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Application Number: 16013887 Document Date: 06/20/2018

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Form Revision Date: August 26, 2013

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

PTO/AIA/82A (07-13)
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TRANSMITTAL FOR POWER OF ATTORNEY TO ONE OR MORE REGISTERED PRACTITIONERS

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	Not Yet Assigned
Filing Date	Concurrently Herewith
First Named Inventor	Jianjian Yi
Title	SEPARATOR AND ENERGY STORAGE DEVICE
Art Unit	N/A
Examiner Name	Not Yet Assigned
Attorney Docket Number	DEHE-1806-USPT

SIGNATURE of Applicant or Patent Practitioner

Signature	/Charles Ho/	Date (Optional)	May 30, 2018
Name	Charles Ho	Registration Number	51,807
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 1 forms are submitted.

{DEHE-1806-USPT/00783505v1}

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

PTO/AIA/82B (07-13)
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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
Not Yet Assigned	Concurrently Herewith

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

[x] 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: 152866

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:

[x] The address associated with the above-mentioned Customer Number

OR

[ ] The address associated with Customer Number:

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):

Ningde Amperex Technology Limited

[ ] Inventor or Joint Inventor (title not required below)

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

[x] 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	ChiLin Cheng	Date (Optional)	
Name	ChiLin Cheng		
Title	manager		

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.

Electronic Patent Application Fee Transmittal	
Application Number:	
Filing Date:	
Title of Invention:	SEPARATOR AND ENERGY STORAGE DEVICE
First Named Inventor/Applicant Name:	Jianjian Yi
Filer:	Charles S. Ho
Attorney Docket Number:	DEHE-1806-USPT
Filed as Large Entity	
Filing Fees for Utility under 35 USC 111(a)	

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Basic Filing:				
UTILITY APPLICATION FILING	1011	1	300	300
UTILITY SEARCH FEE	1111	1	660	660
UTILITY EXAMINATION FEE	1311	1	760	760
Pages:				
Claims:				
Miscellaneous-Filing:				
Petition:				
Patent-Appeals-and-Interference:				

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Post-Allowance-and-Post-Issuance:				
Extension-of-Time:				
Miscellaneous:				
		Total in USD ($)		**1720**

Electronic Acknowledgement Receipt	
EFS ID:	32944477
Application Number:	16013887
International Application Number:	
Confirmation Number:	3106
Title of Invention:	SEPARATOR AND ENERGY STORAGE DEVICE
First Named Inventor/Applicant Name:	Jianjian Yi
Customer Number:	152866
Filer:	Charles S. Ho
Filer Authorized By:	
Attorney Docket Number:	DEHE-1806-USPT
Receipt Date:	20-JUN-2018
Filing Date:	
Time Stamp:	21:36:32
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	yes
Payment Type	CARD
Payment was successfully received in RAM	$1720
RAM confirmation Number	062118INTEFSW21432400
Deposit Account	
Authorized User	
The Director of the USPTO is hereby authorized to charge indicated fees and credit any overpayment as follows:	

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1	Application Data Sheet	Application_Data_Sheet_Fillable_PDF.PDF	1255563 88ce5f525a918c3adc59f9f06361790dcc094b09	no	9
Warnings:					
Information:					
2	Oath or Declaration filed	Executed_DEC.pdf	3339366 f339b8de574c34d9a55b163b14178001a219cba2	no	12
Warnings:					
Information:					
3		Spec.pdf	475665 23da5177f9153d7ed9b8cd526c5bd29c50aac0b2	yes	30

Multipart Description/PDF files in .zip description

Document Description	Start	End
Specification	1	24
Claims	25	27
Abstract	28	28
Drawings-only black and white line drawings	29	30

Warnings:					
Information:					
4	Power of Attorney	Executed_POA.pdf	65776 5fa534fa25132d24fe17d2478a8f2aecd39d157a	no	2
Warnings:					
Information:					

5	Fee Worksheet (SB06)	fee-info.pdf	34550 891d1dcfa43e575d62e8b60729ff6aecb7ed6627	no	2
Warnings:					
Information:					
			Total Files Size (in bytes):	5170920	

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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Application Data Sheet 37 CFR 1.76	Attorney Docket Number	DEHE-1806-USPT
	Application Number	
Title of Invention	SEPARATOR AND ENERGY STORAGE DEVICE	

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
	Jianjian		Yi	

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

City	Ningde, Fujian	Country of Residence [i]	CN

Mailing Address of Inventor:

Address 1	No. 1 Xingang Road, Zhangwan Town, Jiaocheng Zone		
Address 2			
City	Ningde, Fujian	**State/Province**	
Postal Code	352100	**Country** [i]	CN

Inventor 2 Remove

Legal Name

Prefix	Given Name	Middle Name	Family Name	Suffix
	Xinzhi		Zhang	

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

City	Ningde, Fujian	Country of Residence [i]	CN

Mailing Address of Inventor:

Address 1	No. 1 Xingang Road, Zhangwan Town, Jiaocheng Zone		
Address 2			
City	Ningde, Fujian	**State/Province**	
Postal Code	352100	**Country** [i]	CN

Inventor 3 Remove

Legal Name

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Application Data Sheet 37 CFR 1.76	Attorney Docket Number	DEHE-1806-USPT
	Application Number	
Title of Invention	SEPARATOR AND ENERGY STORAGE DEVICE	

Prefix	Given Name	Middle Name	Family Name	Suffix
	Zengbin		Wei	

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

City	Ningde, Fujian	Country of Residence [i]	CN

Mailing Address of Inventor:

Address 1	No. 1 Xingang Road, Zhangwan Town, Jiaocheng Zone
Address 2	
City	Ningde, Fujian **State/Province**
Postal Code	352100 **Country** [i] CN

Inventor 4 Remove

Legal Name

Prefix	Given Name	Middle Name	Family Name	Suffix
	Xinghua		Tao	

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

City	Ningde, Fujian	Country of Residence [i]	CN

Mailing Address of Inventor:

Address 1	No. 1 Xingang Road, Zhangwan Town, Jiaocheng Zone
Address 2	
City	Ningde, Fujian **State/Province**
Postal Code	352100 **Country** [i] CN

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

Correspondence Information:

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	152866		
Email Address		Add Email	Remove Email

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Application Data Sheet 37 CFR 1.76	Attorney Docket Number	DEHE-1806-USPT
	Application Number	
Title of Invention	SEPARATOR AND ENERGY STORAGE DEVICE	

Application Information:

Title of the Invention	SEPARATOR AND ENERGY STORAGE DEVICE		
Attorney Docket Number	DEHE-1806-USPT	**Small Entity Status Claimed**	☐
Application Type	Nonprovisional		
Subject Matter	Utility		
Total Number of Drawing Sheets (if any)		**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	152866		

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Application Data Sheet 37 CFR 1.76	Attorney Docket Number	DEHE-1806-USPT
	Application Number	
Title of Invention	SEPARATOR AND ENERGY STORAGE DEVICE	

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)

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)
201810321779.5	CN	2018-04-11	

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	DEHE-1806-USPT
	Application Number	
Title of Invention	SEPARATOR AND ENERGY STORAGE DEVICE	

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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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	DEHE-1806-USPT
	Application Number	
Title of Invention	SEPARATOR AND ENERGY STORAGE DEVICE	

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	Ningde Amperex Technology Limited		
Mailing Address Information For Applicant:			
Address 1	No. 1 Xingang Road, Zhangwan Town, Jiaocheng Zone		
Address 2			
City	Ningde, Fujian	**State/Province**	
Country	CN	Postal Code	352100
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.

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Application Data Sheet 37 CFR 1.76	Attorney Docket Number	DEHE-1806-USPT
	Application Number	
Title of Invention	SEPARATOR AND ENERGY STORAGE DEVICE	

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	/Charles Ho/			Date (YYYY-MM-DD)	2018-06-20
First Name	Charles	Last Name	Ho	Registration Number	51,807

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

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Application Data Sheet 37 CFR 1.76	Attorney Docket Number	DEHE-1806-USPT
	Application Number	
Title of Invention	SEPARATOR AND ENERGY STORAGE DEVICE	

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.

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DECLARATION (37 CFR 1.63) FOR UTILITY OR DESIGN APPLICATION USING AN APPLICATION DATA SHEET (37 CFR 1.76)

Title of Invention: SEPARATOR AND ENERGY STORAGE DEVICE

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.
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.

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LEGAL NAME OF INVENTOR

Inventor: Yi,JianJian Date (Optional): June 5, 2018

Signature: Yi,Jianlian

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LEGAL NAME OF INVENTOR

Inventor: ZhangXinZhi Date (Optional): June 5, 2018

Signature: ZhangXinZhi

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Inventor: Wei,ZengBin Date (Optional): June 5, 2018

Signature: Wei, ZengBin

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LEGAL NAME OF INVENTOR

Inventor: Tao, XingHua Date (Optional): June 5, 2018

Signature: Tao, XingHua

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CosMX Exhibit 1002, Page 27 of 334

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SEPARATOR AND ENERGY STORAGE DEVICE

CROSS REFERENCES TO RELATED APPLICATIONS

[001] This application claims the benefit of Chinese Patent Application No. 201810321779.5 filed on April 11, 2018. The entire contents of the above application are hereby incorporated by reference in their entirety.

FIELD OF THE APPLICATION

[002] The application relates to the field of energy storage devices, and in particular, to a separator and an energy storage device.

BACKGROUND OF THE APPLICATION

[003] Non-aqueous secondary batteries, particularly lithium-ion batteries, are widely used in portable electronic devices such as notebook computers, digital cameras, camcorders, and cellphones, due to their high energy density and good rate performance. In recent years, the application of lithium-ion batteries as the power supply for electrical vehicles, is also promoting the development of lithium-ion battery technology. In the cycle process of the lithium-ion battery, with the progress of charging and discharging, there will be a gap between the electrode and the separator, resulting in a reduction of the cycle capacity of the lithium-ion battery and thereby having an influence on its service life. Therefore, there is an urgent need for a technical solution to solve the problem of the gap between the separator and the electrode so as to improve the service life of the lithium-ion battery.

SUMMARY OF THE APPLICATION

[004] A separator and an energy storage device are provided according to the present application. With the separator provided by the application, not only the problem of the gap between the separator and the electrode can be solved, but also excellent adhesive force between the separator and the electrode can be maintained; moreover, the rate performance and cycle performance of the energy storage device can be improved due

to the pore structures maintained in the separator of the application.

[005] A separator is provided according to an example of the present application. The separator comprises: a porous substrate; and a porous layer arranged on a surface of the porous substrate, wherein the porous layer comprises inorganic particles and a binder, and a ratio of Dv90 of the inorganic particles to the thickness of the porous layer is in a range of 0.3 to 3.0. The Dv90 of the inorganic particles refers to a particle size which reaches 90% the cumulative volume from the side of small particle size in the granularity distribution on a volume basis.

[006] In the above-described separator, the porous layer has a thickness of 0.2 μm to 10 μm.

[007] In the above-described separator, the porous layer has pores formed by the binder, and the inorganic particles are distributed in the pores.

[008] In the above-described separator, the pores have an average pore size of 0.3 μm to 20 μm.

[009] In the above-described separator, the volume ratio of the inorganic particles to the binder is in a range from 0.2 to 3.0.

[0010] In the above-described separator, the porous layer has a porosity of 20% to 90%.

[0011] In the above-described separator, the inorganic particles are one or more selected from the group consisting of alumina, silica, magnesia, titanium oxide, hafnium dioxide, tin oxide, zirconia, cerium dioxide, nickel oxide, zinc oxide, calcium oxide, boehmite, aluminum hydroxide, magnesium hydroxide, calcium hydroxide, and barium sulfate.

[0012] In the above-described separator, the binder is one or more selected from the group consisting of polyvinylidene fluoride, vinylidene fluoride-hexafluoropropylene copolymer, polyamide, polyacrylonitrile, polyacrylate, polyacrylic acid, polyacrylates, sodium carboxymethylcellulose, polyvinylpyrrolidone, polyvinyl ether, polymethyl methacrylate, polytetrafluoroethylene and polyhexafluoropropylene.

[0013] An energy storage device is further provided according to the present application, which comprises the above-described separator.

[0014] In the above-described energy storage device, the energy storage device is a

lithium-ion battery.

[0015] A method for preparing a separator is further provided according to the present application, the method comprising the steps of:

[0016] mixing inorganic particles with a binder to generate a mixture, and adding a first solvent into the mixture and stirring the mixture with the first solvent to obtain an uniform coating solution; coating the uniform coating solution onto a surface of a porous substrate to form a wet film; immersing the wet film into a coagulating solution for phase transformation; and drying the phase-transformed wet film to obtain the separator.

[0017] In the above-described method, the solid content in the coating solution is in a range of 7% to 25%.

[0018] In the above-described method, the coagulating solution comprises a second solvent and a third solvent, and the second solvent has a mass percentage of 20% to 60%.

[0019] In the above-described method, the first solvent is one or more independently selected from the group consisting of N-methylpyrrolidone (NMP), dimethylacetamide (DMAC) and dimethylformamide (DMF).

[0020] In the above-described method, the porous substrate comprises a polymer film, a multilayer polymer film, or a non-woven fabric formed of any one or more of the following polymers: polyethylene, polypropylene, polyethylene terephthalate, polyphthaloyl diamine, polybutylene terephthalate, polyester, polyacetal, polyamide, polyimide, polyetheretherketone , polyaryletherketone, polyetherimide, polyamide imide, polybenzimidazole, polyethersulfone, polyphenylene oxide, cycloolefin copolymer, polyphenylene sulfide, and polyethylene naphthalene.

[0021] In the above-described method, the polyethylene is at least one component selected from the group consisting of high density polyethylene, low density polyethylene, and ultrahigh molecular weight polyethylene.

[0022] In the above-described method, the second solvent is one or more independently selected from the group consisting of N-methylpyrrolidone, dimethylacetamide and dimethylformamide, and the third solvent is one or more selected from the group consisting of deionized water, ethanol, propanol, acetone,

dimethyl carbonate and diethyl carbonate.

[0023] An excellent adhesion exists between the separator and the electrode according to the present application, thus ensuring that the energy storage device has good safety performance. Moreover, the porous layer is arranged on a surface of the separator, and the inorganic particles contained in the pores in the porous layer can serve to support the pores, and therefore the pores can be well protected from being destroyed. As such, the probability of pore blockage due to compression and swelling in the separator is reduced, the separator would exhibit high ionic conductivity, and the rate performance and cycle performance of the energy storage device are greatly improved.

BRIEF DESCRIPTION OF THE ACCOMPANYING DRAWINGS

[0024] Figure 1 is an electronic microscope image (3000 times magnification) of pores of the lower surface of the porous layer (i.e., the surface of the porous layer that is away from the porous substrate) in example 3;

[0025] Figure 2 is an electronic microscope image (10,000 times magnification) of the cross section of the porous layer in the thickness direction in example 3;

[0026] Figure 3 is an electronic microscope image (3000 times magnification) of pores of the lower surface of the porous layer (i.e., the surface of the porous layer that is away from the porous substrate) in comparative example 2; and

[0027] Figure 4 is an electronic microscope image (10,000 times magnification) of the cross section of the porous layer in the thickness direction in comparative example 2.

DETAILED DESCRIPTION OF THE PREFERRED EXAMPLES

[0028] Exemplary examples will be described in details. While these exemplary examples may be implemented in various forms, the applicationshould not be construed as limited to the examples of the application set forth herein. Rather, these examples are provided with the purpose of making the disclosure of the application thorough and complete and fully conveying the scope of the application to those skilled in the art.

[0029] A separator and a preparation method thereof as well as an energy storage device according to the present application will be described in details hereinafter.

[0030] In a first aspect of the application, the separator comprises a porous substrate and a porous layer. The porous layer is arranged on a surface of the porous substrate. Specifically, the porous layer is arranged on one surface of the porous substrate, or the porous layer is arranged on both surfaces of the porous substrate, or the porous layer is arranged on part of the surface of the porous substrate. The porous substrate comprises a polymer film, a multilayer polymer film, or a non-woven fabric formed of any one or more of the following polymers: polyethylene, polypropylene, polyethylene terephthalate, polyphthaloyl diamine, polybutylene terephthalate, polyester, polyacetal, polyamide, polyimide, polyetheretherketone, polyaryletherketone, polyetherimide, polyamide imide, polybenzimidazole, polyethersulfone, polyphenylene oxide, cycloolefin copolymer, polyphenylene sulfide, and polyethylene naphthalene. The above-mentioned polyethylene is at least one component selected from the group consisting of high density polyethylene, low density polyethylene, and ultrahigh molecular weight polyethylene.

[0031] In an example of the application, the porous layer arranged on the porous substrate comprises a binder and inorganic particles. The porous layer has pores formed by the binder, and the pores at least comprises a part of the inorganic particles. A ratio of Dv90 of the inorganic particles to the thickness of the porous layer is in a range from 0.3 to 3.0. The Dv90 of the inorganic particles refers to a particle size which reaches 90% the cumulative volume from the side of small particle size in the granularity distribution on a volume basis. The binder is one or more selected from the group consisting of polyvinylidene fluoride, vinylidene fluoride-hexafluoropropylene copolymer, polyamide, polyacrylonitrile, polyacrylate, polyacrylic acid, polyacrylates, sodium carboxymethylcellulose, polyvinylpyrrolidone, polyvinyl ether, polymethyl methacrylate, polytetrafluoroethylene and polyhexafluoropropylene. The binder can provide a sufficient binding interface for the electrode, thus ensuring a high adhesive force between the separator and the electrode, and enabling the energy storage device (such as a lithium-ion battery) to have a high safety performance.

[0032] The pores in the porous layer allow the separator to have good electrolyte diffusion and absorption capabilities, improving the ionic conductivity of the separator, and thereby improving the rate performance of the energy storage device (such as a

lithium-ion battery). The average pore size of the porous layer is not less than 0.3 μm, which makes the separator have good electrolyte diffusion and absorption capabilities, improves the ionic conductivity of the separator, reduces the polarization reaction, and thus can improve the rate performance of the energy storage device (such as a lithium-ion battery). The porous layer may have a porosity of 20% to 90%.

[0033] The inorganic particles distributed in the pores of the porous layer provide a good mechanical support for the porous layer, preventing the porous layer from compressing and collapsing during processing the energy storage device (such as a lithium-ion battery), and preventing the porous layer from being compressed and destroyed. Inorganic particles refer to a class of inorganicmaterials obtained from natural or synthetic compounds through the process of shaping and high-temperature sintering or the like. The inorganic particles are one or more selected from the group consisting of alumina, silica, magnesia, titanium oxide, hafnium dioxide, tin oxide, zirconia, cerium dioxide, nickel oxide, zinc oxide, calcium oxide, boehmite, aluminum hydroxide, magnesium hydroxide, calcium hydroxide, and barium sulfate. The inorganic particles may contain polar functional groups such as a hydroxyl group. The surface of the inorganic particles containing polar functional groups can be more easily combined with the non-solvent (third solvent) in the coagulating solution in the preparation process, which facilitates the diffusion of the non-solvent (third solvent) into the porous layer along the surface of the inorganic particles so that larger pores are formed in the vicinity of the inorganic particles, and the rate performance of the energy storage device (such as a lithium-ion battery) is thereby improved. The non-solvent (third solvent) in the coagulating solution will be described below.

[0034] In an example of the present application, the volume ratio of the inorganic particles to the binder in the porous layer is in a range from 0.2 to 3.0. An exchange between the first solvent in the coating solution and the third solvent in the coagulating solution can be increased by increasing the volume ratio of the inorganic particles to the binder, and the porosity of the porous layer is increased; conversely, if the volume ratio of the inorganic particles to the binder is reduced, the porosity of the porous layer will be decreased. If the volume ratio of the inorganic particles to the binder is too low, the average pore size of the porous layer will be decreased, and the porosity of the porous layer will be decreased; moreover, if the content of inorganic particles is decreased, the mechanical strength and heat resistance of the porous layer is decreased. If the volume

ratio of the inorganic particles to the binder is too high, the adhesive force of the porous layer will be reduced, and the porous layer is easily detached from the surface of the porous substrate, resulting in deterioration of the safety performance of the energy storage device (such as a lithium-ion battery).

[0035] The porous layer has a thickness of 0.2 μm to 10 μm. If the thickness of the porous layer is too high, the gas permeability of the porous layer will be deteriorated, and the rate performance of the energy storage device (such as a lithium-ion battery) will be decreased. If the thickness of the porous layer is too low, the adhesive force of the porous layer will be reduced, a gap will easily occur between the separator and the electrode, and the hardness of the energy storage device (such as a lithium-ion battery) will be decreased, resulting in deterioration of the safety performance of the energy storage device (such as a lithium-ion battery).

[0036] In addition, in an example of the present application, pores having a larger average pore size can be obtained by controlling the ratio of Dv90 of the inorganic particles to the thickness of the porous layer. In the electrolyte environment, after the binder (such as polyvinylidene fluoride) in the porous layer swells, more through-holes can be retained, which avoids swelling and pore blockage, ensures a channel for ion transportation, reduces polarization reactions, and improves the rate performance of the energy storage device (such as a lithium-ion battery). The Dv90 of the inorganic particles refers to a particle size which reaches 90% the cumulative volume from the side of small particle size in the granularity distribution on a volume basis.

[0037] In some examples of the present application, the ratio of the Dv90 of the inorganic particles to the thickness of the porous layer is in a range from 0.4 to 1.5. By increasing the ratio of Dv90 of the inorganic particles to the thickness of the porous layer, the mechanical strength of the porous layer is increased, and the porous layer is prevented from undergoing pore blockage due to compression in the preparation or cycle process of the energy storage device (such as a lithium-ion battery), thereby increasing the rate performance of the energy storage device (such as a lithium-ion battery). Conversely, the mechanical properties of the porous layer may be reduced by reducing the ratio of Dv90 of inorganic particles to the thickness of the porous layer, leading to pore blockage of the porous layer due to compression in the preparation and cycle processes of the energy storage device (such as a lithium-ion battery), and the rate performance of the energy storage device (such as a lithium-ion battery) is reduced. In

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addition, if the ratio of the Dv90 of the inorganic particles to the thickness of the porous layer is too high, the pore size distribution of the porous layer tends to be non-uniform, resulting in a non-uniform surface of the porous layer, which further makes the porous layer easy to detach from the surface of the porous substrate and forms defects in the energy storage device (such as a lithium-ion battery). Moreover, if the ratio of Dv90 of the inorganic particles to the thickness of the porous layer is too high, the adhesive force of the porous layer is reduced, affecting the safety performance of the energy storage device (such as a lithium-ion battery). If the ratio of Dv90 of the inorganic particles to the thickness of the porous layer is too low, the inorganic particles cannot be effectively exposed on the surface of the porous layer, which does not facilitate an exchange between the first solvent in the coating solution and the third solvent in the coagulating solution in the preparation of the porous layer, therefore cannot enhance diffusion, and is not advantageous for the development of the pores.

[0038] The method for preparing the separator according to the present application is described below. Firstly, the inorganic particles are mixed with the binder, and then the first solvent is added into the mixture and the mixture is stirred to obtain a uniform coating solution, wherein the binder dissolves in the first solvent. The first solvent is one or more selected from the group consisting of N-methylpyrrolidone (NMP), dimethylacetamide (DMAC) and dimethylformamide (DMF). The porous layer formed using N-methylpyrrolidone (NMP) has the largest average pore size and the highest porosity; the porous layer formed using dimethylformamide (DMF) has the smallest average pore size and the lowest porosity; and the porous layer formed using dimethylacetamide (DMAC) has an average pore size and a porosity between those of the porous layer formed using N-methylpyrrolidone (NMP) and the porous layer formed using dimethylformamide (DMF). The temperature of the coating solution may be in a range from 15 degrees Celsius to 30 degrees Celsius. The solid content of the coating solution may be in a range from 7% to 25%. Within this range, if the solid content of the coating solution is increased, the viscosity of the coating solution is increased, the exchange rate between the third solvent in the coagulating solution and the first solvent in the coating solution becomes lower, and the average pore size and porosity of the formed porous layer are reduced; conversely, if the solid content of the coating solution is reduced, the average pore size and porosity of the porous layer are increased. However, if the solid content of the coating solution is too high and exceeds

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this range, the gas permeability of the porous layer does not meet the requirements and cannot satisfy the use for an energy storage device (such as a lithium-ion battery). If the solid content of the coating solution is too low, which is below this range, the strength of the porous layer is decreased, and it is difficult to form a film on the surface of the porous substrate.

[0039] Next, the coating solution is uniformly coated on the surface of the porous substrate to form a wet film. The coating method of the coating solution is dip coating. Meanwhile, any other suitable coating process may also be used.

[0040] Thereafter, the porous substrate with the wet film is immersed into a coagulating solution for phase transformation, wherein the coagulating solution may include a second solvent and a third solvent, and the second solvent and the third solvent are soluble with each other. The second solvent is one or more selected from the group consisting of N-methylpyrrolidone (NMP), dimethylacetamide (DMAC) and dimethylformamide (DMF), and the third solvent is one or more selected from the group consisting of deionized water, ethanol, propanol, acetone, dimethyl carbonate, and diethyl carbonate. The mass percentage of the second solvent in the coagulating solution may be in a range from 20% to 60%. The average pore size and porosity of the porous layer can be increased by decreasing the content of the second solvent in the coagulating solution. However, if the content of the second solvent is too low, a dense surface film may be formed on the surface of the porous layer that is away from the porous substrate, resulting in deterioration of the gas permeability of the porous layer. If the content of the second solvent is too high, complete pores cannot be formed, or the formed porous layer has a very low average pore size. The temperature of the coagulating solution may be in a range from 15 degrees Celsius to 30 degrees Celsius. The period for phase transformation may be in a range from 10s to 90s.

[0041] Finally, after the completion of the phase transformation, the wet film is dried to obtain a separator, wherein a porous layer is arranged on the surface of the porous substrate, and inorganic particles are distributed in the pores of the porous layer. The drying temperature may be in a range from 60 degrees Celsius to 70 degrees Celsius, and the drying period may be in a range from 10 minutes to 40 minutes.

[0042] According to some examples of the present application, a porous layer is prepared based on a phase transformation (i.e., non-solvent induced phase separation,

NIPS) principle, wherein the first solvent in the coating solution is an organic solvent, and the binder (such as PVDF) can be dissolved in the first solvent. The coagulating solution contains a third solvent (deionized water), and the binder is insoluble in the third solvent (deionized water). Therefore, after the coating solution is coated on the porous substrate and then immersed into the coagulating solution, the first solvent in the coating solution is extracted into the third solvent (deionized water) in the coagulating solution, and the binder in the coating solution is solidified and precipitate to form a porous layer.

[0043] An energy storage device including the above-described separator is further provided according to the present application, such as a lithium-ion battery. In the application, the lithium-ion battery is only an illustrative example of the energy storage device, and the energy storage device may also comprise other suitable devices. The lithium-ion battery further comprises a positive electrode, a negative electrode, and an electrolyte, and the separator of the present application is placed between the positive electrode and the negative electrode. The positive current collector may be aluminum foil or nickel foil, and the negative current collector may be copper foil or nickel foil.

[0044] In the lithium-ion battery described above, the positive electrode comprises a positive electrode material capable of intercalation and deintercalation of lithium (Li) (hereinafter sometimes referred to as "positive electrode material capable of intercalation/deintercalation of lithium (Li)"). Examples of the positive electrode material capable of intercalation/deintercalation of lithium (Li) may include one or more of lithium cobaltate, lithium nickel cobalt manganate, lithium nickel cobalt aluminate, lithium manganate, lithium iron manganese phosphate, lithium vanadium phosphate, lithium vanadium oxide phosphate, lithium iron phosphate, lithium titanate, and lithium-rich manganese-based materials.

