Anyang-si, Gyeonggi-do	State/Province	
Postal Code	14118	**Country** [i]	KR

Inventor 2 Remove

Legal Name

Prefix	Given Name	Middle Name	Family Name	Suffix
	Shan	Hua	JIN	

Residence Information (Select One) US Residency ◉ Non US Residency Active US Military Service

City	Anyang-si, Gyeonggi-do	Country of Residence [i]	KR

Mailing Address of Inventor:

Address 1	4F., 39, LS-ro 116beon-gil, Dongan-gu
Address 2	

City	Anyang-si, Gyeonggi-do	State/Province	
Postal Code	14118	**Country** [i]	KR

All Inventors Must Be Listed - Additional Inventor Information blocks may be generated within this form by selecting the **Add** button. Add

Correspondence Information:

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Application Data Sheet 37 CFR 1.76	Attorney Docket Number	0313221.00022
	Application Number	
Title of Invention	ELECTROLYTIC COPPER FOIL HAVING EXCELLENT HANDLING CHARACTERISTICS IN POSTPROCESSING, AND MANUFACTURING METHOD THEREFOR	

Enter either Customer Number or complete the Correspondence Information section below.
For further information see 37 CFR 1.33(a).

☐ **An Address is being provided for the correspondence Information of this application.**

Customer Number	24573		
Email Address	chicago.patents@klgates.com	Add Email	Remove Email

Application Information:

Title of the Invention	ELECTROLYTIC COPPER FOIL HAVING EXCELLENT HANDLING CHARACTERISTICS IN POSTPROCESSING, AND MANUFACTURING METHOD THEREFOR		
Attorney Docket Number	0313221.00022	**Small Entity Status Claimed**	☐
Application Type	Nonprovisional		
Subject Matter	Utility		
Total Number of Drawing Sheets (if any)	2	**Suggested Figure for Publication (if any)**	

Filing By Reference:

Only complete this section when filing an application by reference under 35 U.S.C. 111(c) and 37 CFR 1.57(a). Do not complete this section if application papers including a specification and any drawings are being filed. Any domestic benefit or foreign priority information must be provided in the appropriate section(s) below (i.e., "Domestic Benefit/National Stage Information" and "Foreign Priority Information").

For the purposes of a filing date under 37 CFR 1.53(b), the description and any drawings of the present application are replaced by this reference to the previously filed application, subject to conditions and requirements of 37 CFR 1.57(a).

Application number of the previously filed application	Filing date (YYYY-MM-DD)	Intellectual Property Authority or Country

Publication Information:

☐ Request Early Publication (Fee required at time of Request 37 CFR 1.219)

☐ **Request Not to Publish.** I hereby request that the attached application not be published under 35 U.S.C. 122(b) and certify that the invention disclosed in the attached application **has not and will not** be the subject of an application filed in another country, or under a multilateral international agreement, that requires publication at eighteen months after filing.

Representative Information:

Representative information should be provided for all practitioners having a power of attorney in the application. Providing this information in the Application Data Sheet does not constitute a power of attorney in the application (see 37 CFR 1.32).
Either enter Customer Number or complete the Representative Name section below. If both sections are completed the customer Number will be used for the Representative Information during processing.

Please Select One:	● Customer Number	US Patent Practitioner	○ Limited Recognition (37 CFR 11.9)
Customer Number	24573		

Application Data Sheet 37 CFR 1.76	Attorney Docket Number	0313221.00022
	Application Number	
Title of Invention	ELECTROLYTIC COPPER FOIL HAVING EXCELLENT HANDLING CHARACTERISTICS IN POSTPROCESSING, AND MANUFACTURING METHOD THEREFOR	

Domestic Benefit/National Stage Information:

This section allows for the applicant to either claim benefit under 35 U.S.C. 119(e), 120, 121, 365(c), or 386(c) or indicate National Stage entry from a PCT application. Providing benefit claim information in the Application Data Sheet constitutes the specific reference required by 35 U.S.C. 119(e) or 120, and 37 CFR 1.78.
When referring to the current application, please leave the "Application Number" field blank.