[0045] In the above-mentioned positive electrode material, the chemical formula of lithium cobaltate may be expressed as $Li_xCo_aM1_bO_{2-c}$, wherein M1 represents at least one selected from the group consisting of nickel (Ni), manganese (Mn), magnesium (Mg), aluminum (Al), boron (B), titanium (Ti), vanadium (V), chromium (Cr), ferrum (Fe), copper (Cu), zinc (Zn), molybdenum (Mo), tin (Sn), calcium (Ca), strontium (Sr), tungsten (W), yttrium (Y), lanthanum (La), zirconium (Zr), and silicon (Si), and the values of x, a, b, and c are respectively within the following ranges: $0.8 \leq x \leq 1.2$, $0.8 \leq a \leq 1$, $0 \leq b \leq 0.2$, $-0.1 \leq c \leq 0.2$.

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[0046] In the above-mentioned positive electrode material, the chemical formula of lithium nickel cobalt manganate or lithium nickel cobalt aluminate may be expressed as $Li_yNi_dM2_eO_{2-f}$, wherein M2 represents at least one selected from the group consisting of cobalt (Co), manganese (Mn), magnesium (Mg), aluminum (Al) , boron (B), titanium (Ti), vanadium (V), chromium (Cr), ferrum (Fe), copper (Cu), zinc (Zn), molybdenum (Mo), tin (Sn), calcium (Ca), yttrium (Sr), tungsten (W), zirconium (Zr), and silicon (Si), and the values of y, d, e, and f are respectively within the following ranges: $0.8 \leq y \leq 1.2$, $0.3 \leq d \leq 0.98$, $0.02 \leq e \leq 0.7$, $-0.1 \leq f \leq 0.2$.

[0047] In the above-mentioned positive electrode material , the chemical formula of lithium manganate is expressed as $Li_zMn_{2-g}M3_gO_{4-h}$, wherein M3 represents at least one selected from the group consisting of cobalt (Co), nickel (Ni), magnesium (Mg), aluminum (Al), boron (B), titanium (Ti), vanadium (V), chromium (Cr), ferrum (Fe), copper (Cu), zinc (Zn), molybdenum (Mo), tin (Sn), calcium (Ca), strontium (Sr), and tungsten (W), and the values of z, g and h are respectively within the following ranges: $0.8 \leq z \leq 1.2$, $0 \leq g < 1.0$, and $-0.2 \leq h \leq 0.2$.

[0048] The negative electrode comprises a negative electrode material capable of intercalation and deintercalation of lithium (Li) (hereinafter, sometimes referred to as "negative electrode material capable of intercalation/deintercalation of lithium (Li)"). Examples of the negative electrode material capable of intercalation/deintercalation of lithium (Li) may include a carbon material, a metal compound, an oxide, a sulfide, a nitride of lithium such as LiN_3, lithium metal, a metal which formed an alloy with lithium, and a polymer material.

[0049] Examples of carbon materials may include low graphitized carbon, easily graphitized carbon, artificial graphite, natural graphite, mesocarbon microbeads, soft carbon, hard carbon, pyrolytic carbon, coke, glassy carbon, organic polymer compound sintered body, carbon fiber and active carbon. Coke may include pitch coke, needle coke, and petroleum coke. The organic polymer compound sintered body refers to materials obtained by calcining and carbonizing a polymer material such as a phenol plastic or a furan resin at a suitable temperature and, and some of these materials are classified into low graphitized carbon or easily graphitized carbon. Examples of polymeric materials may include polyacetylene and polypyrrole.

[0050] Among these negative electrode materials capable of

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intercalation/deintercalation of lithium (Li), further, materials whose charge and discharge voltages are close to the charge and discharge voltages of lithium metal are selected. This is because of the fact that the lower the charge and discharge voltages of the negative electrode material are, the more easily the battery can have a higher energy density. The carbon material can be selected as the negative electrode material, since the crystal structure of the carbon material has only small changes during charging and discharging. Therefore, good cycle characteristics and high charge and discharge capacities can be obtained. In particular, graphite can be selected, since it can provide a high electrochemical equivalent and energy density.

[0051] In addition, the negative electrode material capable of intercalation/deintercalation of lithium (Li) may include elemental lithium metal, metal elements and semi-metal elements capable of forming an alloy together with lithium (Li), alloys and compounds including such elements, etc. In particular, they are used together with the carbon material, since good cycle characteristics and high energy density can be obtained in this case. In addition to alloys comprising two or more metal elements, alloys used herein further include alloys comprising one or more metal elements and one or more semi-metal elements. The alloys may be in the following forms of solid solutions, eutectic crystals (eutectic mixtures), intermetallic compounds, and mixtures thereof.

[0052] Examples of metal elements and semi-metal elements may include tin (Sn), lead (Pb), aluminum (Al), indium (In), silicon (Si), zinc (Zn), antimony (Sb), bismuth (Bi), cadmium (Cd), magnesium (Mg), boron (B), gallium (Ga), germanium (Ge), arsenic (As), silver (Ag), zirconium (Zr), yttrium (Y), and hafnium (Hf). Examples of the above-described alloys and compounds may include a material expressed as a chemical formula: $Ma_sMb_tLi_u$ and a material expressed as a chemical formula: $Ma_pMc_qMd_r$. In these chemical formulas, Ma represents at least one of metal elements and semi-metal elements capable of forming alloys with lithium, Mb represents at least one of these metal elements and semi-metal elements other than lithium and Ma, Mc represents at least one of the non-metal elements, Md represents at least one of these metal elements and semi-metal elements other than Ma, and s, t, u, p, q, and r satisfy $s>0$, $t\geq 0$, $u\geq 0$, $p>0$, $q>0$, and $r\geq 0$, respectively.

[0053] In addition, an inorganic compound that does not include lithium (Li) may be used in the negative electrode, such as MnO_2, V_2O_5, V_6O_{13}, NiS, and MoS.

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[0054] The lithium-ion battery described above further comprises an electrolyte, which may be one or more of a gel electrolyte, a solid electrolyte, and an electrolyte. The electrolyte comprises a lithium salt and a non-aqueous solvent.

[0055] The lithium salt is one or more selected from the group consisting of $LiPF_6$, $LiBF_4$, $LiAsF_6$, $LiClO_4$, $LiB(C_6H_5)_4$, $LiCH_3SO_3$, $LiCF_3SO_3$, $LiN(SO_2CF_3)_2$, $LiC(SO_2CF_3)_3$, $LiSiF_6$, LiBOB, and lithium difluoborate. For example, $LiPF_6$ is used as a lithium salt, since it can provide high ionic conductivity and improve cycle performance.

[0056] The non-aqueous solvent may be a carbonate compound, a carboxylic acid ester compound, an ether compound, other organic solvents or combinations thereof.

[0057] The carbonate compound may be a chain carbonate compound, a cyclic carbonate compound, a fluorinated carbonate compound or combinations thereof.

[0058] Examples of chain carbonate compounds include diethyl carbonate (DEC), dimethyl carbonate (DMC), dipropyl carbonate (DPC), methylpropyl carbonate (MPC), ethyl propyl carbonate (EPC), methyl ethyl carbonate (MEC) and combinations thereof. Examples of the cyclic carbonate compounds include ethylene carbonate (EC), propylene carbonate (PC), butylene carbonate (BC), vinyl ethylene carbonate (VEC), and combinations thereof. Examples of the fluorocarbonate compound include fluoroethylene carbonate (FEC), 1,2-difluoroethylene carbonate, 1,1-difluoroethylene carbonate, 1,1,2-trifluoroethylene carbonate, 1,1,2,2-tetrafluoroethylene carbonate, 1-fluoro-2-methylethyl carbonate, 1-fluoro-1-methyl-ethylene carbonate, 1,2-difluoro-1-methylethylene carbonate, 1,1,2-trifluoro-2-methylethyl carbonate, trifluoromethyl ethylene carbonate, and combinations thereof.

[0059] Examples of carboxylic acid ester compounds include methyl acetate, ethyl acetate, n-propyl acetate, tert-butyl acetate, methyl propionate, ethyl propionate, γ-butyrolactone, decanolactone, valerolactone, mevalonolactone, caprolactone, methyl formate, and combinations thereof.

[0060] Examples of ether compounds include dibutyl ether, tetraethylene glycol dimethyl ether, diethylene glycol dimethyl ether, 1,2-dimethoxyethane, 1,2-diethoxyethane, ethoxy methoxy ethane, 2-methyltetrahydrofuran, tetrahydrofuran, and combinations thereof.

[0061] Examples of other organic solvents include dimethyl sulfoxide, 1,2-dioxolane,

sulfolane, methyl sulfolane, 1,3-dimethyl-2-imidazolidinone, N-methyl-2-pyrrolidone, formamide, dimethylformamide, acetonitrile, trimethyl phosphate, triethyl phosphate, trioctyl phosphate, phosphate esters, and combinations thereof.

[0062] The positive electrode, the separator and the negative electrode are sequentially wound, stacked or folded into an electrode assembly, which is then placed into a packaging shell (for example, an aluminum plastic film), an electrolyte is injected, and the chemical conversion and packaging processes are performed to prepare a lithium-ion battery.

[0063] It should be understood by those skilled in the art that the above-described method for preparing a lithium-ion battery is only an example. Other methods commonly used in the art can be used without departing from the disclosure of the present application.

[0064] Since the separator is wound or stacked together with the positive electrode and the negative electrode, in a case that the above-described porous layer is formed on the surface of the positive electrode or the negative electrode, a corresponding technical effect can also be achieved.

[0065] Some specific examples and comparable examples are listed below to better illustrate this application. In the following examples, reagents, materials, and instruments used are commercially available unless otherwise specified. Some of the parameters used in the examples and comparative examples are shown in Table 1 below.

[0066] Comparative example 1

[0067] (1) Preparation of negative electrode

[0068] The negative electrode active material (artificial graphite), the binder (styrene butadiene rubber), and the conductive agent (conductive carbon black (Super P)) are mixed uniformly with the solvent (deionized water) at a mass ratio of 92:3:5 to prepare a negative electrode slurry, then the negative electrode slurry is coated uniformly on both sides of the negative electrode current collector (copper foil), then a negative electrode active material layer is formed by drying the coated negative electrode current collector (copper foil) at 85 degrees Celsius, then cold pressing, slitting and cutting processes are performed and a negative electrode tab is welded so as to obtain a negative electrode.

[0069] (2) Preparation of positive electrode

[0070] The positive electrode active material (lithium cobaltate ($LiCoO_2$)), the binder (polyvinylidene fluoride (PVDF)), the conductive agent (conductive carbon black (Super P)) are dissolved in the solvent N-methylpyrrolidone (NMP) in a mass ratio of 97:1.5:1.5. A positive electrode slurry is prepared by uniformly stirring the mixture, then the positive electrode slurry is coated uniformly on both sides of the positive electrode current collector (aluminum foil), then a positive electrode active material layer is formed by drying the coated positive electrode current collector (aluminum foil) at 85 degrees Celsius, and then cold pressing, slitting, cutting processes are performed and a positive electrode tab is welded so as to obtain a positive electrode.

[0071] (3) Preparation of separator

[0072] Boehmite is mixed with the binder (polyvinylidene fluoride), then the solvent N-methylpyrrolidone is added and the mixture is uniformly stirred to obtain a coating solution, and the volume ratio of the inorganic particles to the binder is 0.8. The coating solution is coated on the porous substrate (polyethylene) by means of dip coating to form a wet film. The porous substrate (polyethylene) with the wet film is immersed into the coagulating solution containing deionized water (third solvent) and N-methylpyrrolidone (second solvent) for phase transformation, with both the coating solution and the coagulating solution being at a temperature of 25 degrees Celsius. After being immersed in the coagulating solution for 30 seconds, the porous substrate (polyethylene) with the wet film is dried in an oven at 60 degrees Celsius to obtain a separator with a porous layer. The mass content of N-methylpyrrolidone (second solvent) in the coagulating solution is 40%. The ratio of Dv90 of the inorganic particles in the porous layer to the thickness of the porous layer is 0.2.

[0073] (4) Preparation of electrolyte

[0074] A solution prepared with lithium salt $LiPF_6$ and a non-aqueous organic solvent (ethylene carbonate (EC): diethyl carbonate (DEC): ethyl methyl carbonate (EMC): vinylene carbonate (VC) = 8:85:5:2, by a mass ratio) by a mass ratio of 8:92 is used as the electrolyte of the lithium-ion battery.

[0075] (5) Preparation of lithium-ion battery

[0076] An electrode assembly is obtained by winding the positive electrode, the separator, and the negative electrode, and then sealing, injection of the electrolyte,

forming, and suction molding processes are performed to obtain the lithium-ion battery.

[0077] Comparative example 2

[0078] The preparation method is the same as that of comparative example 1, except that the ratio of the Dv90 of the inorganic particles in the porous layer to the thickness of the porous layer is 3.2 in comparative example 2. As can be seen in Figures 3-4, Figure 3 is an electronic microscope image (3000 times magnification) of pores of a lower surface of the porous layer in comparative example 2, Figure 4 is an electronic microscope image (10,000 times magnification) of the cross section of the porous layer in the thickness direction in comparative example 2.

[0079] Example 1

[0080] The preparation method is the same as that of comparative example 1, except that the ratio of the Dv90 of the inorganic particles in the porous layer to the thickness of the porous layer is 0.3 in Example 1.

[0081] Example 2

[0082] The preparation method is the same as that of comparative example 1, except that the ratio of the Dv90 of the inorganic particles in the porous layer to the thickness of the porous layer is 0.5 in Example 2.

[0083] Example 3

[0084] The preparation method is the same as that of comparative example 1, except that the ratio of the Dv90 of the inorganic particles in the porous layer to the thickness of the porous layer is 0.8 in Example 3. As can be seen in Figures 1-2, Figure 1 is an electronic microscope image (3000 times magnification) of pores of a lower surface of the porous layer in example 3, Figure 2 is an electronic microscope image (10,000 times magnification) of the cross section of the porous layer in the thickness direction in example 3.

[0085] Example 4

[0086] The preparation method is the same as that of comparative example 1, except that the ratio of the Dv90 of the inorganic particles in the porous layer to the thickness of the porous layer is 1.0 in Example 4.

[0087] Example 5

[0088] The preparation method is the same as that of comparative example 1, except that the ratio of the Dv90 of the inorganic particles in the porous layer to the thickness of the porous layer is 1.5 in Example 5.

[0089] Example 6

[0090] The preparation method is the same as that of comparative example 1, except that the ratio of the Dv90 of the inorganic particles in the porous layer to the thickness of the porous layer is 2.0 in Example 6.

[0091] Example 7

[0092] The preparation method is the same as that of comparative example 1, except that the ratio of the Dv90 of the inorganic particles in the porous layer to the thickness of the porous layer is 3.0 in Example 7.

[0093] Example 8

[0094] The preparation method is the same as that of comparative example 1, except that the ratio of the Dv90 of the inorganic particles in the porous layer to the thickness of the porous layer is 0.8, and the volume ratio of the inorganic particles to the binder is 0.2 in Example 8.

[0095] Example 9

[0096] The preparation method is the same as that of comparative example 1, except that the ratio of the Dv90 of the inorganic particles in the porous layer to the thickness of the porous layer is 0.8, and the volume ratio of the inorganic particles to the binder is 0.5 in Example 9.

[0097] Example 10

[0098] The preparation method is the same as that of comparative example 1, except that the ratio of the Dv90 of the inorganic particles in the porous layer to the thickness of the porous layer is 0.8, and the volume ratio of the inorganic particles to the binder is 1.2 in Example 10.

[0099] Example 11

[00100] The preparation method is the same as that of comparative example 1, except that the ratio of the Dv90 of the inorganic particles in the porous layer to the thickness of the porous layer is 0.8, and the volume ratio of the inorganic particles to the binder is

2 in Example 11.

[00101] Example 12

[00102] The preparation method is the same as that of comparative example 1, except that the ratio of the Dv90 of the inorganic particles in the porous layer to the thickness of the porous layer is 0.8, and the volume ratio of the inorganic particles to the binder is 3 in Example 12.

[00103] Example 13

[00104] The preparation method is the same as that of comparative example 1, except that the inorganic particles used in Example 13 are alumina, and the ratio of the Dv90 of the inorganic particles in the porous layer to the thickness of the porous layer is 0.8 in Example 13.

[00105] Example 14

[00106] The preparation method is the same as that of comparative example 1, except that the inorganic particles used in Example 14 are magnesium hydroxide, and the ratio of the Dv90 of the inorganic particles in the porous layer to the thickness of the porous layer is 0.8 in Example 14.

[00107] Example 15

[00108] The preparation method is the same as that of comparative example 1, except that the inorganic particles used in Example 15 are titanium oxide, and the ratio of the Dv90 of the inorganic particles in the porous layer to the thickness of the porous layer is 0.8 in Example 15.

[00109] Table 1

	Solid content in the coating solution	Types of inorganic particles	Ratio of the Dv90 of the inorganic particles to the thickness of the porous layer	Volume ratio of the inorganic particles to the binder	Coagulating solution	
					second solvent	content of second solvent
Example 1	15%	boehmite	0.3	0.8	NMP	40%

Example 2	15%	boehmite	0.5	0.8	NMP	40%
Example 3	15%	boehmite	0.8	0.8	NMP	40%
Example 4	15%	boehmite	1.0	0.8	NMP	40%
Example5	15%	boehmite	1.5	0.8	NMP	40%
Example 6	15%	boehmite	2.0	0.8	NMP	40%
Example 7	15%	boehmite	3.0	0.8	NMP	40%
Example 8	15%	boehmite	0.8	0.2	NMP	40%
Example 9	15%	boehmite	0.8	0.5	NMP	40%
Example 3	15%	boehmite	0.8	0.8	NMP	40%
Example 10	15%	boehmite	0.8	1.2	NMP	40%
Example 11	15%	boehmite	0.8	2	NMP	40%
Example 12	15%	boehmite	0.8	3	NMP	40%
Example 3	15%	boehmite	0.8	0.8	NMP	40%
Example 13	15%	alumina	0.8	0.8	NMP	40%
Example 14	15%	magnesium hydroxide	0.8	0.8	NMP	40%
Example 15	15%	titanium oxide	0.8	0.8	NMP	40%
Comparative Example 1	15%	boehmite	0.2	0.8	NMP	40%
Comparative Example 2	15%	boehmite	3.2	0.8	NMP	40%

[00110] Next, the performances of separator and lithium-ion battery are tested.

[00111] (1) Thickness test of porous layer

[00112] Separator samples are placed on a thickness gage (Model VL-50 LITEMATIC from Naitutoyo company) using a 5mm flat bottom probe with a speed of 50mm/min and a pressure of 0.01N. Each of the separator samples provided with a porous layer is measured for 60 thickness points, and the average thickness is taken as the measured value. The thickness of the porous layer is equal to the thickness of the separator minus the thickness of the porous substrate. In a case that there are two porous films, the thickness is divided by 2 to obtain the thickness of each porous layer.

[00113] (2) Gas permeability test of porous layer

[00114] A 100mm x 100mm separator sample provided with a porous layer is cut and tested using a US Gurley 4110N Densometers with 100cc test gas, and the period that the test gas passes completely through the separator sample provided with the porous layer is recorded as a Gurley value. The Gurley value of the porous layer is equal to the Gurley value of the separator provided with the porous layer minus the Gurley value of the separator without the porous layer (i.e., a pure porous substrate).

[00115] (3) Porosity test of porous layer

[00116] The length, width, and thickness of a separator sample provided with a porous layer are measured, and the thickness of the porous layer is obtained by subtracting the thickness of the porous substrate (polyethylene) from the thickness of the separator, and the apparent volume V1 of the porous layer is obtained by calculation. The true volume V20 of the separator sample provided with the porous layer is measured using a true density meter (AccuPyc II Model 1340 Gas Pycnometer, Micromeritics Company), and the true volume V0 of the porous substrate (polyethylene) of the same area is measured. Then, the true volume V2 of the porous layer is equal to V2=V20-V0, and the porosity of the porous layer is equal to 1-V2/V1.

[00117] (4) Rate performance test of lithium-ion battery

[00118] At 25 degrees Celsius, the lithium-ion battery is discharged to 3.0 V at a constant current of 0.2 C, rested for 10 minutes, then is charged to 4.4 V at a constant current of 0.7 C, then is charged to 0.02 C at a constant voltage of 4.4 V, rested for 10min, and is further discharged at a constant current of 0.2 C until the voltage reaches 3.0 V. The discharge capacity at this time is measured and recorded as Q1. Then, the lithium-ion battery is charged to 4.4V at a constant current of 0.7 C, and then charged to

0.02 C at a constant voltage of 4.4 V, rested for 10 minutes, and then is discharged at a constant current of 2 C until the voltage is 3.0 V. The discharge capacity at this time is measured and recorded as Q2.

[00119] 2 C/0.2 C rate performance (%) of the lithium-ion battery is equal to Q2/Q1 x 100%.

[00120] (5) Cycle performance test of lithium-ion battery

[00121] At 25 degrees Celsius, the lithium-ion battery is charged to 4.4 V at a constant current of 0.7 C, then charged to 0.02 C at a constant voltage of 4.4 V, rested for 10 minutes,and discharged to 3.0 V at a constant current of 1 C, rested for 10 minutes. The discharge capacity at this time is measured and recorded as Q3. The above-described steps are regarded as one cycle of charge and discharge. 200 cycles are performed, and the discharge capacity after 200 cycles is recorded as Q4.

[00122] The capacity retention rate (%) of the lithium-ion battery after 200 cycles is equal to Q4/Q3×100%.

[00123] The test results of examples and comparative examples are shown in Table 2 below.

Table 2

	Porosity of porous layer	Gurley value of porous layer (s/100cc)	Thickness of porous layer (μm)	2C/0.2C rate performance	Capacity retention rate after 200 cycles
Example 1	48%	53	2	79.50%	85.70%
Example 2	50%	42	2	83.70%	92.80%
Example 3	52%	30	2	87.50%	95.60%
Example 4	53%	28	2	84.60%	93.10%
Example 5	54%	25	2	82.50%	91.20%

Example 6	56%	20	2	81.70%	85.20%
Example 7	57%	18	2	80.40%	82.70%
Example 8	46%	57	2	81.10%	87.20%
Example 9	49%	43	2	82.80%	91.70%
Example 3	52%	30	2	87.50%	95.60%
Example 10	54%	25	2	83.10%	91.30%
Example 11	56%	21	2	81.50%	88.80%
Example 12	59%	16	2	79.70%	83.80%
Example 3	52%	30	2	87.50%	95.60%
Example 13	50%	43	2	84.40%	92.90%
Example 14	52%	31	2	86.90%	94.30%
Example 15	51%	36	2	84.10%	91.30%
Comparative Example 1	45%	70	2	69.80%	70.50%
Comparative Example 2	60%	16	2	71.30%	72.60%

[00124] As can be seen from a comparison among examples 1-7 and comparative examples 1-2, the ratio of Dv90 of the inorganic particles to the thickness of the porous layer has an effect on the rate performance and cycle performance of the lithium-ion battery, and the probability of pore blockage due to compression swelling in the porous

layer can be reduced effectively by controlling the ratio of the Dv90 of the inorganic particles to the thickness of the porous layer to be in a range from 0.3 to 3.0, so that the rate performance and cycle performance of the lithium-ion battery can be effectively improved. If the ratio of Dv90 of the inorganic particles to the thickness of the porous layer is too high (for example, comparative example 2), the pore size distribution of the porous layer tends to be non-uniform, the surface of the porous layer is heterogeneous , the porous layer is easily detached from the surface of the porous substrate, and defects are formed in the energy storage device (such as a lithium-ion battery), which is not advantageous for the improvement on rate performance and cycle performance. In addition, if the ratio of Dv90 of the inorganic particles to the thickness of the porous layer is too high, the adhesive force of the porous layer is reduced relatively, affecting the safety performance of the energy storage device (such as a lithium-ion battery). If the ratio of Dv90 of the inorganic particles to the thickness of the porous layer is too low (for example, comparative example 1), the inorganic particles cannot be effectively exposed on the surface of the porous layer, which does not facilitate an exchange of the first solvent in the coating solution and the third solvent in the coagulating solution in the preparation process of the porous layer, cannot enhance diffusion, is not advantageous for the development of the pores, and is also not advantageous for the improvement of the rate performance and cycle performance.

[00125] As can be seen from the comparison among Example 3 and Examples 8-12, the volume ratio of inorganic particles to the binder has an effect on the rate performance and cycle performance of the lithium-ion battery. An increase of the volume ratio is advantageous for an exchange of the third solvent in the coagulating solution and the first solvent in the coating solution and the increase of the porosity of the porous layer. If the volume ratio of inorganic particles to the binder is too low, the porosity of the porous layer is decreased, the gas permeability of the separator deteriorates, and the rate performance of the lithium-ion battery is not significantly improved, which is not advantageous for the improvement of the rate performance and cycle performance. If the ratio of the volume ratio of the inorganic particles to the binder is too high, the adhesive force of the porous layer is reduced, gaps are easily formed between the separator and the electrodes, the hardness of the lithium-ion battery is reduced, and thus the rate performance and the cycle performance are not significantly improved.

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[00126] As can be seen from the comparison among Example 3 and Examples 13-15, the use of various inorganic particles can improve the rate performance and cycle performance of the lithium-ion battery, and the types of inorganic particles used have less effect on the rate performance and cycle performance of the lithium-ion battery.

[00127] It should be understood by those skilled in the art that the above-described examples are only illustrative examples and should not be construed limiting the application. The various changes, substitutions, and alterations could be made to the application without departing from the spirit and scope of the application.

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What is claimed is

1. A separator, comprising:

a porous substrate; and

a porous layer arranged on a surface of the porous substrate, wherein the porous layer comprises inorganic particles and a binder, and a ratio of Dv90 of the inorganic particles to the thickness of the porous layer is in a range from 0.3 to 3.0.

2. The separator according to claim 1, wherein the porous layer has a thickness of 0.2 μm to 10 μm.

3. The separator according to claim 1, wherein the porous layer has pores formed by the binder, and the pores at least comprises a part of the inorganic particles.

4. The separator according to claim 3, wherein the pores have an average pore size of 0.3 μm to 20 μm.

5. The separator according to claim 1, wherein a volume ratio of the inorganic particles to the binder is in a range from 0.2 to 3.0.

6. The separator according to claim 1, wherein the porous layer has a porosity of 20% to 90%.

7. The separator according to claim 1, wherein the inorganic particles are one or more selected from the group consisting of alumina, silica, magnesia, titanium oxide, hafnium dioxide, tin oxide, zirconia, cerium dioxide, nickel oxide, zinc oxide, calcium oxide, boehmite, aluminum hydroxide, magnesium hydroxide, calcium hydroxide, and barium sulfate.

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8. The separator according to claim 1, wherein the binder is one or more selected from the group consisting of polyvinylidene fluoride, vinylidene fluoride-hexafluoropropylene copolymer, polyamide, polyacrylonitrile, polyacrylate, polyacrylic acid, polyacrylates, sodium carboxymethylcellulose, polyvinylpyrrolidone, polyvinyl ether, polymethyl methacrylate, polytetrafluoroethylene and polyhexafluoropropylene.

9. An energy storage device, comprising the separator according to claim 1.

10. The energy storage device according to claim 9, wherein the energy storage device is a lithium-ion battery.

11. A method for preparing a separator, wherein the method comprises steps of:

mixing inorganic particles with a binder to generate a mixture;

adding a first solvent into the mixture;

stirring the mixture with the first solvent to obtain a uniform coating solution;

coating the uniform coating solution onto a surface of a porous substrate to form a wet film;

immersing the wet film into a coagulating solution for phase transformation; and

drying the phase-transformed wet film to obtain the separator.

12. The method according to claim 11, wherein the solid content in the coating solution is in a range from 7% to 25%.

13. The method according to claim 11, wherein the coagulating solution comprises a second solvent and a third solvent, and the second solvent has a mass percentage of 20% to 60%.

14. The method according to claim 11, wherein the first solvent is one or more independently selected from the group consisting of N-methylpyrrolidone , dimethylacetamide and dimethylformamide.