Prior Application Status			Remove
Application Number	Continuity Type	Prior Application Number	Filing or 371(c) Date (YYYY-MM-DD)
	a 371 of international	PCT/KR2019/001069	2019-01-25

Additional Domestic Benefit/National Stage Data may be generated within this form by selecting the **Add** button. Add

Foreign Priority Information:

This section allows for the applicant to claim priority to a foreign application. Providing this information in the application data sheet constitutes the claim for priority as required by 35 U.S.C. 119(b) and 37 CFR 1.55. When priority is claimed to a foreign application that is eligible for retrieval under the priority document exchange program (PDX)[i] the information will be used by the Office to automatically attempt retrieval pursuant to 37 CFR 1.55(i)(1) and (2). Under the PDX program, applicant bears the ultimate responsibility for ensuring that a copy of the foreign application is received by the Office from the participating foreign intellectual property office, or a certified copy of the foreign priority application is filed, within the time period specified in 37 CFR 1.55(g)(1).

Remove

Application Number	Country[i]	Filing Date (YYYY-MM-DD)	Access Code[i] (if applicable)
10-2018-0012179	KR	2018-01-31	

Additional Foreign Priority Data may be generated within this form by selecting the **Add** button. Add

Statement under 37 CFR 1.55 or 1.78 for AIA (First Inventor to File) Transition Applications

☐ This application (1) claims priority to or the benefit of an application filed before March 16, 2013 and (2) also contains, or contained at any time, a claim to a claimed invention that has an effective filing date on or after March 16, 2013.
NOTE: By providing this statement under 37 CFR 1.55 or 1.78, this application, with a filing date on or after March 16, 2013, will be examined under the first inventor to file provisions of the AIA.

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Application Data Sheet 37 CFR 1.76	Attorney Docket Number	0313221.00022
	Application Number	
Title of Invention	ELECTROLYTIC COPPER FOIL HAVING EXCELLENT HANDLING CHARACTERISTICS IN POSTPROCESSING, AND MANUFACTURING METHOD THEREFOR	

Authorization or Opt-Out of Authorization to Permit Access:

When this Application Data Sheet is properly signed and filed with the application, applicant has provided written authority to permit a participating foreign intellectual property (IP) office access to the instant application-as-filed (see paragraph A in subsection 1 below) and the European Patent Office (EPO) access to any search results from the instant application (see paragraph B in subsection 1 below).

Should applicant choose not to provide an authorization identified in subsection 1 below, applicant **must opt-out** of the authorization by checking the corresponding box A or B or both in subsection 2 below.

NOTE: This section of the Application Data Sheet is **ONLY** reviewed and processed with the **INITIAL** filing of an application. After the initial filing of an application, an Application Data Sheet cannot be used to provide or rescind authorization for access by a foreign IP office(s). Instead, Form PTO/SB/39 or PTO/SB/69 must be used as appropriate.

1. Authorization to Permit Access by a Foreign Intellectual Property Office(s)

A. Priority Document Exchange (PDX) - Unless box A in subsection 2 (opt-out of authorization) is checked, the undersigned hereby **grants the USPTO authority** to provide the European Patent Office (EPO), the Japan Patent Office (JPO), the Korean Intellectual Property Office (KIPO), the State Intellectual Property Office of the People's Republic of China (SIPO), the World Intellectual Property Organization (WIPO), and any other foreign intellectual property office participating with the USPTO in a bilateral or multilateral priority document exchange agreement in which a foreign application claiming priority to the instant patent application is filed, access to: (1) the instant patent application-as-filed and its related bibliographic data, (2) any foreign or domestic application to which priority or benefit is claimed by the instant application and its related bibliographic data, and (3) the date of filing of this Authorization. See 37 CFR 1.14(h)(1).

B. Search Results from U.S. Application to EPO - Unless box B in subsection 2 (opt-out of authorization) is checked, the undersigned hereby **grants the USPTO authority** to provide the EPO access to the bibliographic data and search results from the instant patent application when a European patent application claiming priority to the instant patent application is filed. See 37 CFR 1.14(h)(2).

The applicant is reminded that the EPO's Rule 141(1) EPC (European Patent Convention) requires applicants to submit a copy of search results from the instant application without delay in a European patent application that claims priority to the instant application.

2. Opt-Out of Authorizations to Permit Access by a Foreign Intellectual Property Office(s)

☐ A. Applicant **DOES NOT** authorize the USPTO to permit a participating foreign IP office access to the instant application-as-filed. If this box is checked, the USPTO will not be providing a participating foreign IP office with any documents and information identified in subsection 1A above.

☐ B. Applicant **DOES NOT** authorize the USPTO to transmit to the EPO any search results from the instant patent application. If this box is checked, the USPTO will not be providing the EPO with search results from the instant application.

NOTE: Once the application has published or is otherwise publicly available, the USPTO may provide access to the application in accordance with 37 CFR 1.14.

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Application Data Sheet 37 CFR 1.76	Attorney Docket Number	0313221.00022
	Application Number	
Title of Invention	ELECTROLYTIC COPPER FOIL HAVING EXCELLENT HANDLING CHARACTERISTICS IN POSTPROCESSING, AND MANUFACTURING METHOD THEREFOR	

Applicant Information:

Providing assignment information in this section does not substitute for compliance with any requirement of part 3 of Title 37 of CFR to have an assignment recorded by the Office.

Applicant 1 — Remove

If the applicant is the inventor (or the remaining joint inventor or inventors under 37 CFR 1.45), this section should not be completed. The information to be provided in this section is the name and address of the legal representative who is the applicant under 37 CFR 1.43; or the name and address of the assignee, person to whom the inventor is under an obligation to assign the invention, or person who otherwise shows sufficient proprietary interest in the matter who is the applicant under 37 CFR 1.46. If the applicant is an applicant under 37 CFR 1.46 (assignee, person to whom the inventor is obligated to assign, or person who otherwise shows sufficient proprietary interest) together with one or more joint inventors, then the joint inventor or inventors who are also the applicant should be identified in this section.

Clear

● Assignee	Legal Representative under 35 U.S.C. 117	Joint Inventor
Person to whom the inventor is obligated to assign.	Person who shows sufficient proprietary interest	

If applicant is the legal representative, indicate the authority to file the patent application, the inventor is:

Name of the Deceased or Legally Incapacitated Inventor:

If the Applicant is an Organization check here. ☒

Organization Name	KCF Technologies Co., Ltd.		
Mailing Address Information For Applicant:			
Address 1	4F., 39, LS-ro 116beon-gil, Dongan-gu		
Address 2			
City	Anyang-si, Gyeonggi-do	**State/Province**	
Country	KR	Postal Code	14118
Phone Number		Fax Number	
Email Address			

Additional Applicant Data may be generated within this form by selecting the Add button. Add

Assignee Information including Non-Applicant Assignee Information:

Providing assignment information in this section does not substitute for compliance with any requirement of part 3 of Title 37 of CFR to have an assignment recorded by the Office.

PTO/AIA/14 (02-18)
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Application Data Sheet 37 CFR 1.76	Attorney Docket Number	0313221.00022
	Application Number	
Title of Invention	ELECTROLYTIC COPPER FOIL HAVING EXCELLENT HANDLING CHARACTERISTICS IN POSTPROCESSING, AND MANUFACTURING METHOD THEREFOR	

Assignee 1

Complete this section if assignee information, including non-applicant assignee information, is desired to be included on the patent application publication. An assignee-applicant identified in the "Applicant Information" section will appear on the patent application publication as an applicant. For an assignee-applicant, complete this section only if identification as an assignee is also desired on the patent application publication.

Remove

If the Assignee or Non-Applicant Assignee is an Organization check here. ☐

Prefix	**Given Name**	Middle Name	**Family Name**	Suffix

Mailing Address Information For Assignee including Non-Applicant Assignee:

Address 1			
Address 2			
City		**State/Province**	
Country i		Postal Code	
Phone Number		Fax Number	
Email Address			

Additional Assignee or Non-Applicant Assignee Data may be generated within this form by selecting the Add button. Add

Signature:

Remove

NOTE: This Application Data Sheet must be signed in accordance with 37 CFR 1.33(b). **However, if this Application Data Sheet is submitted with the INITIAL filing of the application and either box A or B is not checked in subsection 2 of the "Authorization or Opt-Out of Authorization to Permit Access" section, then this form must also be signed in accordance with 37 CFR 1.14(c).**

This Application Data Sheet **must** be signed by a patent practitioner if one or more of the applicants is a **juristic entity** (e.g., corporation or association). If the applicant is two or more joint inventors, this form must be signed by a patent practitioner, **all** joint inventors who are the applicant, or one or more joint inventor-applicants who have been given power of attorney (e.g., see USPTO Form PTO/AIA/81) on behalf of **all** joint inventor-applicants.

See 37 CFR 1.4(d) for the manner of making signatures and certifications.