15. The method according to claim 11, wherein the porous substrate comprises a polymer film, a multilayer polymer film, or a non-woven fabric formed by any one or more of the following polymers: polyethylene, polypropylene, polyethylene terephthalate, polyphthaloyl diamine, polybutylene terephthalate, polyester, polyacetal, polyamide, polyimide, polyetheretherketone , polyaryletherketone, polyetherimide, polyamide imide, polybenzimidazole, polyethersulfone, polyphenylene oxide, cycloolefin copolymer, polyphenylene sulfide, and polyethylene naphthalene.

16. The method according to claim 15, wherein the polyethylene is at least one selected from the group consisting of high density polyethylene, low density polyethylene, and ultrahigh molecular weight polyethylene.

17. The method according to claim 13, wherein the second solvent is one or more independently selected from the group consisting of N-methylpyrrolidone, dimethylacetamide and dimethylformamide, and the third solvent is one or more selected from the group consisting of deionized water, ethanol, propanol, acetone, dimethyl carbonate and diethyl carbonate.

ABSTRACT

The application provides a separator and an energy storage device. The separator comprises: a porous substrate; and a porous layer arranged on a surface of the porous substrate, wherein the porous layer comprises inorganic particles and a binder, and a ratio of Dv90 of the inorganic particles to the thickness of the porous layer is in a range from 0.3 to 3.0. Excellent adhesion exists between the separator and the electrode according to the present application, which ensures that the energy storage device has good safety performance. Moreover, the rate performance and cycle performance of the energy storage device can be greatly improved due to the existence of inorganic particles in the separator.

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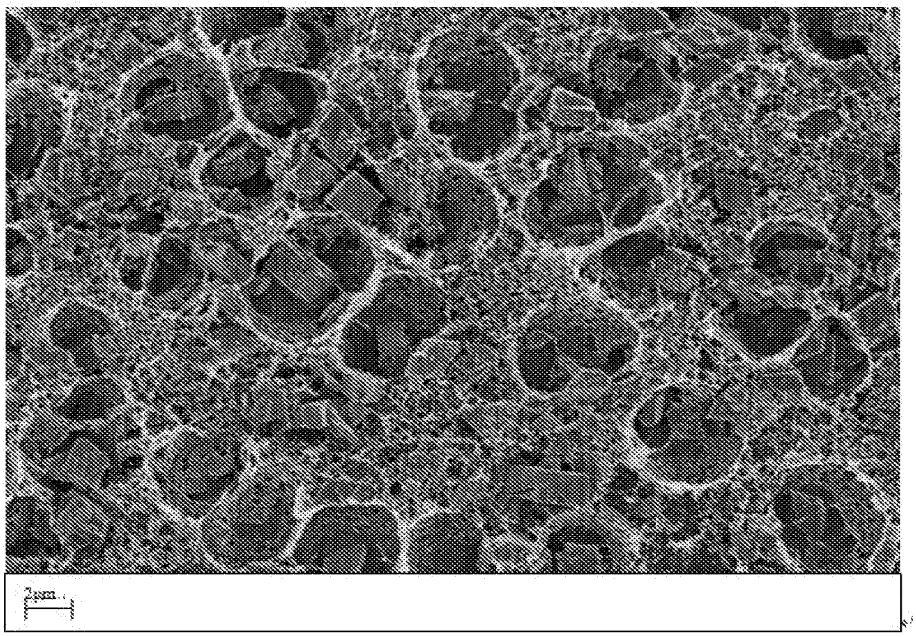


FIG.1

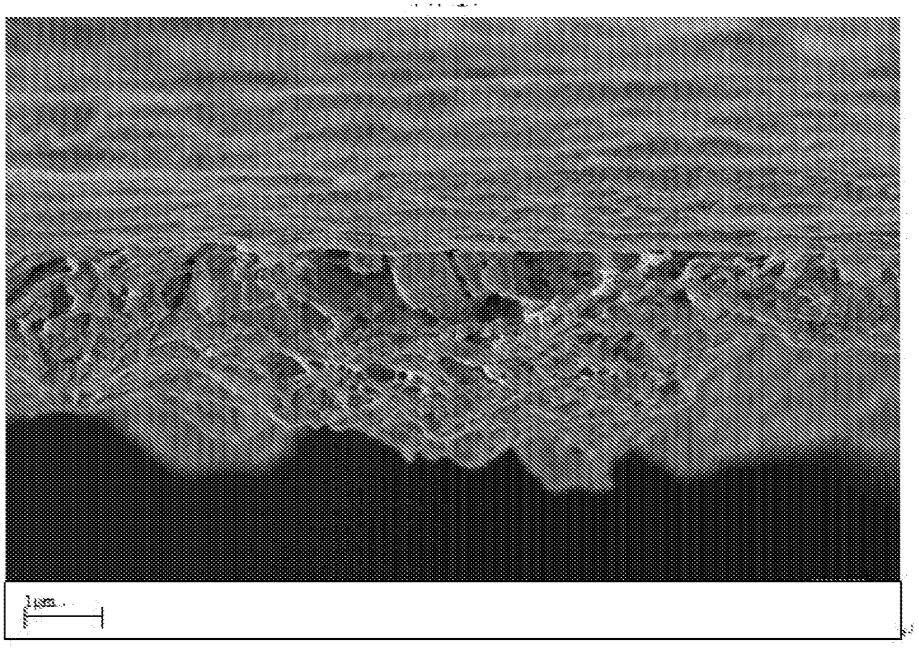


FIG.2

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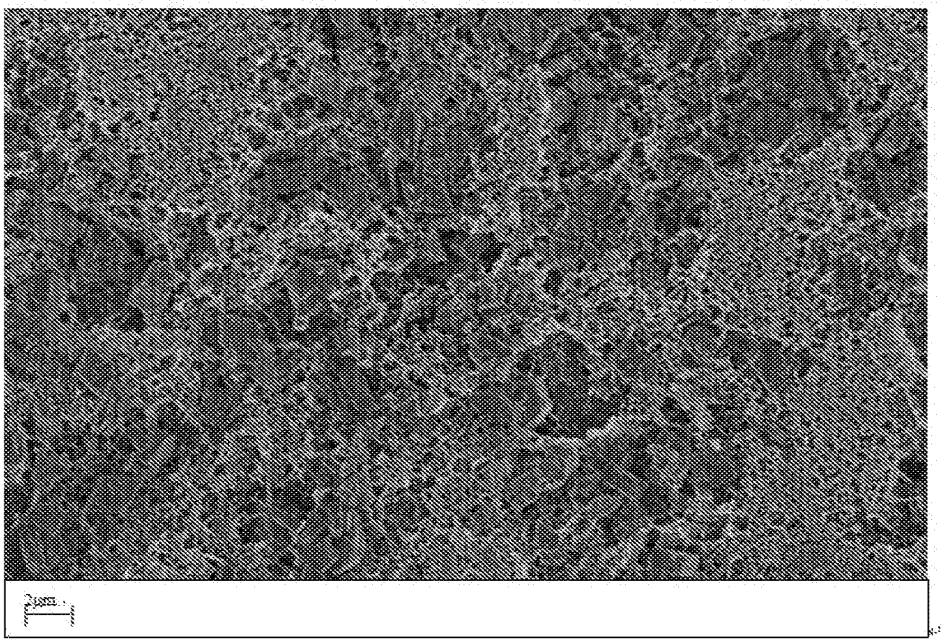


FIG.3

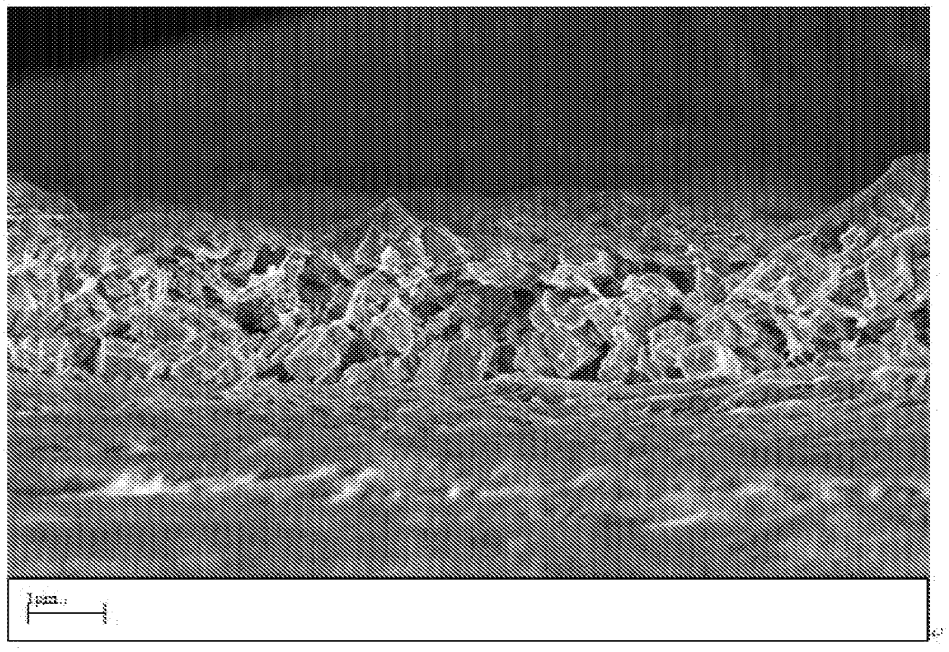


FIG.4

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PATENT APPLICATION FEE DETERMINATION RECORD

Substitute for Form PTO-875

Application or Docket Number: 16/013,887

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	300
SEARCH FEE (37 CFR 1.16(k), (i), or (m))	N/A	N/A	N/A			N/A	660
EXAMINATION FEE (37 CFR 1.16(o), (p), or (q))	N/A	N/A	N/A			N/A	760
TOTAL CLAIMS (37 CFR 1.16(i))	17 minus 20 =	*			OR	x 100 =	0.00
INDEPENDENT CLAIMS (37 CFR 1.16(h))	2 minus 3 =	*				x 460 =	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	1720

APPLICATION AS AMENDED - PART II

		(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($)	OTHER THAN SMALL ENTITY ADDITIONAL FEE($)
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	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	

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AMENDMENT B	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	

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16/013,887	06/20/2018	1726	1720	DEHE-1806-USPT	17	2

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Inventor(s)

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Applicant(s)

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Power of Attorney: The patent practitioners associated with Customer Number 152866

Domestic Applications for which benefit is claimed - None.
A proper domestic benefit claim must be provided in an Application Data Sheet in order to constitute a claim for domestic benefit. See 37 CFR 1.76 and 1.78.

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.)
CHINA 201810321779.5 04/11/2018

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.

Request to Retrieve - This application either claims priority to one or more applications filed in an intellectual property Office that participates in the Priority Document Exchange (PDX) program or contains a proper **Request to Retrieve Electronic Priority Application(s)** (PTO/SB/38 or its equivalent). Consequently, the USPTO will attempt to electronically retrieve these priority documents.

If Required, Foreign Filing License Granted: 07/09/2018

The country code and number of your priority application, to be used for filing abroad under the Paris Convention, is **US 16/013,887**

Projected Publication Date: 10/17/2019

Non-Publication Request: No

Early Publication Request: No

Title

SEPARATOR AND ENERGY STORAGE DEVICE

Preliminary Class

429

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

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PTO/SB/08a (02-18)
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INFORMATION DISCLOSURE STATEMENT BY APPLICANT
(Not for submission under 37 CFR 1.99)

Application Number	16013887
Filing Date	2018-06-20
First Named Inventor	Jianjian Yi
Art Unit	1726
Examiner Name	Not Yet Assigned
Attorney Docket Number	DEHE-1806-USPT

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	1	103474602	CN	A	2013-12-25	Shenzhen Taibai Technology Co., Ltd		☓
	2	205004376	CN	U	2016-01-27	Shenzhen Hongtai Battery Technology Co., Ltd		☒

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INFORMATION DISCLOSURE STATEMENT BY APPLICANT (**Not for submission under 37 CFR 1.99)**		
	Application Number	16013887
	Filing Date	2018-06-20
	First Named Inventor	Jianjian Yi
	Art Unit	1726
	Examiner Name	Not Yet Assigned
	Attorney Docket Number	DEHE-1806-USPT

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		

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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	16013887
	Filing Date	2018-06-20
	First Named Inventor	Jianjian Yi
	Art Unit	1726
	Examiner Name	Not Yet Assigned
	Attorney Docket Number	DEHE-1806-USPT

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	/Charles Ho/	Date (YYYY-MM-DD)	2018-07-13
Name/Print	Charles Ho	Registration Number	51,807

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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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.

Espacenet

Bibliographic data: CN205004376 (U) — 2016-01-27

Power battery's ceramic isolation membrane module for electric automobile

Inventor(s):	ZHOU YONG; LYU JINGSHUANG; GAN FENGJIU ± (ZHOU YONG, ; LYU JINGSHUANG, ; GAN FENGJIU)
Applicant(s):	SHENZHEN HONGTAI BATTERY TECH CO LTD ± (SHENZHEN HONGTAI BATTERY TECHNOLOGY CO., LTD)
Classification:	**- international:** ***H01M2/16*** **- cooperative:**
Application number:	CN20152792354U 20151013
Priority number(s):	CN20152792354U 20151013

Abstract of CN205004376 (U)

The utility model provides a power battery's ceramic isolation membrane module for electric automobile, this power battery's ceramic isolation membrane module for electric automobile includes: PP membrane layer, the symmetry sets up two inorganic ceramic layers of PP membrane layer both sides, the symmetry sets up the tie coat in two inorganic ceramic layer outsides. The beneficial effects of the utility model are that: the stability of the heat of diaphragm is improved, mechanical properties is used for putting forward unfamiliar high temperature resistance, security, cycle life, low self discharge nature.

(19)中华人民共和国国家知识产权局

(12)实用新型专利

(10)授权公告号 CN 205004376 U
(45)授权公告日 2016.01.27

(21)申请号 201520792354.4

(22)申请日 2015.10.13

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(74)专利代理机构 广州番禺容大专利代理事务所(普通合伙) 44326
代理人 刘新年

(51)Int.Cl.
H01M 2/16(2006.01)

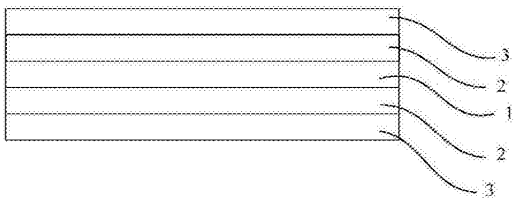
权利要求书1页 说明书2页 附图1页

(54)实用新型名称

一种电动汽车用动力电池的陶瓷隔离膜组件

(57)摘要

本实用新型提供了一种电动汽车用动力电池的陶瓷隔离膜组件，该电动汽车用动力电池的陶瓷隔离膜组件包括：PP隔膜层，对称设置在所述PP隔膜层两侧的两个无机陶瓷层，对称设置在所述两个无机陶瓷层外侧的粘结层。本实用新型的有益效果是：提高隔膜的热稳定性、机械性能，用来提隔膜的耐高温性、安全性、循环寿命、低自放电性。



CN 205004376 U

1. 一种电动汽车用动力电池的陶瓷隔离膜组件，其特征在于，包括：PP 隔膜层，对称设置在所述 PP 隔膜层两侧的两个无机陶瓷层，对称设置在所述两个无机陶瓷层外侧的粘结层。

2. 根据权利要求 1 所述的电动汽车用动力电池的陶瓷隔离膜组件，其特征在于，所述 PP 隔膜层的厚度为 16-40 微米。

3. 根据权利要求 2 所述的电动汽车用动力电池的陶瓷隔离膜组件，其特征在于，所述无机陶瓷层的厚度为 2-3 微米。

4. 根据权利要求 2 所述的电动汽车用动力电池的陶瓷隔离膜组件，其特征在于，所述粘结层的厚度为 2-3 微米。

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一种电动汽车用动力电池的陶瓷隔离膜组件

技术领域

[0001] 本实用新型涉及到电动车的技术领域，尤其涉及到一种电动汽车用动力电池的陶瓷隔离膜组件。

背景技术

[0002] 随着电动汽车行业的发展，动力电池逐渐成为电动汽车部件的核心，动力电池因其具有工作电压高、能量密度大、安全性好、无记忆效应、无污染等优点成为新能源开发的重点研究领域，在电动汽车、风光发电储能、太阳能发电储能、移动基站、空间技术、国防工业等诸多方面具有广阔的应用前景。

[0003] 目前，电动汽车对动力电池的安全性提出极高的要求，现在电动汽车用的动力电池基本使用的隔膜为三层 pp/pe/pp 复合微孔膜，或者单层 PP、PE 单层微孔膜、和涂布膜三种，由于隔膜厚度薄，一般为 16-40 μm 之前，在热稳定性方面差，高温后隔膜容易收缩给造成电池短路，机械性能不强，针刺后容易起火不齐，给电池的后续时候带来一定的安全隐患。

实用新型内容

[0004] 本实用新型的目的是为了克服现有技术的不足，提供了一种电动汽车用动力电池的陶瓷隔离膜组件。

[0005] 本实用新型是通过以上技术方案实现：

[0006] 本实用新型提供了一种电动汽车用动力电池的陶瓷隔离膜组件，该电动汽车用动力电池的陶瓷隔离膜组件包括：PP 隔膜层，对称设置在所述 PP 隔膜层两侧的两个无机陶瓷层，对称设置在所述两个无机陶瓷层外侧的粘结层。

[0007] 优选的，所述 PP 隔膜层的厚度为 16-40 微米。

[0008] 优选的，所述无机陶瓷层的厚度为 2-3 微米。

[0009] 优选的，所述粘结层的厚度为 2-3 微米。

[0010] 本实用新型的有益效果是：提高隔膜的热稳定性、机械性能，用来提隔膜的耐高温性、安全性、循环寿命、低自放电性。

附图说明

[0011] 图 1 是本实用新型实施例提供的电动汽车用动力电池的陶瓷隔离膜组件的结构示意图。

具体实施方式

[0012] 为了使本实用新型的目的、技术方案及优点更加清楚明白，以下结合附图及实施例，对本实用新型进行进一步详细说明。应当理解，此处所描述的具体实施例仅仅用以解释本实用新型，并不用于限定本实用新型。

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[0013] 请参阅图 1，图 1 是本实用新型提供的电动汽车用动力电池的陶瓷隔离膜组件的结构示意图。

[0014] 本实用新型实施例提供了一种电动汽车用动力电池的陶瓷隔离膜组件，该电动汽车用动力电池的陶瓷隔离膜组件包括：PP 隔膜层 1，对称设置在所述 PP 隔膜层 1 两侧的两个无机陶瓷层 2，对称设置在所述两个无机陶瓷层 2 外侧的粘结层 3。

[0015] 具体的，所述 PP 隔膜层 1 的厚度为 16-40 微米。所述无机陶瓷层 2 的厚度为 2-3 微米。所述粘结层 3 的厚度为 2-3 微米。

[0016] 为了方便对本实用新型实施例提供的隔膜组件有清晰的了解，下面对其结构进行详细的说明。

[0017] 本实施例提供的电动汽车用动力电池陶瓷隔膜包括 PP 隔膜，厚度为 16-40 微米厚；上下两层隔膜处理无机陶瓷层 2，涂层厚度 2-3 微米的无机陶瓷层 2。

[0018] 将隔膜展开通过搅拌好的隔膜无机陶瓷氧化铝混合浆料，涂布完后并使用烘箱 70-90 度温度烘烤干，后在处理好的隔膜上涂一层 2-3 μm 的粘结层 3，烘烤干的隔膜再进行电池制作，无机陶瓷层 2 可提高隔膜的热稳定性、机械性能，用来提隔膜的耐高温性、安全性、循环寿命、低自放电性。粘结层 3 可将正极极片、负极极片和隔膜更好的粘合一起，增强动力电池的电化学性能，尤其是对减低内阻，提高电池化成的形成膜，提高耐高温性、安全性、循环寿命、低自放电性，更大的效果在于避免电动汽车使用过程中造成的短路等安全隐患。

[0019] 以上仅为本实用新型的较佳实施例而已，并不用以限制本实用新型，凡在本实用新型的精神和原则之内所作的任何修改、等同替换和改进等，均应包含在本实用新型的保护范围之内。

CosMX Exhibit 1002, Page 76 of 334

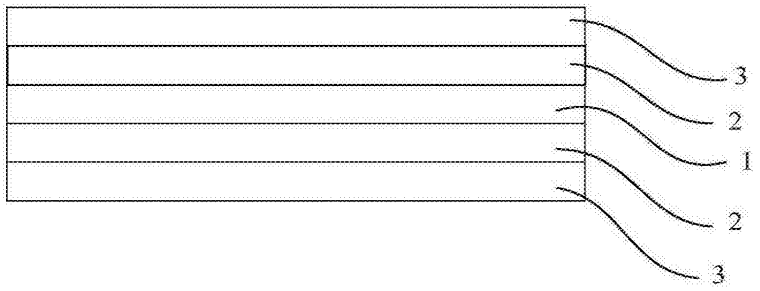


图 1

CosMX Exhibit 1002, Page 77 of 334

Espacenet

Bibliographic data: CN103474602 (A) — 2013-12-25

Pore-forming ceramic isolating membrane of lithium ion battery and preparation method thereof

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Classification: **- international:** ***H01M2/16***
- cooperative:

Application number: CN20131391112 20130830 Global Dossier

Priority number(s): CN20131391112 20130830

Also published as: CN103474602 (B)

Abstract of CN103474602 (A)

The invention discloses a pore-forming ceramic isolating membrane of a lithium ion battery. The pore-forming ceramic isolating membrane comprises an isolating membrane base material, wherein a porous ceramic coating is coated on single surface or double surfaces of the isolating membrane base material; the porous ceramic coating is formed by coating a sizing agent which contains nanometer ceramic powder, a binding agent as well as a pore-forming solvent on the isolating membrane base material, wherein dosage of the nanometer ceramic powder, the binding agent, a stabilizing agent and the pore-forming solvent in the sizing agent is respectively as follows in parts by weight: 88-93 parts of the nanometer ceramic powder, 4-6.5 parts of binding agent powder, 1-1.5 parts of the stabilizing agent, and 2-4 parts of the pore-forming solvent. According to the pore-forming ceramic isolating membrane of the lithium ion battery disclosed by the invention, an absorption rate of electrolyte is improved by improving a ceramic sizing agent, thereby facilitating transfer of lithium ions better, increasing inventory of the electrolyte in the battery and increasing hardness of the battery. Meanwhile, the problems that the ceramic layer is easy to drop on the isolating membrane and the coating thickness or the surface density is uneven are solved by the porous ceramic membrane coated by the novel sizing agent, and therefore, the safety performance of the battery is improved.

(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 103474602 A
(43)申请公布日 2013.12.25

(21)申请号 201310391112.X

(22)申请日 2013.08.30

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(51)Int.Cl.
H01M 2/16(2006.01)

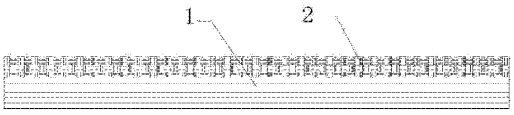
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(54)发明名称

一种锂离子电池造孔陶瓷隔离膜及其制备方法

(57)摘要

本发明公开了一种锂离子电池造孔陶瓷隔离膜，包括隔离膜基材，所述隔离膜基材单面或双面涂布有多孔陶瓷层，所述多孔陶瓷层是通过含有纳米陶瓷粉、粘结剂以及造孔溶剂的浆料涂布在隔离膜基材上而成，浆料中纳米陶瓷粉、粘结剂、稳定剂以及造孔溶剂的用量以重量份计分别为：纳米陶瓷粉88-93份，粘结剂份4-6.5，稳定剂1-1.5，造孔溶剂2-4份。本发明所述的锂离子电池造孔陶瓷隔离膜通过对陶瓷浆料改进，提高了电解液的吸收速度，更有利于锂离子的转移，增加了电池中电解液的保有量，增强了电池的硬度。同时，这种新的浆料涂布的多孔陶瓷膜解决了陶瓷层在隔离膜上易脱落、涂布厚度或面密度不均匀的问题，提高了电池的安全性能。



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1. 一种锂离子电池造孔陶瓷隔离膜，包括隔离膜基材，其特征在于：所述隔离膜基材单面或双面涂布有多孔陶瓷层，所述多孔陶瓷层是通过含有纳米陶瓷粉、造孔溶剂以及粘结剂的浆料涂布在隔离膜基材上而成，浆料中纳米陶瓷粉、粘结剂以及造孔溶剂的用量以重量份计分别为：纳米陶瓷粉 88-93 份，粘结剂份 4-6.5，稳定剂 1-1.5 份，造孔溶剂 2-4 份。

2. 根据权利要求 1 所述的锂离子电池造孔陶瓷隔离膜，其特征在于：所述浆料中纳米陶瓷粉、粘结剂、稳定剂、造孔溶剂的用量分别为 91 份、5.5 份、1 份、2.5 份。

3. 根据权利要求 1 所述的锂离子电池造孔陶瓷隔离膜，其特征在于：所述涂布的多孔陶瓷层厚度为 3-5μm。

4. 根据权利要求 1 所述的锂离子电池造孔陶瓷隔离膜，其特征在于：所述浆料固含量为 25-30%，浆料粘度为 40~50mpa·s。

5. 根据权利要求 1-3 任一项所述的锂离子电池造孔陶瓷隔离膜，其特征在于：所述纳米陶瓷粉为经过纳米化处理的 Al_2O_3 或 $BaSO_4$ 中的一种或两种以任意比混合。

6. 根据权利要求 1 所述的锂离子电池造孔陶瓷隔离膜，其特征在于：所述造孔溶剂为乙酸乙酯；所述粘结剂为聚丙烯酸酯，所述稳定剂为羧甲基纤维素钠。

7. 根据权利要求 1 所述的锂离子电池造孔陶瓷隔离膜，其特征在于：所述隔离膜基材为多孔单层或多层 PP 膜、PE 膜或 PP/PE 复合隔离膜中的一种，隔离膜基材的孔隙率为 40%~47%。

8. 一种如权利要求 1-7 任一项所述的锂离子电池造孔陶瓷隔离膜的涂布方法，其特征在于其工艺步骤如下：

1）陶瓷纳米化处理：将陶瓷原材料纳米化后烘烤、过筛，得到的纳米陶瓷粉备用；

2）浆料配制：按照上述比例将稳定剂加水溶解并搅拌后，加入得到的纳米陶瓷粉搅拌，依次加入粘结剂和造孔溶剂，继续搅拌反应；

3）涂布：升温凸版涂布机的烘箱，烘箱各段从前到后逐步提高温度，将浆料打入料槽中涂布在隔离膜基材的单面或双面，烘干即成。

9. 根据权利要求 8 所述的锂离子电池造孔陶瓷隔离膜的涂布方法，其特征在于：步骤 1）中烘箱的温度为 80-90℃，烘烤时间为 24-36 小时；步骤 2）中搅拌速度为 700-900r/min，搅拌反应时间为 1.5-2h。

10. 根据权利要求 8 所述的锂离子电池造孔陶瓷隔离膜的涂布方法，其特征在于：步骤 3）中烘箱各端的温度范围为 45-50℃。

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技术领域

[0001] 本发明涉及锂离子电池技术领域，具体涉及一种锂离子电池造孔陶瓷隔离膜及其涂布方法。

背景技术

[0002] 锂电池的燃烧甚至爆炸的根本原因是电池内部热失控制造成的，其中正负极片的短路是常见的问题，所以隔离膜在其中具有重要的隔离作用。隔离膜在锂电池中具有隔离电子、导通离子的作用，在隔离膜上涂上一层陶瓷层，当电池中有异物造成隔离膜破损时，短路点在高温度下不会因发热而扩大熔化，不会造成电极之间大面积短路，进而引起电池的燃烧甚至爆炸。随着贮能、电动汽车和电脑等用电器对锂离子电池的要求不断提高，锂离子充电电池单只容量和体积能量密度的不断提高，内部蓄积的能量越来越大，内部短路的危险性也在随之增大。当电池内部短路时，在高温下，陶瓷隔离膜的陶瓷层可以保持隔离膜完整的骨架结构，不因隔离膜基材熔化而失去分隔正负极片的作用，产生正负极片大面积短路。

[0003] 常见陶瓷隔离膜是在用干法或湿法工艺制造的单层或多层 PP、PE、PP/PE 复合隔离膜上涂附陶瓷层提高电池的安全性能，但在使用过程中常出现陶瓷层粘接不牢、吸液速度不够快等现象。有的陶瓷隔离膜在陶瓷层和隔离膜基材层之间加入高分子层，虽然保液性能有提高，但电池的离子通道有影响，且陶瓷层的厚度不够，安全性能不高等问题。

发明内容

[0004] 为了克服现有技术的缺陷，本发明的目的在于提供一种锂离子电池造孔陶瓷隔离膜，以提高锂电池的安全性能、吸液性能、保液性能、多孔陶瓷层的粘接性能以及锂离子通透性。

[0005] 本发明的另一目的在于提供一种锂离子电池造孔陶瓷隔离膜的制备方法，制造出的高安全造孔陶瓷隔离膜，提高锂离子电池的安全性能。

[0006] 为实现上述目的，本发明所采用的技术方案如下：

[0007] 一种锂离子电池造孔陶瓷隔离膜，包括隔离膜基材，所述隔离膜基材单面或双面涂布有多孔陶瓷层，所述多孔陶瓷层是通过含有纳米陶瓷粉、造孔溶剂以及粘结剂的浆料经凸版印刷机涂布而成，浆料中纳米陶瓷粉、造孔溶剂以及粘结剂的用量以重量份计分别为：纳米陶瓷粉 88-93 份，粘结剂份 4-6.5，稳定剂 1-1.5 份，造孔溶剂 2-4 份。

[0008] 本发明还可以通过以下方案实现：

[0009] 作为本发明的一种优选的方案，所述浆料中纳米陶瓷粉、粘结剂、稳定剂造孔溶剂的用量分别为 91 份、5.5 份、1 份，2.5 份。

[0010] 作为本发明的一种优选的方案，所述造孔陶瓷膜的多孔陶瓷层的涂层厚度为 3-5μm。本发明中，将多孔陶瓷层的厚度控制在上述范围之内，在提高多孔陶瓷膜保液能力的同时，也进一步提高了电池的安全性能；优选的所述多孔陶瓷层的厚度，小型电池（单体

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容量 5AH 以内，主要用于 3C 产品等）要求多孔陶瓷层单面涂层厚度为 3-4μm，大电池（单体容量 5AH 以上，主要用于动力电池、电动汽车电池、蓄能电池等）要求多孔陶瓷层单面涂层厚度为 5μm。

[0011] 为了控制涂布的厚度和均匀度，从而达到控制隔离膜质量的目的，作为本发明的一种优选的方案，所述浆料固含量为 25-30%，浆料粘度为 40 ～ 50mpa·s。当浆料粘度和固含量在上述范围时候，有利于凸版涂布机对涂布厚度和均匀度的控制。

[0012] 作为本发明的一种优选的方案，所述纳米陶瓷粉为经过纳米化处理的 Al_2O_3 或 $BaSO_4$ 中的一种或两种以任意比混合。

[0013] 在本发明中，所述造孔溶剂采用乙酸乙酯等低沸点的溶剂；这种低沸点溶剂具有水溶性兼油溶性，在材料中分散均匀，且密度小，所以在烘干过程中首先被蒸发掉，在陶瓷层表面形成微小的细密开孔，造孔隔离膜制作成电池后，为电解液的浸入提供更多的通道。所述粘结剂为聚丙烯酸酯，所述稳定剂为羧甲基纤维素钠。进一步的为了提高多孔陶瓷层的粘结性，所述稳定剂羧甲基纤维素钠的平均分子量 65 ～ 100 万左右，粘接剂聚丙烯酸酯的平均分子量为 30 ～ 120 万。

[0014] 作为本发明的一种优选的方案，所述隔离膜基材为干法或湿法多孔单层或多层 PP 膜、PE 膜或 PP/PE 复合隔离膜中的一种，隔离膜基材的孔隙率为 40% ～ 47%。

[0015] 一种锂离子电池造孔陶瓷隔离膜的涂布方法，其工艺步骤如下：

[0016] 1）陶瓷纳米化处理：将陶瓷原材料纳米化后烘烤、过筛，得到的纳米陶瓷粉备用；

[0017] 2）浆料配制：按照上述比例将稳定剂加水溶解并搅拌后，加入得到的纳米陶瓷粉搅拌，依次加入粘结剂和造孔溶剂，继续搅拌反应；

[0018] 3）涂布：升温涂布机的烘箱，烘箱各段从前到后逐步提高温度，将浆料打入料槽中涂布在隔离膜基材的单面或双面，通过烘箱烘干即成。

[0019] 上述方法中，作为优选的实施方案，所述步骤 1）中烘箱的温度为 80-90℃，烘烤时间为 24-36 小时；步骤 2）中搅拌速度为 700-900r/min，搅拌反应时间为 1.5-2h。

[0020] 上述方法中，作为优选的实施方案，步骤 3）中烘箱各端的温度范围为 45-50℃。

[0021] 相比现有技术，本发明的有益效果在于：本发明所述的锂离子电池造孔陶瓷隔离膜通过对陶瓷浆料的改造，造孔陶瓷层更有利于电解液的快速吸收和提高锂离子的转移速度，增加了电池电解液的保有量，又增强了电池的硬度；这种新配方浆料涂布出的多孔陶瓷膜解决了陶瓷层在隔离膜上易脱落、涂布厚度或面密度不均匀的问题。本发明不仅提高了电池的安全性能，同时也达到普通隔离膜制造的电池无法达到的性能。

[0022] 下面结合附图及具体实施方式对本发明作进一步详细说明。

附图说明

[0023] 图 1 为本发明一种实施方式的结构示意图；

[0024] 图 2 为本发明另一种实施方式的结构示意图；

[0025] 图 3 为隔离膜基材与本发明的造孔陶瓷膜后的隔离膜外观对比，其中（a）为隔离膜基材，（b）为造孔陶瓷隔离膜；

[0026] 图 4 为本发明的造孔陶瓷隔离膜的电镜图；

[0027] 图 5 为本发明的造孔陶瓷隔离膜与普通隔离膜的电铬铁穿刺对比示意图其中（c）

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为普通隔离膜，(d) 为造孔陶瓷隔离膜；

[0028] 图 6 为普通隔离膜与本发明的造孔陶瓷隔离膜电解液的浸润性的照片对比，其中 (e) 为普通隔离膜，(f) 为造孔陶瓷隔离膜。

具体实施方式

[0029] 如图 1 所示，一种实施方式中，本发明所述的锂离子电池造孔陶瓷隔离膜，包括隔离膜基材 1，所述隔离膜基材 1 双面涂布有多孔陶瓷膜 2，所述多孔陶瓷膜是通过含有纳米陶瓷粉、造孔溶剂以及粘结剂的浆料涂布而成，浆料中纳米陶瓷粉、造孔溶剂以及粘结剂的用量以重量份计分别为：纳米陶瓷粉 88-93 份，粘结剂份 4-6.5，稳定剂 1-1.5 份，造孔溶剂 2-4 份。

[0030] 如图 2 所示，另一中实施方式中，与上述方案的区别在于：本发明所述的所述隔离膜基材 1 单面涂布有多孔陶瓷层 2。

[0031] 以下是本发明制备锂离子电池造孔陶瓷隔离膜的具体实施例。

[0032] 实施例 1

[0033] 一种锂离子电池造孔陶瓷隔离膜，其是通过以下方法制备而成：

[0034] 1) 陶瓷纳米化处理：将 Al_2O_3 原料纳米化后于 85℃的烤箱中烘烤 36h，过筛，得到的纳米陶瓷粉备用；

[0035] 2) 浆料配制：取固含量 1.6% 的羧甲基纤维素钠溶液 93.75g，加去离子水 300g，以 800r/min 的转速搅拌 30min；然后加入步骤 1) 的纳米陶瓷粉 144g，以 800r/min 的转速搅拌 3h；加入聚丙烯酸酯 9g，加入造孔溶剂乙酸乙酯 3g，以 800r/min 的转速搅拌 1.5 ～ 2h；用微量去离子水调节浆料黏度为 47mpa·s，浆料固含量为 27.8%；

[0036] 3) 涂布：调试机器，并升温烘箱，涂布机各段的温度控制在 45 ～ 50℃范围内，烘箱各段从前到后逐步提高温度；将浆料打入料槽中，进行试涂，烘干后进行厚度和面密度测试，直到调节达到要求后，开始将浆料涂布在 PP 隔离膜基材上。

[0037] 实施例 2

[0038] 一种锂离子电池造孔陶瓷隔离膜，其是通过以下方法制备而成：

[0039] 1) 陶瓷纳米化处理：将 $BaSO_4$ 原料纳米化处理后于 85℃的烤箱中烘烤 24h，过筛，得到的纳米陶瓷粉备用；

[0040] 2) 浆料配制：取固含量 1.6% 的羧甲基纤维素钠溶液 125g，加去离子水 300g，以 800r/min 的转速搅拌 30min；然后加入步骤 1) 的纳米陶瓷粉 150g，以 800r/min 的转速搅拌 3h；加入聚丙烯酸酯 10g，加入造孔溶剂乙酸乙酯 4g，以 800r/min 的转速搅拌 1.5 ～ 2h；用微量去离子水调节浆料黏度为 48mpa·s；浆料固含量为 27.5%；

[0041] 3) 涂布：调试机器，并升温烘箱，涂布机各段的温度控制在 45 ～ 50℃范围内，烘箱各段从前到后逐步提高温度；将浆料打入料槽中，进行试涂，烘干后进行厚度和面密度测试，直到调节达到要求后，开始将浆料涂布在 PE 隔离膜基材上。

[0042] 实施例 3

[0043] 一种锂离子电池造孔陶瓷隔离膜，其是通过以下方法制备而成：

[0044] 1) 陶瓷纳米化处理：将原料 Al_2O_3 与 $BaSO_4$ 按照质量比为 1 ∶ 1 的比例混合后纳米化处理，于 85℃的烤箱中烘烤 24 ～ 36h，过筛，得到的纳米陶瓷粉备用；

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[0045] 2）浆料配制：取固含量 1.6% 的羧甲基纤维素溶液 93.75g，加去离子水 300g，以 800r/min 的转速搅拌 30min；然后加入步骤 1）的纳米陶瓷粉 145g，以 800r/min 的转速搅拌 3h；加入聚丙烯酸酯 9g，加入造孔溶剂乙酸乙酯 3.5g，以 800r/min 的转速搅拌 1.5 ～ 2h；用微量去离子水调节浆料黏度为 46mpa·s；浆料固含量为 27.3%；

[0046] 3）涂布：调试机器，并升温烘箱，涂布机各段的温度控制在 45 ～ 50℃范围内，烘箱各段从前到后逐步提高温度；将浆料打入料槽中，进行试涂，烘干后进行厚度和面密度测试，直到调节达到要求后，开始将浆料涂布在 PE/PP 复合隔离膜基材上。

[0047] 性能检测：

[0048] 1. 电铬铁穿刺实验：用电烙铁轻触穿刺隔离膜测试（测试条件：电烙铁温度 390℃），测试结果见示意图 5。

[0049] 图 5 的结果显示普通隔离膜在接触点直径明显扩大；本发明的造孔陶瓷膜接触点没有扩大。说明当在电芯内部微短路产生热量或着火点时，陶瓷隔离膜孔径不会继续增大，从而减小了燃烧的风险。

[0050] 2. 浸润性对比：将同一种电解液同时滴在普通陶瓷膜和本发明的造孔陶瓷隔离膜上（测试温度 27℃），测试结果见图 6。

[0051] 图 6 的结果显示在相同时间内电解液在普通陶瓷膜上的扩散速度明显比电解液在本发明的造孔陶瓷隔离膜上的扩散速度。说明本发明的造孔陶瓷隔离膜具有良好的吸液性能和离子通透性能，即具有良好的浸润性。

[0052] 3. 其他性能检测，检测结果见表 1。

[0053] 表 1

[0054]

项目		单位	规格和标准值				检验方法和仪器
外观			乳白色，平整光滑，无划痕，无色斑，无针孔				目测
厚度		um	12±3	16±3	20±3	24±3	千分尺
宽度		mm	根据需求指定				卡尺或投影仪
长度		mm	根据需求指定				收卷计米器
透气度		sec/100cc	190±60	250±60	290±60	320±60	透气度测定仪
孔隙率		%	45±5	45±5	45±5	45±5	GB/T21650.1-2008
穿刺强度		gf	≥320	≥450	≥500	≥550	GB/T23318-2009
拉伸强度	MD	Kgf/cm2	≥1000	≥1125	≥1200	≥1250	GB/T1040.3-2006
	TD		≥800	≥900	≥960	≥1000	

[0055]

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热收缩 130℃/0.5H	MD	%	≤4.0	≤4.0	≤4.0	≤4.0	取 1.5-1.0mm 的隔离膜，标记好测试点，经烘烤后，比较烘烤前后长度和宽度方向上的变化率。
	TD		≤4.0	≤4.0	≤4.0	≤4.0	
面密度		g/m3	10.6±3	12.9±3	14.8±3	17±3	取样器和电子天秤
弧度		mm	≤3.5	≤3.5	≤3.5	≤3.5	取 1 米长的隔离膜平铺在 1 米长的直钢尺上，确保隔离膜的两端同时对齐直钢尺的一边并固定。然后用卡尺在隔离膜的 0.5 米处测量隔离膜到直钢尺边缘的距离。

[0056] 备注：1. MD 指纵向（长度方向）；TD 指横向（宽度方向）

[0057] 2. 此标准是选用 PE 基材单面涂布陶瓷层厚 4μm 后的结果。不同的基材会有所不同。

[0058] 上述实施方式仅为本发明的优选实施方式，不能以此来限定本发明保护的范围，本领域的技术人员在本发明的基础上所做的任何非实质性的变化及替换均属于本发明所要求保护的范围。

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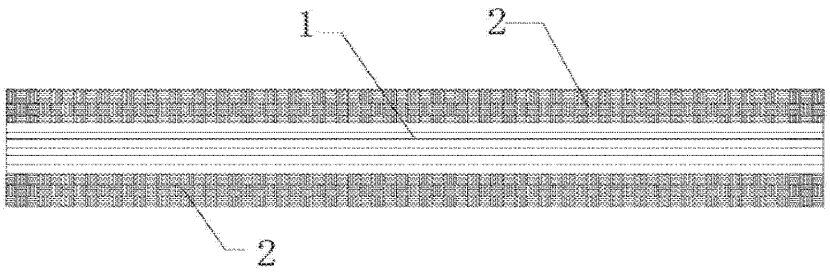


图 1

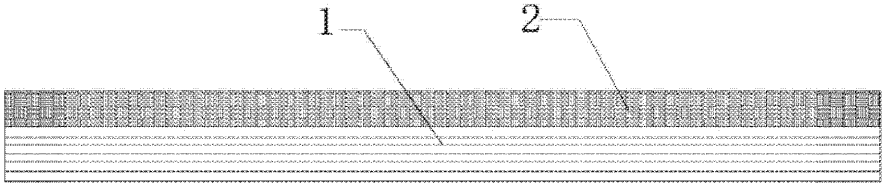


图 2

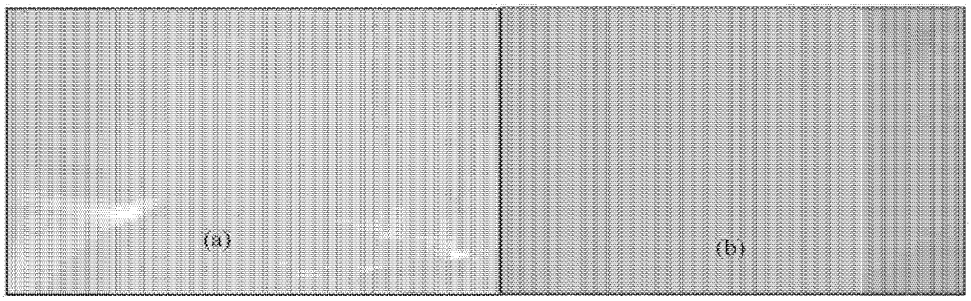


图 3

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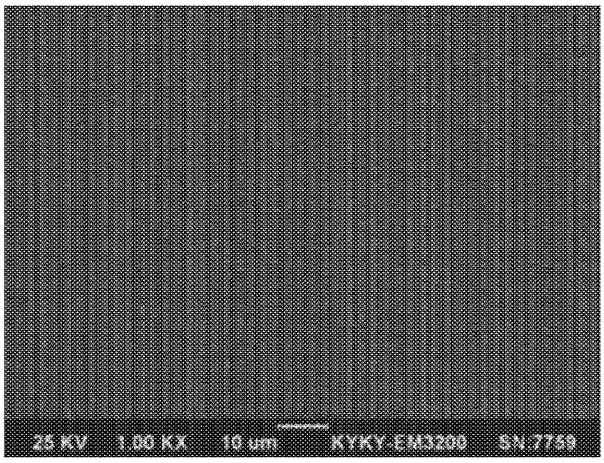


图 4



图 5

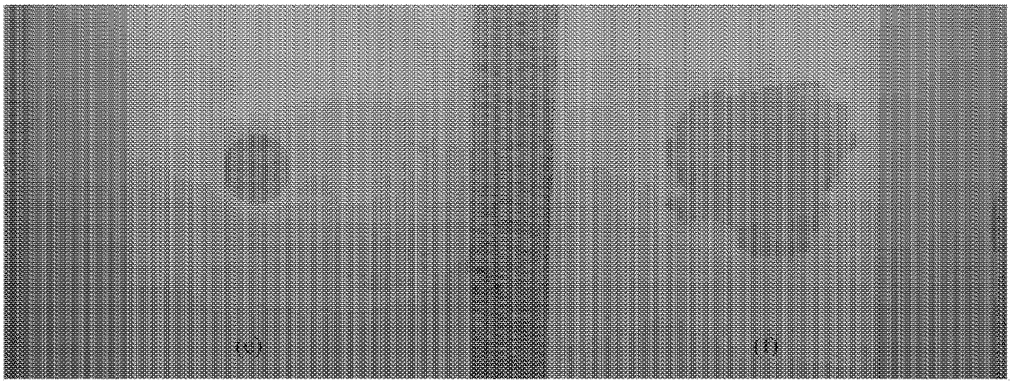


图 6

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Electronic Acknowledgement Receipt	
EFS ID:	33168470
Application Number:	16013887
International Application Number:	
Confirmation Number:	3106
Title of Invention:	SEPARATOR AND ENERGY STORAGE DEVICE
First Named Inventor/Applicant Name:	Jianjian Yi
Customer Number:	129752
Filer:	Charles S. Ho
Filer Authorized By:	
Attorney Docket Number:	DEHE-1806-USPT
Receipt Date:	16-JUL-2018
Filing Date:	20-JUN-2018
Time Stamp:	04:42:43
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	no

File Listing:

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1	Information Disclosure Statement (IDS) Form (SB08)	Information_Disclosure_Statement_Fillable_PDF.PDF	1034281 6a45b400c37c8bdbff8e32c85355a8beab7d3253	no	4
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2	Foreign Reference	CN205004376U.pdf	515210 5df95d89b1bd2a68741e2ab6d6fc590875686f69	no	6
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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.

中华人民共和国国家知识产权局
STATE INTELLECTUAL PROPERTY OFFICE
OF THE PEOPLE'S REPUBLIC OF CHINA

证　　明

本证明之附件是向本局提交的下列专利申请文件副本。

申　　请　　号：201810321779.5

申　请　类　型：发明专利

发明 创造 名称：隔离膜及储能装置

申　　请　　日：2018 年 04 月 11 日

申　　请　　人：宁德新能源科技有限公司

发明人或设计人：易建建、张新枝、魏增斌、陶兴华

局长

申长雨

2018 年 08 月 08 日

2018103217795

权利要求书

1. 一种隔离膜，包括:

多孔基材；以及

多孔层，设置在所述多孔基材的表面，所述多孔层包括无机颗粒和粘结剂，所述无机颗粒的Dv90与所述多孔层厚度的比值为0.3~3.0。

2.根据权利要求1所述的隔离膜，其中，所述多孔层的厚度为0.2~10μm。

3. 根据权利要求1所述的隔离膜，其中，所述多孔层具有由粘结剂形成的孔，所述孔中包括无机颗粒。

4. 根据权利要求3所述的隔离膜，其中，所述孔的平均孔径为0.3μm~20μm。

5. 根据权利要求1所述的隔离膜，其中，所述无机颗粒与所述粘结剂的体积比值为0.2~3.0。

6. 根据权利要求1所述的隔离膜，其中，所述多孔层的孔隙率为20%~90%。

7.根据权利要求1所述的隔离膜，其中，所述无机颗粒选自氧化铝、二氧化硅、氧化镁、氧化钛、二氧化铪、氧化锡、氧化锆、二氧化铈、氧化镍、氧化锌、氧化钙、勃姆石、氢氧化铝、氢氧化镁、氢氧化钙和硫酸钡中的一种或多种。

8.根据权利要求1所述的隔离膜，其中，所述粘结剂选自聚偏氟乙烯、偏氟乙烯-六氟丙烯的共聚物、聚酰胺、聚丙烯腈、聚丙烯酸酯、聚丙烯酸、聚丙烯酸盐、羧甲基纤维素钠、聚乙烯吡咯烷酮、聚乙烯醚、聚甲基丙烯酸甲酯、聚四氟乙烯和聚六氟丙烯中的一种或多种。

9. 一种储能装置，包括根据权利要求1至8中任一项所述的隔离膜。

10. 根据权利要求9所述的储能装置，其中，所述储能装置为锂离子电池。

11. 一种制备隔离膜的方法，其中，所述方法包括步骤:

将无机颗粒与粘结剂混合，加入第一溶剂并搅拌均匀，得到涂布液;

将所述涂布液涂布在多孔基材的表面，形成湿膜;

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将所述湿膜浸入到凝固液中进行相转化;

将相转化的湿膜干燥，得到隔离膜。

12. 根据权利要求 11 所述的方法，其中，所述涂布液中的固含量为 7%~25%。

13. 根据权利要求 11 所述的方法，其中，所述凝固液包括第二溶剂和第三溶剂，所述第二溶剂的质量百分含量为 20%~60%。

14. 根据权利要求 11 或 13 所述的方法，其中，所述第一溶剂和所述第二溶剂各自独立的选自 N-甲基吡咯烷酮、二甲基乙酰胺和二甲基甲酰胺中的一种或多种，所述第三溶剂选自去离子水、乙醇、丙醇、丙酮、碳酸二甲酯和碳酸二乙酯中的一种或多种。

15.根据权利要求 11 所述的方法，所述多孔基材包括以下任一种聚合物或两种以上的混合物形成的聚合物膜、多层聚合物膜、或无纺布：聚乙烯、聚丙烯、聚对苯二甲酸乙二醇酯、聚苯二甲酰苯二胺、聚对苯二甲酸丁二醇酯、聚酯、聚缩醛、聚酰胺、聚酰亚胺、聚醚醚酮、聚芳醚酮、聚醚酰亚胺、聚酰胺酰亚胺、聚苯并咪唑、聚醚砜、聚苯醚、环烯烃共聚物、聚苯硫醚和聚乙烯萘。

16.根据权利要求 15 所述的方法，所述聚乙烯选自高密度聚乙烯、低密度聚乙烯和超高分子量聚乙烯中的至少一种组分。

2018103217795

说明书

隔离膜及储能装置

技术领域

本申请涉及储能装置领域，更具体地，涉及隔离膜和储能装置。

背景技术

非水系二次电池特别是锂离子电池以其能量密度高、倍率性能好等特性，广泛应用于笔记本电脑、数码相机、摄像机和手机等便携电子设备。近些年来锂离子电池作为新能源汽车的供电电源，也在推动锂离子电池技术的发展。锂离子电池在循环过程中，随着充放电的进行，极片与隔离膜之间会产生间隙，导致锂离子电池的循环容量减少，从而影响其使用寿命。因此，急需一种技术方案解决隔离膜和极片之间的间隙问题以提高锂离子电池的使用寿命。

发明内容

本申请提供了一种隔离膜和储能装置，本申请提供的隔离膜不仅能够解决隔离膜和极片之间的间隙问题，而且还能维持隔离膜和极片之间良好的粘结力，同时本申请的隔离膜中维持的孔结构能够提高储能装置的倍率性能和循环性能。

本申请的实施例提供了一种隔离膜，包括：多孔基材；以及多孔层，设置在所述多孔基材的表面，所述多孔层包括无机颗粒和粘结剂，所述无机颗粒的 Dv90 与所述多孔层厚度的比值为 0.3~3.0，所述无机颗粒的 Dv90 是指在体积基准的粒度分布中，从小粒径侧起、达到体积累积 90%的粒径。

在上述隔离膜中，其中，所述多孔层的厚度为 0.2~10μm。

在上述隔离膜中，其中，所述多孔层具有由粘结剂形成的孔，所述孔中包括无机颗粒。

在上述隔离膜中，其中，所述孔的平均孔径为 0.3μm~20μm。

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在上述隔离膜中，其中，所述无机颗粒与所述粘结剂的体积比值为0.2~3.0。

在上述隔离膜中，其中，所述多孔层的孔隙率为20%~90%。

在上述隔离膜中，其中，所述无机颗粒选自氧化铝、二氧化硅、氧化镁、氧化钛、二氧化铪、氧化锡、氧化锆、二氧化铈、氧化镍、氧化锌、氧化钙、勃姆石、氢氧化铝、氢氧化镁、氢氧化钙和硫酸钡中的一种或多种。

在上述隔离膜中，其中，所述粘结剂选自聚偏氟乙烯、偏氟乙烯-六氟丙烯的共聚物、聚酰胺、聚丙烯腈、聚丙烯酸酯、聚丙烯酸、聚丙烯酸盐、羧甲基纤维素钠、聚乙烯吡咯烷酮、聚乙烯醚、聚甲基丙烯酸甲酯、聚四氟乙烯和聚六氟丙烯中的一种或多种。

本申请还提供了一种储能装置，包括上述隔离膜。

在上述储能装置中，其中，所述储能装置为锂离子电池。

本申请还提供了一种制备隔离膜的方法，其中，所述方法包括步骤：

将无机颗粒与粘结剂混合，加入第一溶剂并搅拌均匀，得到涂布液；将所述涂布液涂布在多孔基材的表面，形成湿膜；将所述湿膜浸入到凝固液中进行相转化；将相转化的湿膜干燥，得到隔离膜。

在上述方法中，其中，所述涂布液中的固含量为7%~25%。

在上述方法中，其中，所述凝固液包括第二溶剂和第三溶剂，所述第二溶剂的质量百分含量为20%~60%。

在上述方法中，其中，所述第一溶剂和所述第二溶剂各自独立的选自N-甲基吡咯烷酮(NMP)、二甲基乙酰胺(DMAC)和二甲基甲酰胺(DMF)中的一种或多种，所述第三溶剂选自去离子水、乙醇、丙醇、丙酮、碳酸二甲酯和碳酸二乙酯中的一种或多种。

在上述方法中，其中，所述多孔基材包括以下任一种聚合物或两种以上的混合物形成的聚合物膜、多层聚合物膜、或无纺布：聚乙烯、聚丙烯、聚对苯二甲酸乙二醇酯、聚苯二甲酰苯二胺、聚对苯二甲酸丁二醇酯、聚酯、聚缩醛、聚酰胺、聚酰亚胺、聚醚醚酮、聚芳醚酮、聚醚酰亚胺、聚酰胺酰亚胺、聚苯并咪唑、聚醚砜、聚苯醚、环烯烃共聚物、聚苯硫醚和

聚乙烯荼。

在上述方法中，其中，所述聚乙烯选自高密度聚乙烯、低密度聚乙烯和超高分子量聚乙烯中的至少一种组分。

本申请的隔离膜与极片之间具有优异的粘结性，保证储能装置具有良好的安全性能，同时隔离膜表面设置有多孔层，多孔层中的孔包含的无机颗粒能够对孔起到支持作用，能够很好地维持孔不被破坏，降低隔离膜发生压缩堵孔以及溶胀堵孔的概率，使储能装置具有高的离子电导率，极大地提高储能装置的倍率性能和循环性能。