Signature	/Matthew S. Dicke/			Date (YYYY-MM-DD)	2020-06-30
First Name	Matthew S.	Last Name	Dicke	Registration Number	58819

Additional Signature may be generated within this form by selecting the Add button. Add

PTO/AIA/14 (02-18)
Approved for use through 11/30/2020. OMB 0651-0032
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE
Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it contains a valid OMB control number.

Application Data Sheet 37 CFR 1.76	Attorney Docket Number	0313221.00022
	Application Number	
Title of Invention	ELECTROLYTIC COPPER FOIL HAVING EXCELLENT HANDLING CHARACTERISTICS IN POSTPROCESSING, AND MANUFACTURING METHOD THEREFOR	

This collection of information is required by 37 CFR 1.76. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.14. This collection is estimated to take 23 minutes to complete, including gathering, preparing, and submitting the completed application data sheet form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

Privacy Act Statement

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The information provided by you in this form will be subject to the following routine uses:

1 The information on this form will be treated confidentially to the extent allowed under the Freedom of Information Act (5 U.S.C. 552) and the Privacy Act (5 U.S.C. 552a). Records from this system of records may be disclosed to the Department of Justice to determine whether the Freedom of Information Act requires disclosure of these records.

2. A record from this system of records may be disclosed, as a routine use, in the course of presenting evidence to a court, magistrate, or administrative tribunal, including disclosures to opposing counsel in the course of settlement negotiations.

3 A record in this system of records may be disclosed, as a routine use, to a Member of Congress submitting a request involving an individual, to whom the record pertains, when the individual has requested assistance from the Member with respect to the subject matter of the record.

4. A record in this system of records may be disclosed, as a routine use, to a contractor of the Agency having need for the information in order to perform a contract. Recipients of information shall be required to comply with the requirements of the Privacy Act of 1974, as amended, pursuant to 5 U.S.C. 552a(m).

5. A record related to an International Application filed under the Patent Cooperation Treaty in this system of records may be disclosed, as a routine use, to the International Bureau of the World Intellectual Property Organization, pursuant to the Patent CooperationTreaty.

6. A record in this system of records may be disclosed, as a routine use, to another federal agency for purposes of National Security review (35 U.S.C. 181) and for review pursuant to the Atomic Energy Act (42 U.S.C. 218(c)).

7. A record from this system of records may be disclosed, as a routine use, to the Administrator, General Services, or his/her designee, during an inspection of records conducted by GSA as part of that agency's responsibility to recommend improvements in records management practices and programs, under authority of 44 U.S.C. 2904 and 2906. Such disclosure shall be made in accordance with the GSA regulations governing inspection of records for this purpose, and any other relevant (i.e., GSA or Commerce) directive. Such disclosure shall not be used to make determinations about individuals.

8. A record from this system of records may be disclosed, as a routine use, to the public after either publication of the application pursuant to 35 U.S.C. 122(b) or issuance of a patent pursuant to 35 U.S.C. 151. Further, a record may be disclosed, subject to the limitations of 37 CFR 1.14, as a routine use, to the public if the record was filed in an application which became abandoned or in which the proceedings were terminated and which application is referenced by either a published application, an application open to public inspections or an issued patent.

9. A record from this system of records may be disclosed, as a routine use, to a Federal, State, or local law enforcement agency, if the USPTO becomes aware of a violation or potential violation of law or regulation.

COMBINED ASSIGNMENT AND DECLARATION (37 CFR 1.63) FOR UTILITY OR DESIGN APPLICATION USING AN APPLICATION DATA SHEET (37 CFR 1.76)

Title of Invention	ELECTROLYTIC COPPER FOIL HAVING EXCELLENT HANDLING CHARACTERISTICS IN POSTPROCESSING, AND MANUFACTURING METHOD THEREFOR	Attorney Docket No. 0313221.00022

As the below named inventor, I hereby declare that:

This declaration is directed to: ☒ The attached application, or

☐ United States application or PCT international application number _____

filed on _____

The above-identified application was made or authorized to be made by me.

I believe that I am the original inventor or an original joint inventor of a claimed invention in the application.