附图说明

图 1 为实施例 3 的多孔层下表面（即多孔层远离多孔基材的表面）的孔的电镜图（3000 倍）；

图 2 为实施例 3 的多孔层沿厚度方向的横截面的电镜图（10000 倍）；

图 3 为对比例 2 的多孔层下表面（即多孔层远离多孔基材的表面）的孔的电镜图（3000 倍）；

图 4 为对比例 2 的多孔层沿厚度方向的横截面的电镜图（10000 倍）。

具体实施方式

下面详细充分地说明示例性实施例，不过，这些示例性实施例可以用不同的方式来实施，并且，不应被解释为局限于本申请所阐述的这些实施例。相反，提供这些实施例的目的在于使本申请公开彻底和完整，以及将本申请的范围充分地传达给本领域所属技术人员。

下面详细说明根据本申请的隔离膜及其制备方法和储能装置。

本申请第一方面的隔离膜包括多孔基材以及多孔层。多孔层设置在多孔基材的表面，具体的，多孔层设置在多孔基材的一个表面，或多孔层同时设置在多孔基材的两个表面，或多孔层设置在多孔基材的一部分表面。多孔基材包括以下任一种聚合物或两种以上的混合物形成的聚合物膜、多层聚合物膜、或无纺布：聚乙烯、聚丙烯、聚对苯二甲酸乙二醇酯、聚苯二甲酰苯二胺、聚对苯二甲酸丁二醇酯、聚酯、聚缩醛、聚酰胺、聚酰亚

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胺、聚醚醚酮、聚芳醚酮、聚醚酰亚胺、聚酰胺酰亚胺、聚苯并咪唑、聚醚砜、聚苯醚、环烯烃共聚物、聚苯硫醚和聚乙烯萘。上述聚乙烯选自高密度聚乙烯、低密度聚乙烯和超高分子量聚乙烯中的至少一种组分。

在本申请的实施例中，形成在多孔基材上的多孔层包括粘结剂和无机颗粒。多孔层具有由粘结剂形成的孔，孔中包括无机颗粒。无机颗粒的 Dv90 与多孔层的厚度比值为 0.3~3.0，无机颗粒的 Dv90 是指在体积基准的粒度分布中，从小粒径侧起、达到体积累积 90%的粒径。粘结剂选自聚偏氟乙烯、偏氟乙烯-六氟丙烯的共聚物、聚酰胺、聚丙烯腈、聚丙烯酸酯、聚丙烯酸、聚丙烯酸盐、羧甲基纤维素钠、聚乙烯吡咯烷酮、聚乙烯醚、聚甲基丙烯酸甲酯、聚四氟乙烯和聚六氟丙烯中的一种或多种。粘结剂能够提供对极片的足够的粘结界面，保证隔离膜对极片的高粘结力，使储能装置（例如锂离子电池）具有较高的安全性能。

多孔层中的孔使隔离膜具有很好的电解液扩散和吸收能力，提高了隔离膜的离子电导率，从而可提高储能装置（例如锂离子电池）的动力学性能。多孔层的平均孔径不小于 0.3μm，这使得隔离膜具有良好的电解液扩散和吸收能力，提高了隔离膜的离子电导率，减少极化反应，从而可提高储能装置(例如锂离子电池)的动力学性能。多孔层的孔隙率可为 20%~90%。

在多孔层的孔中分布的无机颗粒能够对多孔层起到很好的机械支撑作用，防止多孔层在储能装置（例如锂离子电池）的加工过程中发生压缩坍塌，避免多孔层被压缩破坏。无机颗粒是指用天然或合成的化合物经过成形和高温烧结等加工过程制成的一类无机非金属材料。无机颗粒选自氧化铝、二氧化硅、氧化镁、氧化钛、二氧化铪、氧化锡、氧化锆、二氧化铈、氧化镍、氧化锌、氧化钙、勃姆石、氢氧化铝、氢氧化镁、氢氧化钙和硫酸钡中的一种或多种。无机颗粒可以含有极性官能团，例如羟基。含有极性官能团的无机颗粒的表面更容易在制备过程中与凝固液内的非溶剂（第三溶剂）结合，有利于非溶剂（第三溶剂）沿着无机颗粒表面扩散进入多孔层，从而在无机颗粒的附近形成较大的孔，从而提升储能装置（例如锂离子电池）的动力学性能。关于凝固液中的的非溶剂（第三溶剂），将在下面进行说明。

在本申请的实施例中，多孔层中的无机颗粒与粘结剂的体积比值为0.2~3.0。增大无机颗粒与粘结剂的体积比值，有助于提升涂布液内的第一溶剂与凝固液内的第三溶剂的交换，多孔层的孔隙率增加，反之多孔层的孔隙率降低。如果无机颗粒与粘结剂的体积比值过小，则多孔层的平均孔径减小，孔隙率降低，而且无机颗粒含量降低，多孔层的机械强度和耐热性能降低；如果无机颗粒与粘结剂的体积比值过大，多孔层的粘结力降低，多孔层容易从多孔基材的表面脱落，导致储能装置（例如锂离子电池）的安全性能变差。

多孔层的厚度为 0.2μm ~ 10μm，其中，若多孔层的厚度较大，则多孔层的透气性能变差，会降低储能装置（例如锂离子电池）的动力学性能，若多孔层的厚度较小，则多孔层的粘结力降低，隔离膜和极片之间容易出现间隙，储能装置（例如锂离子电池）的硬度降低，导致储能装置（例如锂离子电池）的安全性能变差。

此外，在本申请的实施例中，通过对无机颗粒的 Dv90 与多孔层厚度的比值的控制，可以得到平均孔径较大的孔，在电解液环境中，多孔层中的粘结剂（例如聚偏氟乙烯）发生溶胀后，贯通孔能够得到较多的保留，避免出现溶胀堵孔，保障了离子传输的通道，减少极化反应，提升储能装置（例如锂离子电池）的动力学性能。其中，无机颗粒的 Dv90 是指在体积基准的粒度分布中，从小粒径侧起、达到体积累积 50%的粒径。

在本申请的一些实施例中，无机颗粒的 Dv90 与多孔层厚度的比值为0.4~1.5。增大无机颗粒的 Dv90 与多孔层厚度的比值，有助于提升多孔层的机械强度，防止多孔层在储能装置（例如锂离子电池）的制备或循环过程中发生压缩堵孔，提升储能装置（例如锂离子电池）的动力学性能；反之，减小无机颗粒的 Dv90 与多孔层厚度的比值，则会降低多孔层的机械性能，导致多孔层在储能装置（例如锂离子电池）的制备及循环过程中被压缩堵孔，降低储能装置（例如锂离子电池）的动力学性能。另外，如果无机颗粒的 Dv90 与多孔层厚度的比值过大，则容易导致多孔层的孔径分布不均匀，进而导致多孔层表面不均匀，多孔层容易从多孔基材表面剥离，在储能装置（例如锂离子电池）中形成缺陷。此外，无机颗粒的 Dv90 与多孔

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层厚度的比值过大，会导致多孔层的粘结力下降，影响储能装置（例如锂离子电池）的安全性能；而无机颗粒的 Dv90 与多孔层厚度的比值过小，则无机颗粒不能有效地露出于多孔层的表面，从而不能在多孔层的制备过程中促进涂布液内的第一溶剂与凝固液内的第三溶剂的交换，从而不能起到增强扩散的作用，不利于孔的发展。

下面描述了本申请的隔离膜的制备方法。首先，将无机颗粒与粘结剂混合，然后加入第一溶剂并均匀搅拌，得到涂布液，其中粘结剂溶于第一溶剂中。该第一溶剂选自 N-甲基吡咯烷酮（NMP）、二甲基乙酰胺（DMAC）和二甲基甲酰胺（DMF）中的一种或多种。其中，使用 N-甲基吡咯烷酮（NMP）形成的多孔层的平均孔径最大、孔隙率最高；使用二甲基甲酰胺（DMF）形成的多孔层的平均孔径最小、孔隙率最低；使用二甲基乙酰胺（DMAC）则形成多孔层的平均孔径和孔隙率介于 N-甲基吡咯烷酮和二甲基甲酰胺之间。涂布液的温度可为 15℃～30℃。涂布液的固含量可为 7%～25%，在此范围内，涂布液的固含量增加，则涂布液的粘度升高，凝固液内的第三溶剂和涂布液中的第一溶剂的交换速度变慢，所形成的多孔层的平均孔径和孔隙率都降低；反之，则多孔层的平均孔径和孔隙率均升高。但是，若涂布液的固含量过高，超出此范围，则多孔层的透气性不合要求，无法满足储能装置（例如锂离子电池）的使用；若涂布液的固含量过低，低于此范围，则多孔层的强度下降，甚至难以在多孔基材的表面成膜。

接着，将涂布液均匀涂布在多孔基材的表面上，形成湿膜。涂布液的涂布方式选用浸渍涂布，当然，也可以采用其他任何合适的涂布工艺。

之后，将带有湿膜的多孔基材浸入到凝固液中进行相转化，其中，凝固液可以包括第二溶剂以及第三溶剂，第二溶剂与第三溶剂互溶。第二溶剂选自 N-甲基吡咯烷酮（NMP）、二甲基乙酰胺（DMAC）和二甲基甲酰胺（DMF）中的一种或多种，第三溶剂选自去离子水、乙醇、丙醇、丙酮、碳酸二甲酯和碳酸二乙酯中的一种或多种。凝固液中第二溶剂的质量百分含量可为 20%~60%。降低凝固液中第二溶剂的含量，有助于提高多孔层的平均孔径以及孔隙率。但若第二溶剂的含量过低，则多孔层的远离多孔基材的表面会形成致密表皮，反而导致多孔层的透气性变差，若第二溶剂的

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含量过高，则不能形成完整的孔或者形成的多孔层的平均孔径很低。凝固液的温度可为 15℃～30℃。相转化的时间可为 10s～90s。

最后，在相转化结束后，干燥得到隔离膜，其中多孔基材表面设置有多孔层，其中，无机颗粒分布在多孔层的孔中。干燥温度可为 60℃～70℃，干燥时间可为 10min～40min。

根据本申请的一些实施例，利用相转化（即非溶剂致相分离法，NIPS）原理制备出多孔层。其中，涂布液中的第一溶剂是有机溶剂，粘结剂（例如 PVDF）可以溶于第一溶剂。凝固液中含有第三溶剂（去离子水），而粘结剂不溶于去离子水，因此将涂布液涂布在多孔基材上再浸入凝固液中之后，由于涂布液中的第一溶剂被萃取到凝固液内的第三溶剂去离子水中，涂布液中的粘结剂凝固析出，形成多孔层。

本申请还提供了包括上述隔离膜的储能装置，例如锂离子电池。在本申请中，锂离子电池仅作为储能装置的示例性实例，储能装置还可以包括其他合适的装置。锂离子电池还包括正极极片、负极极片以及电解质，其中，本申请的隔离膜插入在正极极片和负极极片之间。正极集流体可以为铝箔或镍箔，负极集流体可为铜箔或镍箔。

在上述锂离子电池中，正极极片包括能够吸收和释放锂（Li）的正极材料（下文中，有时称为“能够吸收/释放锂 Li 的正极材料”）。能够吸收/释放锂（Li）的正极材料的实例可以包括钴酸锂、镍钴锰酸锂、镍钴铝酸锂、锰酸锂、磷酸锰铁锂、磷酸钒锂、磷酸钒氧锂、磷酸铁锂、钛酸锂和富锂锰基材料中的一种或多种。

在上述正极材料中，钴酸锂的化学式可以为 $Li_xCo_aM1_bO_{2-c}$，其中，M1 表示选自镍（Ni）、锰（Mn）、镁（Mg）、铝（Al）、硼(B)、钛(Ti)、钒(V)、铬(Cr)、铁（Fe）、铜（Cu）、锌（Zn）、钼（Mo）、锡（Sn）、钙（Ca）、锶（Sr）、钨（W）、钇（Y）、镧（La）、锆（Zr）和硅（Si）中的至少一种，x、a、b 和 c 值分别在以下范围内：$0.8 \leqslant x \leqslant 1.2$、$0.8 \leqslant a \leqslant 1$、$0 \leqslant b \leqslant 0.2$、$-0.1 \leqslant c \leqslant 0.2$;

在上述正极材料中，镍钴锰酸锂或镍钴铝酸锂的化学式可以为 $Li_yNi_dM2_eO_{2-f}$，其中，M2 表示选自钴（Co）、锰（Mn）、镁（Mg）、铝

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（Al）、硼（B）、钛（Ti）、钒（V）、铬（Cr）、铁（Fe）、铜（Cu）、锌（Zn）、钼（Mo）、锡（Sn）、钙（Ca）、锶（Sr）、钨（W）、锆（Zr）和硅（Si）中的至少一种，y、d、e和f值分别在以下范围内：$0.8 \leqslant y \leqslant 1.2$、$0.3 \leqslant d \leqslant 0.98$、$0.02 \leqslant e \leqslant 0.7$、$-0.1 \leqslant f \leqslant 0.2$;

在上述正极材料中，锰酸锂的化学式为 $Li_zMn_{2-g}M3_gO_{4-h}$，其中M3表示选自钴（Co）、镍（Ni）、镁（Mg）、铝（Al）、硼（B）、钛（Ti）、钒（V）、铬（Cr）、铁（Fe）、铜（Cu）、锌（Zn）、钼（Mo）、锡（Sn）、钙（Ca）、锶（Sr）和钨（W）中的至少一种，z、g和h值分别在以下范围内：$0.8 \leqslant z \leqslant 1.2$、$0 \leqslant g < 1.0$ 和 $-0.2 \leqslant h \leqslant 0.2$。

负极极片包括能够吸收和释放锂（Li）的负极材料（下文中，有时称为“能够吸收/释放锂Li的负极材料”）。能够吸收/释放锂（Li）的负极材料的例子可以包括碳材料、金属化合物、氧化物、硫化物、锂的氮化物例如 LiN_3、锂金属、与锂一起形成合金的金属和聚合物材料。

碳材料的例子可以包括低石墨化的碳、易石墨化的碳、人造石墨、天然石墨、中间相碳微球、软碳、硬碳、热解碳、焦炭、玻璃碳、有机聚合物化合物烧结体、碳纤维和活性碳。其中，焦炭可以包括沥青焦炭、针状焦炭和石油焦炭。有机聚合物化合物烧结体指的是通过在适当的温度下煅烧聚合物材料例如苯酚塑料或者呋喃树脂以使之碳化获得的材料，将这些材料中的一些分成低石墨化碳或者易石墨化的碳。聚合物材料的例子可以包括聚乙炔和聚吡咯。

在能够吸收/释放锂（Li）的这些负极材料中，更进一步地，选择充电和放电电压接近于锂金属的充电和放电电压的材料。这是因为负极材料的充电和放电电压越低，电池越容易具有更高的能量密度。其中，负极材料可以选择碳材料，因为在充电和放电时它们的晶体结构只有小的变化，因此，可以获得良好的循环特性以及大的充电和放电容量。尤其可以选择石墨，因为它可以给出大的电化学当量和高的能量密度。

此外，能够吸收/释放锂（Li）的负极材料可以包括单质锂金属、能够和锂（Li）一起形成合金的金属元素和半金属元素，包括这样的元素的合金和化合物等等。特别地，将它们和碳材料一起使用，因为在这种情况中，

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可以获得良好的循环特性以及高能量密度。除了包括两种或者多种金属元素的合金之外，这里使用的合金还包括包含一种或者多种金属元素和一种或者多种半金属元素的合金。该合金可以处于以下状态固溶体、共晶晶体(共晶混合物)、金属间化合物及其混合物。

金属元素和半金属元素的例子可以包括锡（Sn）、铅（Pb）、铝（Al）、铟（In）、硅（Si）、锌（Zn）、锑（Sb）、铋（Bi）、镉（Cd）、镁（Mg）、硼（B）、镓（Ga）、锗（Ge）、砷（As）、银（Ag）、锆（Zr）、钇（Y）和铪（Hf）。上述合金和化合物的例子可以包括具有化学式：$Ma_sMb_tLi_u$的材料和具有化学式：$Ma_pMc_qMd_r$的材料。在这些化学式中，Ma表示能够与锂一起形成合金的金属元素和半金属元素中的至少一种元素；Mb表示除锂和Ma之外的金属元素和半金属元素中的至少一种元素；Mc表示非金属元素中的至少一种元素；Md表示除Ma之外的金属元素和半金属元素中的至少一种元素；并且s、t、u、p、q和r满足$s>0$、$t\geq0$、$u\geq0$、$p>0$、$q>0$和$r\geq0$。

此外，可以在负极中使用不包括锂（Li）的无机化合物，例如MnO_2、V_2O_5、V_6O_{13}、NiS和MoS。

上述锂离子电池还包括电解质，电解质可以是凝胶电解质、固态电解质和电解液中的一种或多种，电解液包括锂盐和非水溶剂。

锂盐选自$LiPF_6$、$LiBF_4$、$LiAsF_6$、$LiClO_4$、$LiB(C_6H_5)_4$、$LiCH_3SO_3$、$LiCF_3SO_3$、$LiN(SO_2CF_3)_2$、$LiC(SO_2CF_3)_3$、$LiSiF_6$、LiBOB和二氟硼酸锂中的一种或多种。例如，锂盐选用$LiPF_6$，因为它可以给出高的离子导电率并改善循环特性。

非水溶剂可为碳酸酯化合物、羧酸酯化合物、醚化合物、其它有机溶剂或它们的组合。

碳酸酯化合物可为链状碳酸酯化合物、环状碳酸酯化合物、氟代碳酸酯化合物或其组合。

链状碳酸酯化合物的实例为碳酸二乙酯（DEC）、碳酸二甲酯（DMC）、碳酸二丙酯（DPC）、碳酸甲丙酯（MPC）、碳酸乙丙酯（EPC）、碳酸甲乙酯（MEC）及其组合。所述环状碳酸酯化合物的实例为碳酸亚乙酯（EC）、

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碳酸亚丙酯（PC）、碳酸亚丁酯（BC）、碳酸乙烯基亚乙酯（VEC）及其组合。所述氟代碳酸酯化合物的实例为碳酸氟代亚乙酯（FEC）、碳酸 1,2-二氟亚乙酯、碳酸 1,1-二氟亚乙酯、碳酸 1,1,2-三氟亚乙酯、碳酸 1,1,2,2-四氟亚乙酯、碳酸 1-氟-2-甲基亚乙酯、碳酸 1-氟-1-甲基亚乙酯、碳酸 1,2-二氟-1-甲基亚乙酯、碳酸 1,1,2-三氟-2-甲基亚乙酯、碳酸三氟甲基亚乙酯及其组合。

羧酸酯化合物的实例为乙酸甲酯、乙酸乙酯、乙酸正丙酯、乙酸叔丁酯、丙酸甲酯、丙酸乙酯、γ-丁内酯、癸内酯、戊内酯、甲瓦龙酸内酯、己内酯、甲酸甲酯及其组合。

醚化合物的实例为二丁醚、四甘醇二甲醚、二甘醇二甲醚、1,2-二甲氧基乙烷、1,2-二乙氧基乙烷、乙氧基甲氧基乙烷、2-甲基四氢呋喃、四氢呋喃及其组合。

其它有机溶剂的实例为二甲亚砜、1,2-二氧戊环、环丁砜、甲基环丁砜、1,3-二甲基-2-咪唑烷酮、N-甲基-2-吡咯烷酮、甲酰胺、二甲基甲酰胺、乙腈、磷酸三甲酯、磷酸三乙酯、磷酸三辛酯、和磷酸酯及其组合。

将正极极片、隔离膜、负极极片按顺序卷绕或堆叠或折叠成电极组件，之后装入包装壳（例如铝塑膜）中，注入电解液，化成、封装，即制成锂离子电池。

本领域的技术人员将理解，以上描述的锂离子电池的制备方法仅是实施例。在不背离本申请公开的内容的基础上，可以采用本领域常用的其他方法。

由于隔离膜与正极极片和负极极片卷绕或堆叠在一起，当在正极极片或负极极片的表面上形成上述多孔层时，同样可以起到相应的技术效果。

下面列举了一些具体实施例和对比例以更好地对本申请进行说明。在下述实施例中，所使用到的试剂、材料以及仪器如没有特殊的说明，均可商购获得。下表 1 中示出了实施例和对比例中所使用的一些参数。

对比例 1

（1）负极极片的制备

将负极活性材料人造石墨、粘结剂丁苯橡胶、导电剂导电炭黑（Super

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P）按质量比 92:3:5 与溶剂去离子水混合均匀制成负极浆料，之后将负极浆料均匀涂覆在负极集流体铜箔的正反两面上，然后在 85℃下烘干，形成负极活性材料层，然后进行冷压、分条、裁片、焊接负极极耳，得到负极极片。

（2）正极极片的制备

将正极活性材料钴酸锂（$LiCoO_2$）、粘结剂聚偏氟乙烯（PVDF）、导电剂导电炭黑（Super P）按质量比 97:1.5:1.5 溶于溶剂 N-甲基吡咯烷酮（NMP）中，搅拌均匀制成正极浆料，然后将正极浆料均匀涂布在正极集流体铝箔的正反两个表面上，之后在 85℃下烘干，得到正极活性材料层，之后经过冷压、分条、裁片、焊接正极极耳，得到正极极片。

（3）隔离膜的制备

将勃姆石与粘结剂聚偏氟乙烯混合，然后加入溶剂 N-甲基吡咯烷酮并均匀搅拌，得到涂布液，无机颗粒与粘结剂的体积比值为 0.8；采用浸渍涂布将涂布液涂布于多孔基材（聚乙烯）上，形成湿膜；将带有湿膜的多孔基材（聚乙烯）浸入到含有去离子水（第三溶剂）和 N-甲基吡咯烷酮（第二溶剂）的凝固液中进行相转化，其中涂布液和凝固液温度均为 25℃；浸入凝固液中 30s 后，进入烘箱于 60℃条件下烘干，得到带有多孔层的隔离膜。凝固液中的 N-甲基吡咯烷酮（第二溶剂）的质量含量为 40%。多孔层中的无机颗粒 Dv90 与多孔层厚度的比值为 0.2。

（4）电解液的制备

将锂盐 $LiPF_6$ 与非水有机溶剂（碳酸乙烯酯（EC）：碳酸二乙酯（DEC）：碳酸甲乙酯（EMC）：碳酸亚乙烯酯（VC）=8:85:5:2，质量比）按质量比 8：92 配制而成的溶液作为锂离子电池的电解液。

（5）锂离子电池的制备

将正极极片、隔离膜以及负极极片卷绕后，得到电极组件，之后经过封装、注入电解液、化成、抽气成型，得到锂离子电池。

对比例 2

与对比例 1 的制备方法一致，不同的是对比例 2 中的多孔层中的无机

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颗粒 Dv90 与多孔层厚度的比值为 3.2。

实施例 1

与对比例 1 的制备方法一致，不同的是实施例 1 中多孔层中的无机颗粒 Dv90 与多孔层厚度的比值为 0.3。

实施例 2

与对比例 1 的制备方法一致，不同的是实施例 2 中多孔层中的无机颗粒 Dv90 与多孔层厚度的比值为 0.5。

实施例 3

与对比例 1 的制备方法一致，不同的是实施例 3 中多孔层中的无机颗粒 Dv90 与多孔层厚度的比值为 0.8。

实施例 4

与对比例 1 的制备方法一致，不同的是实施例 4 中多孔层中的无机颗粒 Dv90 与多孔层厚度的比值为 1.0。

实施例 5

与对比例 1 的制备方法一致，不同的是实施例 5 中多孔层中的无机颗粒 Dv90 与多孔层厚度的比值为 1.5。

实施例 6

与对比例 1 的制备方法一致，不同的是实施例 6 中多孔层中的无机颗粒 Dv90 与多孔层厚度的比值为 2.0。

实施例 7

与对比例 1 的制备方法一致，不同的是实施例 7 中多孔层中的无机颗粒 Dv90 与多孔层厚度的比值为 3.0。

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实施例 8

与对比例 1 的制备方法一致，不同的是实施例 8 中多孔层中的无机颗粒 Dv90 与多孔层厚度的比值为 0.8，无机颗粒与粘结剂的体积比值为 0.2。

实施例 9

与对比例 1 的制备方法一致，不同的是实施例 9 中多孔层中的无机颗粒 Dv90 与多孔层厚度的比值为 0.8，无机颗粒与粘结剂的体积比值为 0.5。

实施例 10

与对比例 1 的制备方法一致，不同的是实施例 10 中多孔层中的无机颗粒 Dv90 与多孔层厚度的比值为 0.8，无机颗粒与粘结剂的体积比值为 1.2。

实施例 11

与对比例 1 的制备方法一致，不同的是实施例 11 中多孔层中的无机颗粒 Dv90 与多孔层厚度的比值为 0.8，无机颗粒与粘结剂的体积比值为 2。

实施例 12

与对比例 1 的制备方法一致，不同的是实施例 12 中多孔层中的无机颗粒 Dv90 与多孔层厚度的比值为 0.8，无机颗粒与粘结剂的体积比值为 3。

实施例 13

与对比例 1 的制备方法一致，不同的是实施例 13 中采用的无机颗粒为氧化铝，多孔层中的无机颗粒 Dv90 与多孔层厚度的比值为 0.8。

实施例 14

与对比例 1 的制备方法一致，不同的是实施例 14 中采用的无机颗粒为氢氧化镁，多孔层中的无机颗粒 Dv90 与多孔层厚度的比值为 0.8。

实施例 15

与对比例 1 的制备方法一致，不同的是实施例 15 中采用的无机颗粒为氧化钛，多孔层中的无机颗粒 Dv90 与多孔层厚度的比值为 0.8。

表 1

	涂布液固含量	无机颗粒的种类	无机颗粒 Dv90 与多孔层厚度的比值	无机颗粒与粘结剂的体积比值	凝固液	
					第二溶剂	第二溶剂含量
实施例 1	15%	勃姆石	0.3	0.8	NMP	40%
实施例 2	15%	勃姆石	0.5	0.8	NMP	40%
实施例 3	15%	勃姆石	0.8	0.8	NMP	40%
实施例 4	15%	勃姆石	1.0	0.8	NMP	40%
实施例 5	15%	勃姆石	1.5	0.8	NMP	40%
实施例 6	15%	勃姆石	2.0	0.8	NMP	40%
实施例 7	15%	勃姆石	3.0	0.8	NMP	40%
实施例 8	15%	勃姆石	0.8	0.2	NMP	40%
实施例 9	15%	勃姆石	0.8	0.5	NMP	40%
实施例 3	15%	勃姆石	0.8	0.8	NMP	40%
实施例 10	15%	勃姆石	0.8	1.2	NMP	40%
实施例 11	15%	勃姆石	0.8	2	NMP	40%
实施例 12	15%	勃姆石	0.8	3	NMP	40%
实施例 3	15%	勃姆石	0.8	0.8	NMP	40%
实施例 13	15%	氧化铝	0.8	0.8	NMP	40%
实施例 14	15%	氢氧化镁	0.8	0.8	NMP	40%
实施例 15	15%	氧化钛	0.8	0.8	NMP	40%
对比例 1	15%	勃姆石	0.2	0.8	NMP	40%
对比例 2	15%	勃姆石	3.2	0.8	NMP	40%

接下来对隔离膜和锂离子电池的性能进行测试。

（1）多孔层的厚度测试

将隔离膜样品放置在测厚仪(Naitutoyo公司的VL-50型LITEMATIC)上，使用5mm的平底探头，探头行进速度为50mm/min，压力为0.01N。每个设有多孔层的隔离膜样品测定60个厚度点，取厚度平均值作为测定值。多孔层的厚度为隔离膜的厚度减去多孔基材的厚度，当有两层多孔膜时，还需除以2，得到每层多孔层的厚度。

（2）多孔层的透气性测试

裁取100mm×100mm的设有多孔层的隔离膜样品，利用美国Gurley 4110N透气度测试仪，使用100cc的测试气体模式进行测试，记录测试气体全部通过设有多孔层的隔离膜样品的时间，即为Gurley值。多孔层的Gurley值为设有多孔层的隔离膜的Gurley值减去未设有多孔层的隔离膜（即纯多孔基材）的Gurley值。

（3）多孔层的孔隙率测试

测量设有多孔层的隔离膜样品的长度、宽度和厚度，用隔离膜的厚度减去多孔基材（聚乙烯）的厚度即得到多孔层的厚度，计算得到多孔层的表观体积V1。利用真密度仪（micromeritics公司的AccuPycⅡ1340型Gas Pycnometer）测试设有多孔层的隔离膜样品的真实体积V20，并测试相同面积的多孔基材(聚乙烯)的真实体积V0，则多孔层的真实体积V2=V20-V0，多孔层的孔隙率=1-V2/V1。

（4）锂离子电池的倍率性能测试

在25℃下，将锂离子电池以0.2C恒流放电至3.0V，静置10min，然后以0.7C恒流充电至4.4V，接着再以4.4V恒压充电至0.02C，静置10min，进一步以0.2C恒流放电至电压为3.0V，测量此时的放电容量，记为Q1。然后以0.7C恒流充电至4.4V，再恒压充电至0.02C，静置10min，以2C恒流放电至电压为3.0V，测量此时的放电容量，记为Q2。

锂离子电池2C/0.2C倍率性能（%）=Q2/Q1×100%。

（5）锂离子电池的循环性能测试

在25℃下，将锂离子电池以0.7C恒流充电至4.4V，再以4.4V恒压充电至0.02C，静置10min，以1C恒流放电至3.0V，静置10min，测量此时的放电容量，记为Q3。以上述步骤作为一个循环充放电，进行200次循环，200次循环后的放电容量记为Q4。

锂离子电池循环200次后的容量保持率（%）=Q4/Q3×100%。

实施例和对比例的测试结果如下表2所示。

表2

	多孔层的孔隙率	多孔层的Gurley值(s/100cc)	多孔层的厚度(μm)	2C/0.2C倍率性能	循环200次后的容量保持率
实施例1	48%	53	2	79.50%	85.70%
实施例2	50%	42	2	83.70%	92.80%
实施例3	52%	30	2	87.50%	95.60%
实施例4	53%	28	2	84.60%	93.10%
实施例5	54%	25	2	82.50%	91.20%
实施例6	56%	20	2	81.70%	85.20%
实施例7	57%	18	2	80.40%	82.70%
实施例8	46%	57	2	81.10%	87.20%
实施例9	49%	43	2	82.80%	91.70%
实施例3	52%	30	2	87.50%	95.60%
实施例10	54%	25	2	83.10%	91.30%
实施例11	56%	21	2	81.50%	88.80%
实施例12	59%	16	2	79.70%	83.80%
实施例3	52%	30	2	87.50%	95.60%
实施例13	50%	43	2	84.40%	92.90%
实施例14	52%	31	2	86.90%	94.30%
实施例15	51%	36	2	84.10%	91.30%
对比例1	45%	70	2	69.80%	70.50%

对比例 2	60%	16	2	71.30%	72.60%

通过比较实施例 1-7 和对比例 1-2 可知，无机颗粒的 Dv90 与多孔层厚度的比值对锂离子电池的倍率性能和循环性能有影响，控制无机颗粒的 Dv90 与多孔层厚度的比值在 0.3~3.0，可有效降低多孔层发生压缩堵孔和溶胀堵孔的概率，从而可有效改善锂离子电池的倍率性能和循环性能。若无机颗粒的 Dv90 与多孔层厚度的比值过大（例如对比例 2），容易导致多孔层的孔径分布不均匀，并导致多孔层表面不均匀，多孔层容易从多孔基材表面剥离，在储能装置（例如锂离子电池）中形成缺陷，对倍率性能和循环性能的改善不利，此外无机颗粒的 Dv90 与多孔层厚度的比值过大，导致多孔层的粘结力相对降低，影响储能装置（例如锂离子电池）的安全性能；若无机颗粒的 Dv90 与多孔层厚度的比值过小（例如对比例 1），则无机颗粒不能有效的露出于多孔层的表面，从而不能在多孔层的制备过程中促进涂布液内的第一溶剂与凝固液内的第三溶剂的交换，从而不能起到增强扩散的作用，不利于孔的发展，同样不利于改善倍率性能和循环性能。

通过比较实施例 3 和实施例 8-12 可知，无机颗粒与粘结剂的体积比值对锂离子电池的倍率性能和循环性能有影响，提升体积比值，有助于凝固液内的第三溶剂和涂布液内的第一溶剂的交换，多孔层的孔隙率增加。若无机颗粒与粘结剂的体积比值过小，则多孔层的孔隙率降低，隔离膜的透气性变差，锂离子电池的动力学性能改善不明显，对改善倍率性能和循环性能不利；若无机颗粒与粘结剂的体积比值过大，则多孔层的粘结力降低，隔离膜和极片之间容易出现间隙，锂离子电池的硬度降低，从而导致倍率性能和循环性能的改善也不明显。

通过比较实施例 3 和实施例 13-15 可知，采用各种无机颗粒均可以改善锂离子电池的倍率性能和循环性能，采用的无机颗粒的种类的不同对锂离子电池的倍率性能和循环性能的影响不是很大。

本领域技术人员应理解，以上实施例仅是示例性实施例，不能理解为对本申请的限制，在不背离本申请的精神和范围的情况下，可以进行多种变化、替换以及改变。

说明书附图

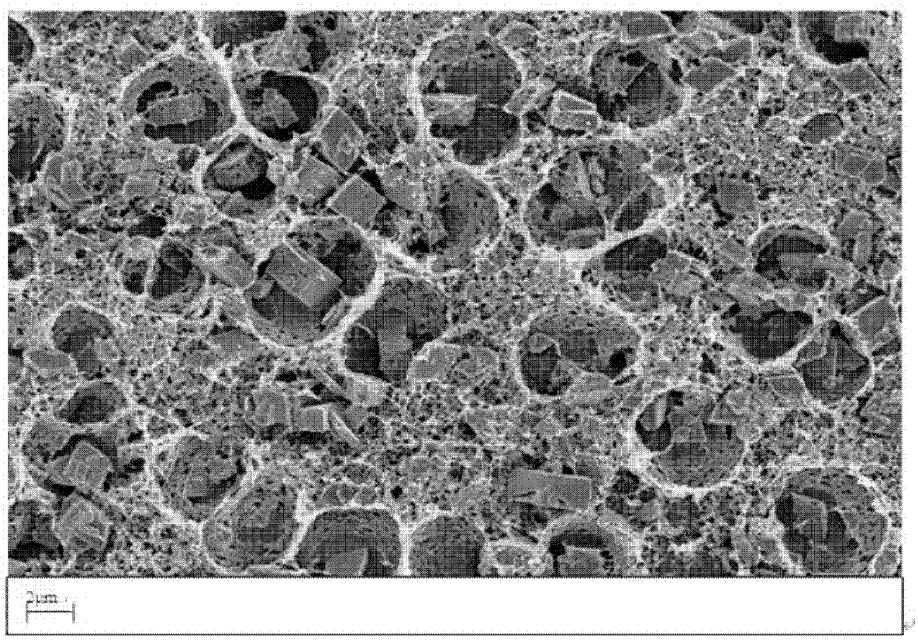


图 1

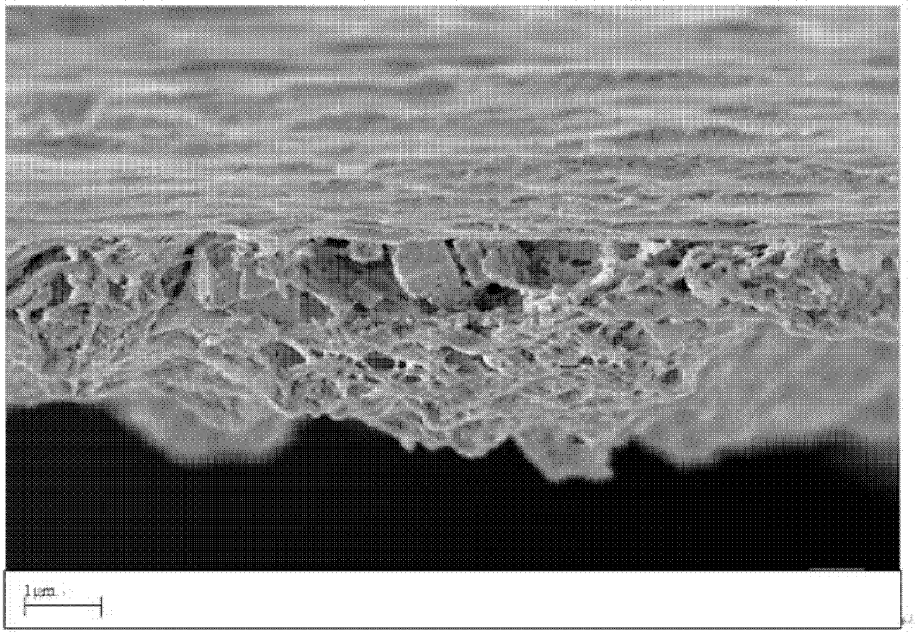


图 2

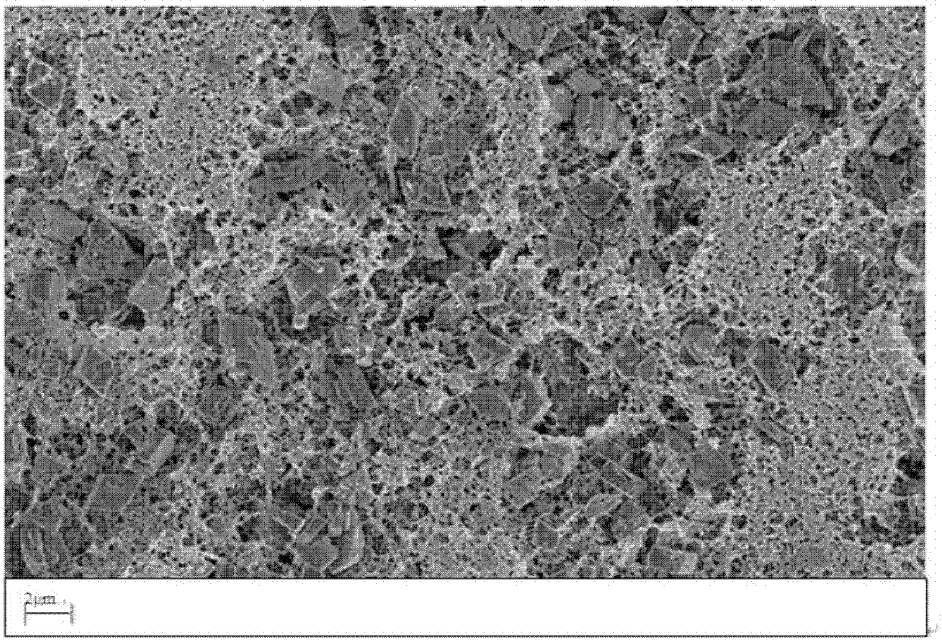


图 3

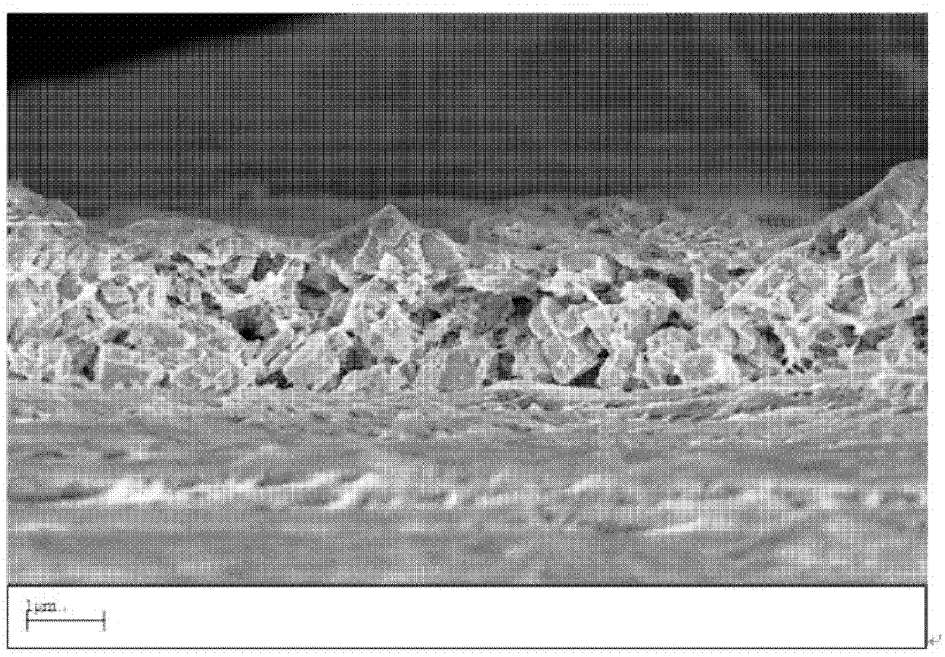


图 4

PTO/SB/08a (02-18)
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Application Number	16013887
Filing Date	2018-06-20
First Named Inventor	Jianjian Yi
Art Unit	1729
Examiner Name	Chmielecki, Scott J.
Attorney Docket Number	DEHE-1806-USPT

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	2	103155217	CN	A	2013-06-12	Teijin Limited		☒

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	Art Unit	1729
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	Attorney Docket Number	DEHE-1806-USPT

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	Application Number	16013887
	Filing Date	2018-06-20
	First Named Inventor	Jianjian Yi
	Art Unit	1729
	Examiner Name	Chmielecki, Scott J.
	Attorney Docket Number	DEHE-1806-USPT

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The fee set forth in 37 CFR 1.17 (p) has been submitted herewith.

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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	/Charles Ho/	Date (YYYY-MM-DD)	2019-08-05
Name/Print	Charles Ho	Registration Number	51,807

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EFS ID:	36776703
Application Number:	16013887
International Application Number:	
Confirmation Number:	3106
Title of Invention:	SEPARATOR AND ENERGY STORAGE DEVICE
First Named Inventor/Applicant Name:	Jianjian Yi
Customer Number:	129752
Filer:	Charles S. Ho/Ethan Huang
Filer Authorized By:	Charles S. Ho
Attorney Docket Number:	DEHE-1806-USPT
Receipt Date:	05-AUG-2019
Filing Date:	20-JUN-2018
Time Stamp:	23:56:59
Application Type:	Utility under 35 USC 111(a)

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1	Foreign Reference	CN1882436A.pdf	1827555 d9c0879c01829c142b17dc34f5422de9402d4a0c	no	25
Warnings:					

Information:					
2	Foreign Reference	CN103155217A.pdf	1277094 035d7ca3fed7e21eac6d227ed38b4c0fbf2626eb	no	17
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New International Application Filed with the USPTO as a Receiving Office

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Espacenet

Bibliographic data: CN1882436 (A) — 2006-12-20

Composite microporous film, and production method and use thereof

Inventor(s): KOICHI YAMADA KAZUHIRO KONO [JP] + (YAMADA KAZUHIRO,KONO KOICHI, ; YAMADA KAZUHIRO, ; KONO KOICHI)

Applicant(s): TONEN SEKIYUKAGAKU KK [JP] + (TONEN SEKIYUKAGAKU KK)

Classification: - international: ***B01D69/02; B01D69/12; B01D71/26; B01D71/32; B01D71/34; B32B27/30; B32B27/32; C08J9/36; H01M2/16***

- cooperative: **B01D69/02**; **B01D69/12**; **B01D71/26**; **B01D71/32**; **B01D71/34**; **H01M2/145**; **H01M2/1653**; **H01M2/1686**; H01M10/052; Y10T428/31909

Application number: CN20048034190 20041117

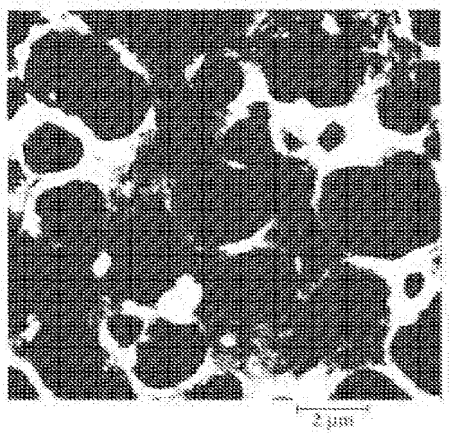
Priority number(s): WO2004JP17061 20041117 ; JP20030389841 20031119

Also published as: CN1882436 (B) EP1685955 (A1) EP1685955 (A4) JP5057419 (B2) JPWO2005049318 (A1) more

Abstract of CN1882436 (A)

Disclosed is a composite microporous film which is obtained by applying a liquid mixture containing (a) a fluororesin which can be gelated, (b) a good solvent therefor and (c) a poor solvent therefor having a dipole moment of not more than 1.8 Debye to at least one surface of a polyolefin microporous film and drying it, thereby forming a coating layer composed of a porous body of the fluororesin on the surface. The composite microporous film has columnar through holes in the

Fig. 1



coating layer, and has an excellent balance among permeability, adhesion to electrodes, mechanical strength, thermal shrinkage resistance, shutdown characteristics and meltdown characteristics.

[19] 中华人民共和国国家知识产权局

[12] 发明专利申请公开说明书

[21] 申请号 200480034190.3

[51] Int. Cl.
B32B 27/30 (2006.01)
B32B 27/32 (2006.01)
H01M 2/16 (2006.01)
C08J 9/36 (2006.01)
B01D 69/12 (2006.01)
B01D 71/26 (2006.01)

[43] 公开日 2006 年 12 月 20 日

[11] 公开号 CN 1882436A

[51] Int. Cl. (续)
B01D 71/32 (2006.01)
[22] 申请日 2004.11.17
[21] 申请号 200480034190.3
[30] 优先权
[32] 2003.11.19 [33] JP [31] 389841/2003
[86] 国际申请 PCT/JP2004/017061 2004.11.17
[87] 国际公布 WO2005/049318 日 2005.6.2
[85] 进入国家阶段日期 2006.5.19
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[74] 专利代理机构 北京市柳沈律师事务所
代理人 张平元 赵仁临

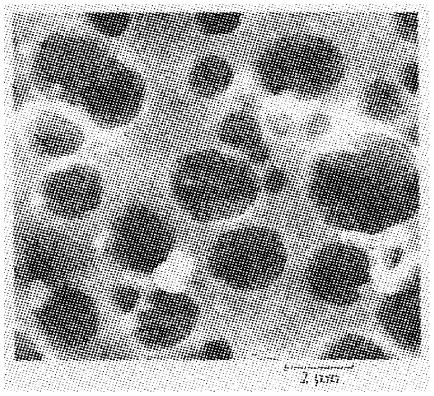
权利要求书 1 页 说明书 20 页 附图 1 页

[54] 发明名称

复合微多孔膜及其制造方法和用途

[57] 摘要

本发明涉及一种复合微多孔膜，该复合微多孔膜是，通过在聚烯烃微孔膜的至少一面涂布含有(a)可以凝胶化的氟树脂、和(b)其良溶剂、(c)偶极矩为 1.8Debye 或 1.8Debye 以下的不良溶剂的混合液，并干燥，再形成含有上述氟树脂的多孔质体的覆盖层而得到的复合微多孔膜，其特征在于，该多孔膜在上述覆盖层上具有圆柱状的贯通孔，并且透过性、对电极的粘接性、机械强度、耐热收缩性、封闭特性以及熔化特性的平衡性优异。



1.一种复合微多孔膜，该复合微多孔膜是在聚烯烃微多孔膜的至少一面形成含有可以凝胶化的氟树脂的多孔质体的覆盖层的复合微多孔膜，其特征在于，上述覆盖层具有圆柱状的贯通孔。

2.按照权利要求 1 所述的复合微多孔膜，其特征在于，上述贯通孔的平均孔径为 0.1~50μm。

3.一种方法，该方法是权利要求 1 或 2 所述的复合微多孔膜的制造方法，其特征在于，在聚烯烃微多孔膜的至少一面涂布含有（a）可以凝胶化的氟树脂、和（b）其良溶剂、和（c）偶极矩为 1.8Debye 或 1.8Debye 以下的不良溶剂的混合液，并干燥而形成含有上述氟树脂的多孔质体的覆盖层。

4.一种电池用隔板，其特征在于，该隔板由权利要求 1 或 2 所述的复合微多孔膜制成。

5.一种电池，其特征在于，该电池使用权利要求 1 或 2 所述的复合微多孔膜作为电池用隔板。

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复合微多孔膜及其制造方法和用途

技术领域

本发明涉及复合微多孔膜及其制造方法和用途，特别是，涉及透过性、对电极的粘接性、机械强度、耐热收缩性、封闭（シャットダウン）特性以及熔化（メルトダウン）特性的平衡性优异的复合微多孔膜及其制造方法和用途。

背景技术

聚烯烃微多孔膜广泛使用于以锂电池用为首的电池用隔板、各种电容器用隔膜、各种过滤器、透湿防水衣料、反渗透过滤膜、超滤膜、精密过滤膜等各种用途。

在锂二次电池用和锂离子电池用隔板中，为防止由于外部电路的短路、过充电等引起的电池发热、起火、破裂事故等，在要求具有由于异常时的发热使细孔封闭而停止电池反应的功能的同时，还要求具有即使在高温下也可以维持形状而防止正极物质和负极物质直接反应的危险情况的功能。但是，现在作为隔板广泛使用的、制造时伴有拉伸的聚烯烃微多孔膜中，存在在高温下的形状维持特性低的问题。

随着携带用电子仪器或笔记本型个人电脑的小型化和轻量化，谋求锂离子二次电池的薄型化和高容量化，但为防止随之而来的电池容量降低、电极间短路、循环利用性能降低等，也要求隔板对电极的粘接性的提高。但是，在这一点上，以往的聚烯烃微多孔膜是不充分的。

作为兼备离子传导性和对电极的粘接性的隔板，特开 2001-118558 号中提出了在聚烯烃微多孔膜的至少一面上以 50%或 50%以下的表面覆盖率散布 5μm 或 5μm 以下的厚度的离子传导性聚合物层的锂离子二次电池用隔板。但是，由于该隔板的制造方法是在聚烯烃微多孔膜的至少一面简单地涂布离子传导性聚合物的溶液并干燥，因此，有时难以控制离子传导性聚合物层的孔径，得到的隔板的透过性有可能不充分。

作为兼备封闭特性和电解液保持性的隔板，特开 2002-216734 号中提出

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了具有：在两表层上具有由含有熔点为 145℃或 145℃以下的偏氟乙烯的共聚物构成的微多孔层，并将由熔点为 140℃或 140℃以下的聚烯烃构成的微多孔层作为中间层的三层结构微多孔膜的锂电池用隔板。但是该隔板通过（1）首先制作由含有偏氟乙烯的共聚物构成的微多孔膜和聚烯烃微多孔膜，将它们重叠后，进行拉伸或压合的方法，或者（2）将上述各聚合物溶液同时挤出，通过冷却使之相分离，形成三层片，除去成膜用溶剂之后进行拉伸或拉伸后除去成膜用溶剂的方法来制造。在上述（1）的方法中，通过压合容易使细孔封闭，而在上述（2）的方法中，为得到高透过性的膜必须以高倍率进行拉伸，因此不能得到良好的耐热收缩性。另外，在上述（1）和（2）的任意一个方法中，只要不在各微多孔膜层的熔点附近就都存在容易产生剥离的问题。

作为改善在电池制造工序中的电解液注入性、循环利用特性等的微多孔膜，本申请人此前提出了在聚烯烃微多孔膜的至少一面上形成由可以凝胶化的功能性高分子的多孔质体构成的覆盖层，并且多孔质体的平均孔径比聚烯烃微多孔膜的最大孔径大的复合膜[特开 2002-240215 号（专利文献 1）]。该复合膜通过（1）在聚烯烃微多孔膜的至少一面涂布溶解在良溶剂中的高分子物质并通过将涂布后的微多孔膜浸渍在不良溶剂中进行相分离后，进行干燥的方法，（2）在聚烯烃微多孔膜的至少一面上涂布溶解在良溶剂和不良溶剂的混合溶剂中的高分子物质，并通过选择性蒸发良溶剂而进行相分离后，除去残留溶剂的方法，或者（3）在聚烯烃微多孔膜的至少一面上涂布溶解在良溶剂中的高分子物质，并通过冷却进行相分离后，进行干燥的方法。

但是在上述（1）的方法中可知，随着在不良溶剂中的浸渍，得到的复合膜的覆盖层容易剥离，得到的隔板对电极的粘接性不充分，细孔的形成也不充分。在上述（2）的方法中可知，不进行不良溶剂的最优化，因此有时不能在覆盖层上形成充分的细孔。在上述（3）的方法中，由于仅使用良溶剂，有时难以控制多孔体层的孔径，得到的隔板的透过性有可能不充分。

另外，聚烯烃微多孔膜通过运用作为其特征的微细孔结构，在气-气分离、液-液分离、固-液分离等用途中作为分离膜使用。在分离膜中，有膜全体为微细孔结构的均匀结构膜、具有设置在膜表面或内部的微孔结构和支持其的稀疏的细孔结构的不均匀结构膜、由微多孔膜层和多孔性支持体层组成的复合膜等，可以从这些之中，视分离对象适当选择。近年来，对由聚烯烃

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微多孔膜构成的分离膜，不仅在分离性能上，而且在机械强度上都要求提高。

因此，在特开平 6-198146 号中提出了，由 2 层的微多孔膜层构成，一层微多孔膜层比另一微多孔膜层薄，并且具有更为微细的孔结构的精密过滤膜。该精密过滤膜通过（1）在微多孔膜支持体上涂布高分子组合物溶液，将涂布后的微多孔膜支持体浸渍在对上述溶液的溶剂为混合性的，而对于高分子组合物为非混合性的液体中之后，使高分子组合物凝固的方法，或者，（2）将高分子组合物种类或浓度不同的 2 种高分子组合物溶液同时挤出形成层压体之后，采用凝固的方法制造。但是，如上所述，在上述（1）和（2）的任意一个方法中，2 层微多孔膜层之间容易剥离。

专利文献 1：特开 2002-240215 号公报

发明内容

发明所要解决的问题

因此，本发明的目的在于，提供透过性、对电极的粘接性、机械强度、耐热收缩性、封闭特性以及熔化特性的平衡性优异的复合微多孔膜及其制造方法和用途。

解决问题的方法

鉴于上述问题，经过深入研究的结果，本发明者们发现通过在聚烯烃微多孔膜的至少一面涂布含有（a）可以凝胶化的氟树脂、和（b）其良溶剂、（c）偶极矩为 1.8Debye（德拜（电偶极矩单位））或 1.8Debye 以下的不良溶剂的混合液，并干燥，再形成含有上述氟树脂的多孔质体的覆盖层而得到的复合微多孔膜在上述覆盖层上形成圆柱状的贯通孔，因此透过性、对电极的粘接性、机械强度、耐热收缩性、封闭特性以及熔化特性的平衡性优异，由此想到本发明。

即，本发明的复合微多孔膜的特征在于，在聚烯烃微多孔膜的至少一面形成由可以凝胶化的氟树脂的多孔质体构成的覆盖层，并且，上述覆盖层具有圆柱状的贯通孔。

上述贯通孔的平均孔径优选 0.1~50μm，更为优选 0.5~10μm。上述氟树脂优选聚偏氟乙烯和/或偏氟乙烯共聚物。偏氟乙烯共聚物优选聚（六氟丙烯-偏氟乙烯）共聚物，上述覆盖层的厚度通常为 0.001~50μm。

本发明优选的实施方式的复合微多孔膜具有下面的物性（1）~（7）。

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（1）氟树脂层的平均贯通孔径（圆柱状贯通孔的平均孔径）比聚烯烃微多孔膜的最大孔径大。