AND WHEREAS, KCF TECHNOLOGIES CO., LTD. (hereinafter "ASSIGNEE"), a corporation duly organized and existing under the laws of Republic of Korea and having its principal office and place of business at 4F., 39, LS-ro 116beon-gil, Dongan-gu, Anyang-si, Gyeonggi-do, 14118, desires to acquire the entire right, title, and interest therein;

NOW, THEREFORE, in consideration of One Dollar ($1.00) and other good and valuable consideration, the receipt and sufficiency of which are hereby acknowledged, I do hereby sell, assign, and transfer, and hereby set over unto ASSIGNEE, its successors, assigns and legal representatives, the full and exclusive right, title and interest to said invention in the United States of America and all foreign countries, including, without limitation, said invention as described in the aforesaid application, to be held and enjoyed by me, its successors and assigns, as fully and entirely as the same would have been held and enjoyed by me had this assignment and sale not been made, including, without limitation, all rights to the aforesaid application and to any United States Letters Patent therefor, when issued together with all improvements thereon and betterments thereof, all related applications including, but not limited to, divisions, continuations, continuations-in-part, reissues and reexaminations thereof and substitutions of or for said application, and all foreign rights including the right to make application for Letters Patent for said inventions in any and all foreign countries and the right to claim priority as to the filing date under the International Convention on the basis for the aforesaid application for United States Letters Patent; and I hereby authorizes and requests the Commissioner of Patents to issue all Letters Patent issuing therefrom to ASSIGNEE, for its interest as ASSIGNEE, its successors, assigns and legal representatives.

I hereby agree to execute any papers, provide any information and testify in any interference or litigation at the request of ASSIGNEE, its successors, assigns and legal representatives, when deemed essential to ASSIGNEE's, its successors', assigns' and legal representatives' full enjoyment, protection, enforcement and title in and to such invention and rights hereby transferred.

I furthermore agree upon request of said ASSIGNEE, its successors, assigns and legal representatives, and without further remuneration, to execute any and all papers desired by said ASSIGNEE, its successors, assigns and legal representatives, for the filing and granting of foreign applications and the perfecting of title thereto in said ASSIGNEE, its successors, assigns and legal representatives.

I hereby acknowledge that any willful false statement made in this declaration is punishable under 18 U.S.C. 1001 by fine or imprisonment of not more than five (5) years, or both.

LEGAL NAME OF INVENTOR

Inventor: Seung Min KIM Date: June / 18 / 2020

Signature: 

COMBINED ASSIGNMENT AND DECLARATION (37 CFR 1.63) FOR UTILITY OR DESIGN APPLICATION USING AN APPLICATION DATA SHEET (37 CFR 1.76)

20061376 /김승민 / 정수기술연구소 /2020-06-18 08:57/ 본인 문서로서 무단 복사 및 외부 유출을 금합니다.

COMBINED ASSIGNMENT AND DECLARATION (37 CFR 1.63) FOR UTILITY OR DESIGN APPLICATION USING AN APPLICATION DATA SHEET (37 CFR 1.76)

Title of Invention	ELECTROLYTIC COPPER FOIL HAVING EXCELLENT HANDLING CHARACTERISTICS IN POSTPROCESSING, AND MANUFACTURING METHOD THEREFOR	Attorney Docket No. 0313221.00022

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NOW, THEREFORE, in consideration of One Dollar ($1.00) and other good and valuable consideration, the receipt and sufficiency of which are hereby acknowledged, I do hereby sell, assign, and transfer, and hereby set over unto ASSIGNEE, its successors, assigns and legal representatives, the full and exclusive right, title and interest to said invention in the United States of America and all foreign countries, including, without limitation, said invention as described in the aforesaid application, to be held and enjoyed by me, its successors and assigns, as fully and entirely as the same would have been held and enjoyed by me had this assignment and sale not been made, including, without limitation, all rights to the aforesaid application and to any United States Letters Patent therefor, when issued together with all improvements thereon and betterments thereof, all related applications including, but not limited to, divisions, continuations, continuations-in-part, reissues and reexaminations thereof and substitutions of or for said application, and all foreign rights including the right to make application for Letters Patent for said inventions in any and all foreign countries and the right to claim priority as to the filing date under the International Convention on the basis for the aforesaid application for United States Letters Patent; and I hereby authorizes and requests the Commissioner of Patents to issue all Letters Patent issuing therefrom to ASSIGNEE, for its interest as ASSIGNEE, its successors, assigns and legal representatives.

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I hereby acknowledge that any willful false statement made in this declaration is punishable under 18 U.S.C. 1001 by fine or imprisonment of not more than five (5) years, or both.

LEGAL NAME OF INVENTOR

Inventor: Shan Hua JIN Date: 2020.06.17

Signature: Jin Shan Hua

DocCode – SCORE

SCORE Placeholder Sheet for IFW Content

Application Number: 16959352 Document Date: 06/30/2020

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