（2）将厚度换算为 20μm 时的透气度（JIS P8117）为 10~1500 秒/100cc，优选 20~1500 秒/100cc。

（3）穿刺（突刺）强度为 2500mN/20μm 或 2500mN/20μm 以上，优选 3000mN/20μm 或 3000mN/20μm 以上。

（4）在 130℃的温度下处理 1 小时后的热收缩率在长方向（MD）和宽方向（TD）均为 35%或 35%以下，优选 30%或 30%以下。

（5）关于封闭特性，在 130℃的温度下处理 1 小时后的透气度为 10000 秒/100cc 或 10000 秒/100cc 以上。

（6）熔化温度为 155℃或 155℃以上。

（7）关于对电极的粘接性，重叠在电极上，并用压合机于 40℃×5 分钟的加热加压时，即使在浸渍在电解液的状态下也不易剥离。

本发明的复合微多孔膜的制造方法的特征在于，在聚烯烃微多孔膜的至少一面涂布含有（a）可以凝胶化的氟树脂、和（b）其良溶剂、和（c）偶极矩为 1.8Debye 或 1.8Debye 以下的不良溶剂的混合液，并干燥，再形成含有上述氟树脂的多孔质体的覆盖层。

上述不良溶剂优选选自碳原子数为 6 或 6 以上的芳香族烃、1-丁醇、叔丁醇、以及碳原子数为 5 或 5 以上的脂肪族烃中的至少一种。上述碳原子数为 6 或 6 以上的芳香族烃优选选自甲苯、邻二甲苯、间二甲苯、对二甲苯以及乙基苯中的至少一种。作为上述良溶剂，优选丙酮。

为得到复合微多孔膜更加优异的特性，上述聚烯烃微多孔膜优选满足下述条件（8）~（14）。

（8）孔隙率为 25~95%。

（9）将厚度换算为 20μm 时的透气度（JIS P8117）为 1500 秒/100cc 或 1500 秒/100cc 以下。

（10）平均贯通孔径为 0.005~1μm。

（11）拉伸断裂强度为 50MPa 或 50MPa 以上。

（12）穿刺强度为 2500mN/20μm 或 2500mN/20μm 以上。

（13）热收缩率（105℃/8 小时）在 MD 方向以及 TD 方向均为 16%或 16%以下。

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（14）厚度为 5~200μm。

为得到复合微多孔膜的更加优异的特性，上述聚烯烃优选满足下述条件（15）~（22）。

（15）含有聚乙烯和/或聚丙烯。

（16）上述（15）中记载的聚乙烯为选自超高分子量聚乙烯、高密度聚乙烯、中密度聚乙烯以及低密度聚乙烯中的至少一种。

（17）上述（15）或（16）中记载的聚乙烯为重均分子量（Mw）为 5×10^5 或 5×10^5 以上的超高分子量聚乙烯。

（18）上述（17）记载的超高分子量聚乙烯的 Mw 为 1×10^6~15×10^6 的范围内。

（19）上述（15）~（18）中任意一项记载的聚烯烃的重均分子量（Mw）和数均分子量（Mn）之比 Mw/Mn（分子量分布）为 5~300。

（20）上述（15）~（19）中任意一项记载的聚烯烃含有聚乙烯组合物。

（21）上述（20）中记载的聚乙烯组合物含有 Mw 为 5×10^5 或 5×10^5 以上的超高分子量聚乙烯和 Mw 为 1×10^4 或 1×10^4 以上且不足 5×10^5 的高密度聚乙烯。

（22）以赋予封闭功能（在电池内部温度上升时为防止起火等事故而使微多孔膜熔融堵塞微多孔切断电流的功能）为目的，上述（15）~（21）中任意一项记载的聚烯烃是添加了选自分支状低密度聚乙烯、直链状低密度聚乙烯、使用单中心催化剂制造的乙烯-α烯烃共聚物以及分子量为 1×10^3~4×10^3 的低分子量的聚乙烯中的至少一种的聚烯烃组合物。

本发明的复合微多孔膜作为电池用隔板是有用的。

发明效果

本发明的复合微多孔膜是，在聚烯烃微多孔膜的至少一面上涂布含有可凝胶化的氟树脂、和其良溶剂、和偶极矩为 1.8Debye 或 1.8Debye 以下的不良溶剂的混合液并干燥，形成含有上述氟树脂的多孔质体构成的覆盖层，因此，在上述覆盖层上形成圆柱状的贯通孔，透过性、对电极的粘接性、机械强度、耐热收缩性、封闭特性以及熔化特性的平衡性优异。

本发明的复合微多孔膜用作电池用隔板时对电解液具有亲和性，在电池制造工序中的电解液注入性优异，对电池反应是稳定的，即使反复充放电也不会产生电池构成部件之间的间隙，电极-隔板之间的界面电阻小，可以在

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长时间内保持绝缘性，因此，可以得到安全性以及可靠性优异的电池。再有，本发明复合微多孔膜对药液的浸润性、分离性能、透过性以及机械强度优异，因此，作为分离膜是优异的。

附图说明

[图 1]是示出实施例 1 的复合微多孔膜的表面的探测显微镜照片（×7500）。

[图 2]是示出比较例 1 的复合微多孔膜的表面的探测显微镜照片（×7500）。

具体实施方式

[1]聚烯烃微多孔膜

（1）聚烯烃

聚烯烃可以是单一物质或含有2种或2种以上的聚烯烃的组合物的任何一种。聚烯烃优选含有聚乙烯和/或聚丙烯的。聚烯烃的重均分子量（Mw）没有特别的限制，通常为 1×10^4~1×10^7，优选 1×10^4~5×10^6，更为优选 1×10^5~4×10^6。

作为聚乙烯，可以举出，超高分子量聚乙烯、高密度聚乙烯、中密度聚乙烯以及低密度聚乙烯。这些聚乙烯不仅可以是乙烯的均聚物，也可以是含有少量其他的α-烯烃的共聚物。作为乙烯以外的其他α-烯烃优选丙烯、丁烯-1、己烯-1、戊烯-1、4-甲基戊烯-1、辛烯、醋酸乙烯、甲基丙烯酸甲酯、苯乙烯等。其中，作为聚乙烯优选超高分子量聚乙烯。超高分子量聚乙烯的Mw优选 5×10^5 或 5×10^5 以上，更为优选 1×10^6~15×10^6 的范围内，特别优选 1×10^6~5×10^6 的范围内。通过将超高分子量的聚乙烯的Mw控制在 15×10^6 或 15×10^6 以下，可以容易地进行熔融挤出。

聚烯烃更优选含有聚乙烯组合物的。作为聚乙烯组合物，可以使用Mw不同的2种或2种以上的超高分子量聚乙烯彼此的组合物、同样的高密度聚乙烯的彼此组合物、同样的中密度聚乙烯彼此的组合物、或同样的低密度聚乙烯彼此的组合物，使用选自超高分子量聚乙烯、高密度聚乙烯、中密度聚乙烯以及低密度聚乙烯的二种或二种以上的聚乙烯的混合组合物也没问题。其中，作为聚乙烯组合物，优选含有Mw为 5×10^5 或 5×10^5 以上的超高分

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子量聚乙烯和 Mw 为 1×10^4 或 1×10^4 以上~不足 5×10^5 的聚乙烯的聚乙烯组合物。作为 Mw 为 1×10^4 或 1×10^4 以上~不足 5×10^5 的聚乙烯，可以使用高密度聚乙烯、中密度聚乙烯和低密度聚乙烯中的任意一种，但特别优选使用高密度聚乙烯。Mw 为 1×10^4 或 1×10^4 以上~不足 5×10^5 的聚乙烯可以使用二种或二种以上的 Mw 不同的聚乙烯，也可以使用二种或二种以上密度不同的聚乙烯。通过将聚乙烯组合物的 Mw 的上限控制在 15×10^6 或 15×10^6 以下，可以容易地熔融挤出。聚乙烯组合物中的 Mw 为 5×10^5 或 5×10^5 以上的超高分子量聚乙烯含量优选将聚乙烯组合物全体作为 100 质量%时为 21 质量%或 21 质量%以上，更加优选 21~50 质量%。

聚烯烃的重均分子量（Mw）和数均分子量（Mn）之比 Mw/Mn（分子量分布）没有限定，优选 5~300 的范围内，更为优选 10~100 的范围内。如果 Mw/Mn 不足 5 时，由于高分子量成分过多，因此，聚烯烃溶液的挤出困难，Mw/Mn 超过 300 时，低分子量成分过多，因此得到的微多孔膜的强度低。Mw/Mn 是作为分子量分布的尺度来使用的，该值越大分子量分布的幅度就越大。即，由单一物质构成的聚烯烃的情况下，Mw/Mn 表示其分子量分布的宽度，其值越大，分子量分布就越宽。由单一物质构成的聚烯烃的 Mw/Mn 可以通过由多阶段聚合来制备聚烯烃来适当调整。作为多阶段聚合法，优选在第 1 阶段聚合高分子量成分，在第 2 阶段聚合低分子量成分的二阶段聚合。聚烯烃为组合物时，Mw/Mn 越大，配合的各成分的 Mw 差越大，另外，越小则 Mw 的差越小。聚烯烃组合物的 Mw/Mn 可以通过调整各成分的分子量或混合比例来适当调整。

使用本发明的复合微多孔膜作为电池用隔板时，为提高熔化温度，并提高电池的高温保存特性，聚烯烃组合物优选含有聚丙烯。聚丙烯的 Mw 优选 1×10^4~4×10^6 的范围。作为聚丙烯，除均聚物以外，还可以使用含有其它 α-烯烃的嵌段和/或无规共聚物。作为嵌段共聚物和无规共聚物含有的其他的 α-烯烃优选乙烯。聚丙烯的添加量优选将聚烯烃组合物全体作为 100 质量份时为 80 质量份或 80 质量份以下。

为提高作为电池用隔板用途的特性，聚烯烃组合物优选含有赋予封闭功能的聚烯烃。作为赋予封闭功能的聚烯烃，可以使用例如低密度聚乙烯。作为低密度聚乙烯，优选选自分支状低密度聚乙烯（LDPE）、线状低密度聚乙烯（LLDPE）、由单中心催化剂制造的乙烯/α-烯烃共聚物、以及 Mw 为 1

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$\times 10^3$~4×10^3 范围内的低分子量聚乙烯中的至少一种。其中，其添加量优选将聚烯烃全体作为 100 质量份时为 20 质量份或 20 质量份以下。该添加量多时，在拉伸时容易产生断裂。

作为含有超高分子量聚乙烯的聚烯烃组合物，可以使用除上述的 Mw 为 1×10^4 或 1×10^4 以上~不足 5×10^5 的聚乙烯、用于提高上述熔化温度的聚丙烯、以及上述赋予封闭功能的聚烯烃之外，还可以添加选自 Mw 为 1×10^4~4×10^6 的聚丁烯-1，Mw 为 1×10^3~1×10^4 的聚乙烯蜡以及 Mw 为 1×10^4~4×10^6 的乙烯 · α-烯烃共聚物中的至少一种的物质。制成在超高分子量聚乙烯中添加了其他聚烯烃的聚烯烃组合物时，其他的聚烯烃的添加量优选将聚烯烃组合物全体作为 100 质量份时为 80 质量份或 80 质量份以下。

（2）制造方法

为制造聚烯烃微多孔膜，可以采用例如特公平 6-104736 号中公开的方法。但并不限定于该方法。利用特公平 6-104736 号中公开的方法时，（i）在上述聚烯烃中添加成膜用溶剂后，进行熔融混炼，制备聚烯烃溶液，（ii）通过模唇挤出聚烯烃溶液后，冷却，形成凝胶状成型物，（iii）拉伸得到的凝胶状成型物，（iv）通过洗净溶剂将拉伸物洗净除去成膜用溶剂，（v）将得到的膜干燥，由此，可以制造聚烯烃微多孔膜。

（3）期望的物性

作为本发明中使用的聚烯烃微多孔膜，优选的是，孔隙率为 25~95%，将厚度换算为 20μm 时的透气度（JIS P8117）为 1500 秒/100cc 或 1500 秒/100cc 以下，平均贯通孔径为 0.005~1μm，拉伸断裂强度为 50MPa 或 50MPa 以上，穿刺强度为 2500mN/20μm 或 2500mN/20μm 以上，热收缩率（105℃/8 小时）在长方向（MD）和宽方向（TD）均为 16%或 16%以下，厚度为 5~200μm。

[2]氟树脂层

本发明的复合微多孔膜在聚烯烃微多孔膜的至少一面上形成含有可以凝胶化的氟树脂的多孔质体的覆盖层，上述覆盖层具有圆柱状的贯通孔。通过在聚烯烃微多孔膜上形成氟树脂层，可以显著提高对电极的粘接性。由于氟树脂层具有圆柱状的细孔，因此不会损害聚烯烃微多孔膜的透过性。这里，所谓圆柱状的贯通孔，意味着从开口部到与聚烯烃微多孔膜的接触面，几乎保持相同直径的圆状断面，并且几乎垂直贯通的细孔，不必是准确的圆柱状。

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圆柱状贯通孔的平均孔径优选 0.1~50μm，更为优选 0.5~10μm。优选将圆柱状贯通孔的平均孔径制成比聚烯烃微多孔膜的最大孔径大，由此可以进一步提高透过性。氟树脂层的厚度根据聚烯烃微多孔膜的平均贯通孔径或孔隙率而有所不同，但通常为 0.001~50μm。氟树脂层的厚度比 0.001μm 薄时，容易发生缺陷，另一方面，超过 50μm 时，透过性有可能恶化。

作为可以凝胶化的氟树脂，可以举出选自聚偏氟乙烯、聚氟乙烯、偏氟乙烯共聚物以及氟乙烯共聚物中的至少一种。偏氟乙烯共聚物的偏氟乙烯单元含有率、以及氟乙烯共聚物的氟乙烯单元含有率优选分别为 75 质量%或 75 质量%以上，更加优选 90 质量%或 90 质量%以上。作为和偏氟乙烯或氟乙烯共聚的单体的例子，可以举出，六氟丙烯、四氟乙烯、三氟丙烯、乙烯、丙烯、异丁烯、苯乙烯、氯乙烯、偏氯乙烯、二氟氯乙烯、甲酸乙烯酯、乙酸乙烯酯、丙酸乙烯酯、丁酸乙烯酯、丙烯酸及其盐、甲基丙烯酸甲酯、甲基丙烯酸烯丙酯、丙烯腈、甲基丙烯腈、N-丁氧基甲基丙烯酰胺、乙酸烯丙酯、乙酸异丙烯酯等。

其中，作为氟树脂，优选聚偏氟乙烯和偏氟乙烯共聚物。作为偏氟乙烯共聚物，优选聚（六氟丙烯-偏氟乙烯）共聚物。

也可以将氟树脂交联，由此复合微多孔膜可以吸收电解液并抑制在高温下膨润时的形状变化。作为交联方法，可以举出，照射电离放射线的方法，使用交联剂的方法，硫化的方法等。作为电离放射线，可以使用α射线、β射线、γ射线、电子射线等。作为交联剂，可以举出，具有 2 个或 2 个以上的不饱和键的化合物，例如丁二烯、异戊二烯等。

氟树脂也可以通过接枝聚合改性。作为可以在接枝聚合中使用的化合物，可以举出，乙烯、苯乙烯、氯乙烯、乙酸乙烯酯、丙烯酸、丙烯酸甲酯、甲基乙烯基甲酮、丙烯酰胺、丙烯腈、偏氯乙烯、甲基丙烯酸、甲基丙烯酸甲酯等。通过将氟树脂制成使用上述化合物的接枝聚合物可以进一步提高对电极的粘接性。只要不损害其效果，氟树脂中还可以混合其他的树脂。

氟树脂的熔点优选比构成聚烯烃微多孔膜的聚烯烃的熔点高，更加优选高 5℃或 5℃以上。

[3]复合微多孔膜的制造方法

本发明的复合微多孔膜通过在聚烯烃微孔膜的至少一面涂布含有（a）上述的氟树脂、和（b）其良溶剂、（c）偶极矩为 1.8Debye 或 1.8Debye 以下

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的不良溶剂的混合液，并干燥来制造。仅使用良溶剂作为溶剂时，由于氟树脂层的结构过密，因此不能形成圆柱状的细孔，透过性恶化。另一方面，仅使用不良溶剂作为溶剂时，上述氟树脂的分散性恶化，涂布混合液变得困难。

作为良溶剂，可以举出，例如，丙酮、N-甲基-2-吡咯烷酮（NMP）、二甲基甲酰胺（DMF）、二甲基亚砜（DMSO）、环己酮、γ-丁内酯（GBL）、碳酸亚乙酯、二甲基乙酰胺、甲乙酮（MEK）、二乙醚、乙酸乙酯、四氢呋喃（THF）、磷酸三乙酯以及乙酸酐。其中，优选丙酮作为良溶剂。

不良溶剂的偶极矩有必要在1.8Debye或1.8Debye以下。不良溶剂的偶极矩超过1.8Debye时，不能在氟树脂层上形成圆柱状的细孔，得到的复合微多孔膜的透过性显著恶化。不良溶剂的偶极矩优选1.0Debye或1.0Debye以下。作为偶极矩为1.8Debye或1.8Debye以下的不良溶剂，可以举出，例如，选自碳原子数为6或6以上的芳香烃、1-丁醇、叔丁醇、异丁醇、碳原子数为5或5以上的脂肪族烃中的至少一种。其中，作为不良溶剂，优选选自甲苯（偶极矩：0.375Debye）、邻二甲苯（偶极矩：0.44Debye）、对二甲苯（偶极矩：0.35Debye）、对二甲苯（偶极矩：0Debye）、乙基苯（偶极矩：0.35Debye）、1-丁醇（偶极矩：1.68Debye）、叔丁醇（偶极矩：1.66Debye）、以及异丁醇（偶极矩：1.79Debye）中的至少一种。这里，偶极矩是由分子轨道法得出的计算值。但是，在不损害本发明的效果的范围内，上述的偶极矩为1.8Debye或1.8Debye以下的不良溶剂中还可以视需要含有少量的偶极矩超过1.8Debye的不良溶剂。

细孔是通过将由不良溶剂使氟树脂相进行微相分离的相分离结构经除去不良溶剂固定化而形成。除去不良溶剂后，残留有良溶剂时，有时会对相分离结构的固定化带来不良影响。因此，在干燥时，优选良溶剂比不良溶剂先行挥发。因此，不良溶剂的沸点优选为在良溶剂的沸点或该沸点以上，更为优选比良溶剂的沸点高。另外，良溶剂和不良溶剂优选不是共沸的。

具体地，良溶剂和不良溶剂的沸点之差优选30℃或30℃以上，更加优选50℃或50℃以上。例如，使用丙酮（沸点56.5℃）作为良溶剂时，与使用乙醇（沸点78.3℃、偶极矩1.68Debye）或异丙醇（沸点82.4℃、偶极矩1.79Debye）作为不良溶剂相比，使用沸点差为30℃或30℃以上的溶剂时，在容易控制贯通孔的孔径的同时，贯通孔的形状也近乎正确的圆柱状。

作为对丙酮优选的不良溶剂的具体例子，可以举出，选自甲苯（沸点：

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110.6℃）、邻二甲苯（沸点：144.4℃）、间二甲苯（沸点：139.1℃）、对二甲苯（沸点：138.4℃）、乙基苯（沸点：136.2℃）、1-丁醇（沸点：117.7℃）以及异丁醇（沸点：107.9℃）中的至少一种。良溶剂和不良溶剂的组合更为优选的组合为良溶剂/不良溶剂=丙酮/二甲苯（选自邻二甲苯、间二甲苯以及对二甲苯中的至少一种）、丙酮/甲苯以及丙酮/丁醇（1-丁醇或叔丁醇）。

混合液中的氟树脂的含量可以通过涂布方法以及需要形成的覆盖层的厚度来适当调整，但通常为1~20质量%。良溶剂和不良溶剂的混合比没有特别的限制，但良溶剂/不良溶剂以重量比计优选10/90~95/5，更加优选20/80~90/10，特别优选30/70~90/10。

混合液的涂布可以通过常用的流延或涂布方法，例如，辊涂法、气刀刮涂法、刮板涂布法、棒涂法、刮条涂布法、普通涂布(コンマコータ)法、凹版涂布法、丝网涂布法、口模涂法、微凹版涂布法等进行。

涂布混合液之后，通过干燥除去良溶剂和不良溶剂。作为干燥方法，可以是风干、热风干燥、在烘箱内的加热干燥等常用的方法。视需要还可以进行减压干燥。优选的是，风干后进行热干燥。作为风干方法，可以举出，例如，强制吹送低湿度的气体的方法。热干燥处理的温度优选50~90℃的范围，热干燥时间优选1~10分钟的范围。

氟树脂层的平均贯通孔径（圆柱状贯通孔的平均孔径）可以通过适当选择不良溶剂、混合液中不良溶剂的浓度、干燥速度等来控制。

通过以上的制造方法，可以得到聚烯烃微多孔膜和氟树脂层的粘接性优异的复合膜。因此，本发明的复合膜作为隔板使用时的耐久性的优异。

[4]复合微多孔膜

本发明的优选的实施方式的复合微多孔膜具有以下物性。

（1）将厚度换算为20μm时的透气度（JIS P8117）为10~1500秒/100cc，优选20~1500秒/100cc。透气度超过1500秒/100cc时，将复合微多孔膜作为电池用隔板使用时，高速率放电时或低温放电时的电池容量减少。另一方面，不足10秒/100cc时，电池内部温度上升时封闭不能充分进行。

（2）穿刺强度为2500mN/20μm或2500mN/20μm以上，优选3000mN/20μm或3000mN/20μm以上。穿刺强度不足2500mN/20μm时，将复合微多孔膜作为电池用隔板组装成电池时，有可能发生短路。

（3）130℃的温度下进行1小时处理后的热收缩率在MD方向和TD方

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向均为35%或35%以下，优选30%或30%以下。热收缩率超过35%时，由于将复合微多孔膜作为电池用隔板组装成电池时的异常发热，隔板端部收缩，短路发生的可能性变高。

（4）关于封闭特性，在130℃的温度下处理1小时后的透气度为10000秒/100cc或10000秒/100cc以上。

（5）熔化温度为155℃或155℃以上。

（6）关于对电极的粘接性，将电极和复合微多孔膜重叠，用压合机在40℃×5分钟下加热加压时，即使在浸渍在电解液中的状态下也不易剥离。

这样，由于本发明的复合微多孔膜透过性、对电极的粘接性、机械强度、耐热收缩性、封闭特性以及熔化特性的平衡性优异，因此适合电池用隔板、分离膜等用途。另外，复合微多孔膜的厚度可以视用途适当选择，但例如作为电池用隔板使用时，优选5~200μm。

由本发明的复合微多孔膜构成的隔板对于使用其的电池的种类没有特别的限制，但特别适合于锂二次电池用途。使用由本发明的复合微多孔膜制成的隔板的锂二次电池，可以使用已知的电极和电解液。另外，使用由本发明的复合微多孔膜构成的隔板的锂二次电池的结构也是已知的。

实施例

通过以下实施例更为详细地说明本发明，但本发明并不限定于这些例子。

实施例1

（1）氟树脂混合液的调制

在室温下将2.7质量份的聚（六氟丙烯-偏氟乙烯）共聚物（商品名：Kynar2801、ATOFINA社制造、六氟丙烯含有率：约10质量%、熔融粘度：2300~2700Pa·s）溶解在73质量份的丙酮中，配制氟树脂溶液。在得到的氟树脂溶液（75.7质量份）中添加24.3质量份的混合二甲苯[邻二甲苯（偶极矩：0.44Debye）和间二甲苯（偶极矩：0.35Debye）的合计含有率：80摩尔%或80摩尔%以上]，配制氟树脂混合液。

（2）覆盖层的形成

边以2米/分的速度传送聚乙烯微多孔膜[商品名：セティーラ、东燃化学（株）制、厚度21.9μm、透气度：253sec/100cc、穿刺强度：3028mN/20

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μm、热收缩率：16%（MD：105℃/8小时）、5.5%（TD：105℃/8小时）、拉伸断裂强度：90MPa（MD）、65MPa（TD）、平均贯通孔径：0.04μm、最大孔径：0.2μm、孔隙率：47%]，边通过微凹版涂布法（辊网（ロールメッシュ）：#55、辊径：20mm、转速：48rpm）涂布上述混合液。接着，通过将温度调整至60℃的干燥炉（4m）中，进行干燥，制作复合微多孔膜。

实施例2

除将甲苯（偶极矩：0.375Debye）作为不良溶剂配制氟树脂混合液以外，与实施例1同样制作复合微多孔膜。

实施例3

除将丙酮的配合比例设定为68.1质量份，添加作为不良溶剂的29.2质量份的1-丁醇（偶极矩：1.68Debye）配制氟树脂混合液以外，与实施例1同样地制作复合微多孔膜。

实施例4

除使用“Kynar2821”（商品名，ATOFINA社制造，六氟丙烯含有率：约10质量%、熔融粘度：1200~2000Pa·s）作为聚（六氟丙烯-偏氟乙烯）共聚物，将丙酮的配合比例设定为77.8质量份，将混合二甲苯的配合比例设定为19.5质量份，调制氟树脂混合液以外，与实施例1同样地制作复合微多孔膜。

实施例5

除将甲苯作为不良溶剂配制氟树脂混合液以外，与实施例4同样地制作复合微多孔膜。

实施例6

除使用“Kynar2851”（商品名，ATOFINA社制造，六氟丙烯含有率：约5质量%、熔融粘度：1700~2700Pa·s）作为聚（六氟丙烯-偏氟乙烯）共聚物，调制氟树脂混合液以外，与实施例4同样地制作复合微多孔膜。

比较例1

除将丙酮的配合比例设定为97.3质量份，不添加不良溶剂，配制氟树脂混合液以外，与实施例1同样地制作复合微多孔膜。

比较例2

除将丙酮的配合比例设定为68.1质量份，添加29.2质量份的乙酸丁酯（偶极矩：1.84Debye）作为不良溶剂，配制氟树脂混合液以外，与实施例1

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同样地制作复合微多孔膜。

比较例 3

（1）氟树脂混合液的配制

在室温下将 2.7 质量份的聚（六氟丙烯-偏氟乙烯）共聚物（商品名：Kynar2801）溶解在 97.3 质量份的 N-甲基-2-吡咯烷酮（NMP）中，调制氟树脂的 NMP 溶液。

（2）覆盖层的形成

以 2 米/分的速度传送与实施例 1 同样的聚乙烯微多孔膜（商品名：セティーラ），同时通过微凹版涂布法（辊网：#55、辊径：20mm、转速：48rpm）涂布上述氟树脂的 NMP 溶液。从涂布后的膜上切取 6cm × 6cm 的样品，在室温下在乙醇浴中浸渍 0.1 分钟。然后在调整温度至 60℃的烘箱中干燥 5 分钟，制作复合微多孔膜。

比较例 4

除将涂布了与比较例 3 同样的氟树脂的 NMP 溶液的样品膜浸渍在 1-丁醇浴中以外，与比较例 3 同样地制作复合微多孔膜。

比较例 5

除将涂布了与比较例 3 同样的氟树脂的 NMP 溶液的样品膜浸渍在混合二甲苯浴中以外，与比较例 3 同样地制作复合微多孔膜。

比较例 6

除将涂布了与比较例 3 同样的氟树脂的 NMP 溶液的样品膜浸渍在甲苯浴中以外，与比较例 3 同样地制作复合微多孔膜。

对实施例 1 和比较例 1 的复合微多孔膜的表面进行摄影的探测显微镜照片（×7500）示于图 1（实施例 1）和图 2（比较例 1）。如图 1 所示，实施例 1 的复合微多孔膜具有直径为 0.4~4μm 的圆柱状的贯通孔。与此相反，如图 2 所示，在比较例 1 的复合微多孔膜中，氟树脂堆积为粒子状，没有形成圆柱状的细孔。

实施例 1~6 以及比较例 1~6 得到的复合微多孔膜的物性用以下方法测定。作为比较例 7，关于在实施例 1~6 和比较例 1~6 中使用的聚乙烯微多孔膜的物性也用同样的方法进行测定。

· 覆盖层的状态：通过探测显微镜进行观察。

· 覆盖层的厚度：通过接触厚度计（株式会社ミツトヨ制造）测定覆盖

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层形成后的厚度，并计算出与聚乙烯微多孔膜的厚度之差。

·覆盖层的平均贯通孔径：使用探测显微镜测定 10 个贯通孔的直径，并进行平均。

·透气度：按照 JIS P8117 进行测定，求出换算为 20μm 的膜厚的值。

·孔隙率：通过重量法进行测定。

·穿刺强度：使用直径 1mm（0.5mm R）的针以 2mm/秒的速度测定对复合多微多孔膜进行穿刺时的最大负重，并求出换算为 20μm 膜厚的值。

·热收缩率：复合微多孔膜以沿其 MD 方向被固定的状态固定在框板上（固定的长度为 3.5cm），在 130℃的温度下处理 1 小时，测定 TD 方向的收缩率。

·封闭特性：测定在热收缩率测定条件（130℃/1 小时）下处理后的透气度（JIS P8117），并求出换算成 20μm 膜厚的值。

·熔化特性：在内部尺寸为 4cm × 3cm 的框板上以其 MD 方向沿框板的长边方向的方式固定复合微多孔膜，在 150℃的温度下进行 10 分钟热处理，确认有无破膜。然后，边以每次 5℃分阶段地提高温度边进行同样的热处理，将首次破膜的温度作为熔化温度。

·将复合微多孔膜夹在 2 片板状电极（正极：$LiCoO_2$、负极：石墨）之间，使之含浸电解液（电解质：$LiPF_6$、溶剂：碳酸亚乙酯+碳酸二乙酯）。然后，用压合机进行 40℃ × 5 分钟加热加压后，将电极和复合微多孔膜剥离，调查其难易程度。表示判定基准的记号分别是，○：难以剥离、以及×：可以容易地剥离。

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表 1

例 No.	实施例 1	实施例 2	实施例 3	实施例 4
聚烯烃微多孔膜	PE 微多孔膜(4)	PE 微多孔膜(4)	PE 微多孔膜(4)	PE 微多孔膜(4)
涂布液				
氟树脂 含量（wt%）	P(VDF-HFP) 共聚物(5) 2.7	P(VDF-HFP) 共聚物(5) 2.7	P(VDF-HFP) 共聚物(5) 2.7	P(VDF-HFP) 共聚物(7) 2.7
良溶剂 含量（wt%）	丙酮 73.0	丙酮 73.0	丙酮 68.1	丙酮 77.8
不良溶剂 μ(1)(Debye) 含量(wt%)	混合二甲苯(6) 0.44/0.34 24.3	甲苯 0.375 24.3	1-丁醇 1.68 29.2	混合二甲苯(6) 0.44/0.34 19.5
涂布后向不良溶剂的浸渍				
不良溶剂 μ(1)(Debye) 浸渍时间（分）	— — —	— — —	— — —	— — —
干燥条件				
温度(℃)	60	60	60	60
时间(分)	2	2	2	2
复合微多孔膜的物性				
覆盖层的状态	形成了圆柱状的细孔	形成了圆柱状的细孔	形成了圆柱状的细孔,但氟树脂堆积成为粒子状	形成了圆柱状的细孔
覆盖层的厚度(μm)	1.0	1.0	0.9	0.5
覆盖层的平均贯通孔径(μm)	2	2	2	5
透气度(sec/100cc)	523	548	1208	419
穿刺强度(mN/20μm)	3733	3645	3361	3616
热收缩率 TD(%)	29	29	29	30
封闭特性(2) (sec/100cc)	27000	55000	31000	41000
熔化温度(℃)	160	160	160	160
和电极的粘接性(3) 正极 负极	 ○ ○	 ○ ○	 ○ ○	 ○ ○

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表 1(续)

例 No.	实施例 5	实施例 6	比较例 1	比较例 2
聚烯烃微多孔膜	PE 微多孔膜(4)	PE 微多孔膜(4)	PE 微多孔膜(4)	PE 微多孔膜(4)
涂布液				
氟树脂	P(VDF-HFP) 共聚物(7)	P(VDF-HFP) 共聚物(8)	P(VDF-HFP) 共聚物(5)	P(VDF-HFP) 共聚物(5)
含量（wt%）	2.7	2.7	2.7	2.7
良溶剂	丙酮	丙酮	丙酮	丙酮
含量（wt%）	77.8	77.8	97.3	68.1
不良溶剂	甲苯	混合二甲苯(6)	—	乙酸丁酯
μ(1)(Debye)	0.375	0.44/0.34	—	1.84
含量(wt%)	19.5	19.5	—	29.2
涂布后向不良溶剂的浸渍				
不良溶剂	—	—	—	—
μ(1)(Debye)	—	—	—	—
浸渍时间（分）	—	—	—	—
干燥条件				
温度(℃)	60	60	60	60
时间(分)	2	2	2	2
复合微多孔膜的物性				
覆盖层的状态	形成了圆柱状的细孔	形成了圆柱状的细孔	细孔的形成不明显,氟树脂堆积成为粒子状	细孔的形成不明显,氟树脂堆积成为粒子状
覆盖层的厚度(μm)	0.5	0.4	0.8	0.5
覆盖层的平均贯通孔径(μm)	5	5	不能测定	不能测定
透气度(sec/100cc)	683	362	65000	5800
穿刺强度(mN/20μm)	3410	3361	3528	3479
热收缩率 TD(%)	30	29	28	28
封闭特性(2) (sec/100cc)	100000	31000	>100000	60000
熔化温度(℃)	160	160	160	160
和电极的粘接性(3)				
正极	○	○	○	○
负极	○	○	○	○

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表 1(续)

例 No.	比较例 3	比较例 4	比较例 5	比较例 6
聚烯烃微多孔膜	PE 微多孔膜(4)	PE 微多孔膜(4)	PE 微多孔膜(4)	PE 微多孔膜(4)
涂布液				
氟树脂	P(VDF-HFP) 共聚物(5)	P(VDF-HFP) 共聚物(5)	P(VDF-HFP) 共聚物(5)	P(VDF-HFP) 共聚物(5)
含量（wt%）	2.7	2.7	2.7	2.7
良溶剂	NMP(9)	NMP(9)	NMP(9)	NMP(9)
含量（wt%）	97.3	97.3	97.3	97.3
不良溶剂	—	—	—	—
μ(1)(Debye)	—	—	—	—
含量(wt%)	—	—	—	—
涂布后向不良溶剂的浸渍				
不良溶剂	乙醇	1-丁醇	混合二甲苯(6)	甲苯
μ(1)(Debye)	1.68	1.68	0.44/0.34	0.375
浸渍时间（分）	0.1	0.1	0.1	0.1
干燥条件				
温度(℃)	60	60	60	60
时间(分)	5	5	5	5
复合微多孔膜的物性				
覆盖层的状态	氟树脂堆积成为纤维状	不只是细孔的形成不充分，而且覆盖层剥离	不只是细孔的形成不充分，而且覆盖层剥离	不只是细孔的形成不充分，而且覆盖层剥离
覆盖层的厚度(μm)	0.8	0	0	0
覆盖层的平均贯通孔径(μm)	不能测量	—	—	—
透气度(sec/100cc)	1551	265	260	259
穿刺强度(mN/20μm)	3224	3038	2999	3018
热收缩率 TD(%)	29	32	32	32
封闭特性(2) (sec/100cc)	50000	1900	1810	1850
熔化温度(℃)	160	155	155	155
和电极的粘接性(3)				
正极	○	×	×	×
负极	○	×	×	×

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表 1(续)

例 No.	比较例 7
聚烯烃微多孔膜	PE 微多孔膜(4)
涂布液	
氟树脂 含量（wt%）	— —
良溶剂 含量（wt%）	— —
不良溶剂 μ(1)(Debye) 含量(wt%)	— — —
涂布后向不良溶剂的浸渍	
不良溶剂 μ(1)(Debye) 浸渍时间（分）	— — —
干燥条件	
温度(℃)	—
时间(分)	—
复合微多孔膜的物性	
覆盖层的状态	—
覆盖层的厚度(μm)	—
覆盖层的平均贯通孔径(μm)	—
透气度(sec/100cc)	253
穿刺强度(mN/20μm)	3028
热收缩率 TD(%)	16(MD)/5.5(TD)(10)
封闭特性(2) (sec/100cc)	1820
熔化温度(℃)	155
和电极的粘接性(3) 正极 负极	 × ×

注：（1）偶极矩

（2）130℃的温度下进行 1 小时处理后的透气度

（3）将复合微多孔膜夹在 2 片板状电极（正极：$LiCoO_2$、负极：石墨）之间，使之含浸电解液（电解质：$LiPF_6$、溶剂：碳酸亚乙酯+碳酸二乙酯）后，用压合机进行 40℃ × 5 分钟加热加压，将电极和复合微多孔膜剥离，调查剥离的难易程度。

（4）聚乙烯微多孔膜，商品名：セティーラ、东燃化学（株）制

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（5）聚（六氟丙烯-偏氟乙烯）共聚物（商品名：Kynar2801、ATOFINA社制造、六氟丙烯含有率：约10质量%、熔融粘度：2300~2700Pa·s）

（6）邻二甲苯（偶极矩：0.44Debye）和间二甲苯（偶极矩：0.35Debye）的合计含有率：80摩尔%或80摩尔%以上。

（7）聚（六氟丙烯-偏氟乙烯）共聚物（商品名：Kynar2821，ATOFINA社制造，六氟丙烯含有率：约10质量%、熔融粘度：1200~2000Pa·s）

（8）聚（六氟丙烯-偏氟乙烯）共聚物（商品名：Kynar2851，ATOFINA社制造，六氟丙烯含有率：约5质量%、熔融粘度：1700~2700Pa·s）

（9）N-甲基-2-吡咯烷酮

（10）分别对微多孔膜在105℃的温度下进行8小时处理时的长方向（MD）、宽方向（TD）的收缩率进行3次测定，求平均值。

如表1所示，按照本发明的方法制造的实施例1~6的复合多孔膜在透气度、穿刺强度、热收缩率、封闭特性、熔化特性以及对电极的粘接性上是优异的。另一方面，在比较例1中，由于在涂布液中没有混合不良溶剂，因此没有形成圆柱状的细孔，透气度差。在比较例2中，由于在涂布液中混合了偶极矩超过1.8Debye的不良溶剂，因此没有形成圆柱状的细孔，透气度差。在比较例3中，由于没有向涂布液中混合不良溶剂，在涂布后，浸渍在不良溶剂中，因此没有形成圆柱状的细孔，透气度差。在比较例4~6中，由于没有向涂布液中混合不良溶剂，在涂布后，浸渍在不良溶剂中，因此，不仅细孔的形成不充分，而且覆盖层发生剥离。在比较例7中，由于没有氟树脂层，因此封闭特性和对电极的粘接性差。

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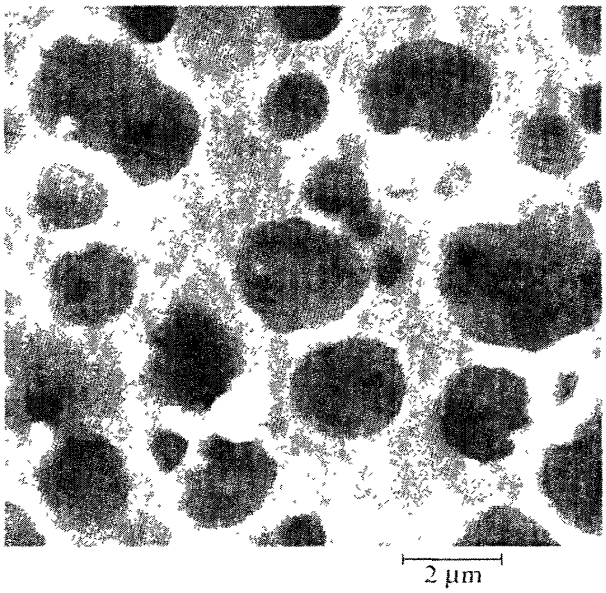


图 1

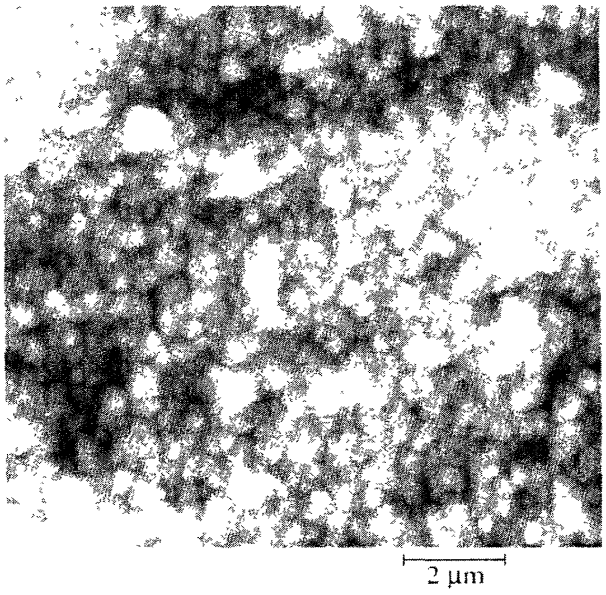


图 2

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Espacenet

Bibliographic data: CN103155217 (A) — 2013-06-12

Nonaqueous secondary battery separator and nonaqueous secondary battery

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Applicant(s): TEIJIN LTD ± (TEIJIN LIMITED, ; 帝人株式会社)

Classification: - international: ***H01M2/16***
- cooperative: **H01M2/145**; **H01M2/162**; **H01M2/1653**; **H01M2/1686**; H01M2008/1293; Y02E60/12; Y02E60/525

Application number: CN20118049794 20111021 Global Dossier

Priority number (s): WO2011JP74260 20111021 ; JP20110086386 20110408

Also published as: CN103155217 (B) EP2696394 (A1) EP2696394 (A4) EP2696394 (B1) KR101297771 (B1) more

Abstract of CN103155217 (A)

The purpose of the present invention is to provide a nonaqueous secondary battery separator having excellent adhesion to an electrode, and capable of ensuring sufficient ion permeability after adhesion to the electrode. This nonaqueous secondary battery separator is: provided with a porous substrate and an adhesive porous layer that contains a polyvinylidene fluoride resin and is formed on at least one surface of the porous substrate; and characterized in that the degree of crystallinity of the adhesive porous layer is 20-35%.

(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 103155217 A
(43)申请公布日 2013.06.12

(21)申请号 201180049794.5

(22)申请日 2011.10.21

(30)优先权数据
2011-086386 2011.04.08 JP

(85)PCT申请进入国家阶段日
2013.04.15

(86)PCT申请的申请数据
PCT/JP2011/074260 2011.10.21

(87)PCT申请的公布数据
WO2012/137377 JA 2012.10.11

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(51)Int.Cl.
H01M 2/16(2006.01)

权利要求书1页 说明书14页

(54)发明名称

非水系二次电池用隔膜及非水系二次电池

(57)摘要

本发明的目的在于提供一种非水系二次电池用隔膜，其与电极的粘合性优异，且在与电极粘合后也能够确保充分的离子透过性。本发明的非水系二次电池用隔膜的特征在于，具备多孔基材、以及在上述多孔基材的至少一面形成的含有聚偏氟乙烯系树脂的粘合性多孔层，上述粘合性多孔层的结晶度为20～35%。

CN 103155217 A

1. 非水系二次电池用隔膜，其特征在于，具备多孔基材、以及在所述多孔基材的至少一面形成的含有聚偏氟乙烯系树脂的粘合性多孔层，

所述粘合性多孔层的结晶度为 20 ～ 35%。

2. 根据权利要求 1 所述的非水系二次电池用隔膜，其特征在于，在所述多孔基材的一面形成的所述粘合性多孔层的重量为 0.5g/m^2 ～ 1.5g/m^2。

3. 根据权利要求 1 或 2 所述的非水系二次电池用隔膜，其特征在于，所述粘合性多孔层形成在所述多孔基材的表面和背面。

4. 根据权利要求 3 所述的非水系二次电池用隔膜，其特征在于，在所述多孔基材的两面形成的所述粘合性多孔层的两面的总重量为 1.0g/m^2 ～ 3.0g/m^2，

所述粘合性多孔层的一面侧的重量与另一面侧的重量之差相对于两面总重量在 20% 以下。

5. 根据权利要求 1 ～ 4 中任一项所述的非水系二次电池用隔膜，其特征在于，从形成有所述粘合性多孔层的状态的所述非水系二次电池用隔膜的葛尔莱值值减去所述多孔基材的葛尔莱值后的值在 300 秒 /100cc 以下。

6. 根据权利要求 1 ～ 5 中任一项所述的非水系二次电池用隔膜，其特征在于，所述多孔基材为含有聚乙烯的聚烯烃微多孔膜。

7. 根据权利要求 1 ～ 5 中任一项所述的非水系二次电池用隔膜，其特征在于，所述多孔基材为含有聚乙烯和聚丙烯的聚烯烃微多孔膜。

8. 根据权利要求 7 所述的非水系二次电池用隔膜，其特征在于，所述聚烯烃微多孔膜为至少 2 层以上的结构，该 2 层中的一层含有聚乙烯，另一层含有聚丙烯。

9. 非水系二次电池，其使用权利要求 1 ～ 8 中任一项所述的隔膜。

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非水系二次电池用隔膜及非水系二次电池

技术领域

[0001] 本发明涉及非水系二次电池用隔膜及非水系二次电池。

背景技术

[0002] 以锂离子二次电池为代表的非水系二次电池被广泛地用作笔记本电脑、手机、数码相机、摄像放像机等便携式电子设备的电源。此外，近年来，由于具有高能量密度这样的特征，这些电池在汽车等的应用也在研究中。

[0003] 伴随着便携式电子设备的小型化、轻量化，非水系二次电池外包装在简约化。起初，使用不锈钢电池罐作为外包装，但随后开发出了铝罐外包装，现在还开发出了铝复合包装的软外包装。使用铝复合软外包装时，外包装柔软，因此，伴随着充放电，电极与隔膜之间有时会有间隙形成，存在循环寿命变差这样的技术课题。从解决该课题的观点出发，将电极与隔膜进行粘合的技术是重要的，已有很多技术提案。

[0004] 作为其中的一个提案，已知有使用将由聚偏氟乙烯系树脂构成的多孔层(以下，也称为粘合性多孔层)成型于作为以往隔膜的聚烯烃微多孔膜上而得的隔膜的技术(例如参见专利文献1)。就粘合性多孔层而言，若在含有电解液的状态下重叠在电极上并热压，则能够使电极与隔膜良好地接合，起到粘合剂的作用。因此，能够改善软包装电池的循环寿命。

[0005] 另外，在使用以往的金属罐外包装来制作电池的情况下，将电极与隔膜在重合的状态下进行卷绕来制作电池元件，将该元件与电解液一起封入金属罐外装内，制成电池。另一方面，在使用上述专利文献1这样的隔膜来制作软包装电池的情况下，按与上述金属罐外包装电池同样的方法制作电池元件，将其与电解液一起封入软外包装装内，最后加入热压工序，制成电池。由此，在使用如上所述的具有粘合性多孔层的隔膜的情况下，能够按与上述金属罐外装电池同样的方法制作电池元件，因此还具有无需对以往的金属罐外包装电池的制造工序加以大幅变更的优点。

[0006] 从上述背景出发，就聚烯烃微多孔膜上层叠有粘合性多孔层的隔膜而言，过去已有各种技术提案。例如，在专利文献1中，从确保充分的粘合性与兼顾离子透过性这样的观点出发，着眼于聚偏氟乙烯系树脂层的多孔结构与厚度，提出了新的技术方案。

[0007] 现有技术文献

[0008] 专利文献

[0009] 专利文献1：日本特许第4127989号公报

发明内容

[0010] 但是，一般的非水系二次电池的正极或者负极由集电体与在该集电体上形成的含有电极活性物质及粘合树脂的活性物质层所构成。而且，上述粘合性多孔层在通过热压与电极接合的情况下，会与电极中的粘合树脂粘合。因此，为了确保更良好的粘合性，优选电极内的粘合树脂量多。

[0011] 然而，为了进一步提高电池的能量密度，有必要提高电极中的活性物质的含量，优

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选粘合树脂含量少。因此，在现有技术中为了确保充分的粘合性，有必要在更高的温度、更高的压力之类的严格条件下进行热压。而且，在现有技术中，在这样的严格条件下进行热压时，存在由聚偏氟乙烯系树脂构成的粘合性多孔层的多孔结构崩塌的问题。因此，热压工序后的离子透过性会不充分，难以获得良好的电池特性。

[0012] 另外，以往用于电极的粘合树脂通常为聚偏氟乙烯系树脂，与此相对，近年来应用苯乙烯-丁二烯橡胶的情况也在增加。对于这样的使用苯乙烯-丁二烯橡胶的电极，若用以往的具备粘合性多孔层的隔膜，则难以兼顾离子透过性与粘合性而获得充分的电池特性。

[0013] 从这样的背景出发，本发明的目的在于提供一种非水系二次电池用隔膜，其与现有技术相比，与电极的粘合性优异，且在与电极粘合后也能够确保充分的离子透过性。

[0014] 本发明为了解决上述课题，采用以下构成。

[0015] 1、一种非水系二次电池用隔膜，其特征在于，具备多孔基材以及在所述多孔基材的至少一面形成的含有聚偏氟乙烯系树脂的粘合性多孔层，

[0016] 所述粘合性多孔层的结晶度为 20 ～ 35%。

[0017] 2、根据上述 1 所述的非水系二次电池用隔膜，其特征在于，在所述多孔基材的一面形成的所述粘合性多孔层的重量为 0.5g/m^2 ～ 1.5g/m^2。

[0018] 3、根据上述 1 或 2 所述的非水系二次电池用隔膜，其特征在于，所述粘合性多孔层形成在所述多孔基材的表面和背面。

[0019] 4、根据上述 3 所述的非水系二次电池用隔膜，其特征在于，在所述多孔基材的两面形成的所述粘合性多孔层的两面的总重量为 1.0g/m^2 ～ 3.0g/m^2，

[0020] 所述粘合性多孔层的一面侧的重量与另一面侧的重量之差相对于两面总重量在 20% 以下。

[0021] 5、根据上述 1 ～ 4 中任一项所述的非水系二次电池用隔膜，其特征在于，从形成有所述粘合性多孔层的状态的所述非水系二次电池用隔膜的 Gurley 值（葛尔莱值）减去所述多孔基材的 Gurley 值后的值在 300 秒 /100cc 以下。

[0022] 6、根据上述 1 ～ 5 中任一项所述的非水系二次电池用隔膜，其特征在于，所述多孔基材为含有聚乙烯的聚烯烃微多孔膜。

[0023] 7、根据上述 1 ～ 5 中任一项所述的非水系二次电池用隔膜，其特征在于，所述多孔基材为含有聚乙烯与聚丙烯的聚烯烃微多孔膜。

[0024] 8、根据上述 7 所述的非水系二次电池用隔膜，其特征在于，所述聚烯烃微多孔膜为至少 2 层以上的结构，该 2 层中的一层含有聚乙烯，另一层含有聚丙烯。

[0025] 9、一种非水系二次电池，其使用上述 1 ～ 8 中任一项所述的隔膜。

[0026] 根据本发明，能够提供一种非水系二次电池用隔膜，其与现有非水系二次电池用隔膜相比，与电极的粘合性优异，且在与电极粘合后也能够确保充分的离子透过性。使用这样的本发明的隔膜，能够提供能量密度高、高性能的铝复合外包装的非水系二次电池。

具体实施方式

[0027] 本发明的非水系二次电池用隔膜的特征在于，具备多孔基材、以及在上述多孔基材的至少一面形成的含有聚偏氟乙烯系树脂的粘合性多孔层，上述粘合性多孔层的结晶度为 20 ～ 35%。以下，对本发明进行详细说明。在以下说明中，含“～”的数值范围是指包含

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上限值及下限值的数值范围。

[0028] 〔多孔基材〕

[0029] 在本发明中，所谓多孔基材是指内部具有空孔或空隙的基材。作为这样的基材，可列举出微多孔膜，无纺布、纸状片材等纤维状物构成的多孔性片材，或者在微多孔膜、多孔性片材上层叠 1 层以上的其它多孔性层而得的复合多孔片材等。应予说明，所谓微多孔膜是指为内部具有多个微孔且这些微孔连接的结构，气体或者液体能够从一面流通到另一面的膜。

[0030] 构成多孔基材的材料能够使用具有电绝缘性的有机材料或者无机材料中的任一种。从对基材赋予关断功能的观点出发，特别优选使用热塑性树脂作为基材的构成材料。在此，所谓关断功能是指在电池温度升高的情况下，热塑性树脂会熔化并阻塞多孔基材的孔，从而截断离子的移动、防止电池热失控的功能。作为热塑性树脂，优选熔点低于 200℃的热塑性树脂，特别优选聚烯烃。

[0031] 作为使用聚烯烃的多孔基材，优选聚烯烃微多孔膜。作为聚烯烃微多孔膜，可使用具有充分的力学物性与离子透过性的适用于以往的非水系二次电池用隔膜的聚烯烃微多孔膜。而且，就聚烯烃微多孔膜而言，从具有上述关断功能这样的观点出发，优选含有聚乙烯，作为聚乙烯的含量，优选在 95 重量％以上。

[0032] 另外，从赋予在暴露于高温时不容易破膜的程度的耐热性的观点出发，优选含有聚乙烯与聚丙烯的聚烯烃微多孔膜。作为这样的聚烯烃微多孔膜，可举出聚乙烯与聚丙烯在 1 张片材中混杂的微多孔膜。在这样的微多孔膜中，从兼顾关断功能与耐热性的观点出发，优选含有 95 重量％以上的聚乙烯与 5 重量％以下的聚丙烯。另外，从兼顾关断功能与耐热性的观点出发，还优选聚烯烃微多孔膜为至少 2 层以上的结构且为该 2 层中的一层含有聚乙烯、另一层含有聚丙烯的层叠结构的聚烯烃微多孔膜。

[0033] 聚烯烃的重均分子量优选 10 万～ 500 万。若重均分子量小于 10 万，则有时难以确保充分的力学物性。另外，若大于 500 万，则有时关断特性变差，有时成型变得困难。

[0034] 这样的聚烯烃微多孔膜例如可通过以下方法制造。即，可举出如下方法：依次实施（i）将熔融的聚烯烃树脂从 T 型模挤出、制成片材的工序、（ii）对上述片材实施结晶化处理的工序、（iii）拉伸片材的工序、及（iv）将片材进行热处理的工序，形成微多孔膜。另外，还可举出如下方法等：依次实施（i）将聚烯烃树脂与液体石蜡等增塑剂一起熔融，将其从 T 型模挤出，再将其冷却、制成片材的工序、（ii）拉伸片材的工序、（iii）从片材提取增塑剂的工序、及（iv）对片材进行热处理的工序，形成微多孔膜。

[0035] 作为由纤维状物构成的多孔性片材，可使用由包括聚对苯二甲酸乙二醇酯等聚酯，聚乙烯、聚丙烯等聚烯烃，芳香族聚酰胺、聚酰亚胺、聚醚砜、聚砜、聚醚酮、聚醚酰亚胺等耐热性高分子等纤维状物，或者这些纤维状物的混合物构成的多孔性片材。

[0036] 作为复合多孔片材，可采用在由微多孔膜、由纤维状物构成的多孔性片材上层叠功能层而得的构成。从可利用功能层而附加进一步的功能的方面出发，优选这样的复合多孔片材。作为功能层，例如从赋予耐热性的观点出发，可使用由耐热性树脂构成的多孔层、由耐热性树脂及无机填料构成的多孔层。作为耐热性树脂，可举出选自芳香族聚酰胺、聚酰亚胺、聚醚砜、聚砜、聚醚酮、及聚醚酰亚胺中的 1 种或 2 种以上的耐热性高分子。作为无机填料，可良好地使用氧化铝等金属氧化物、氢氧化镁等金属氢氧化物等。其中，作为复合化

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的方法，可举出对多孔性片材涂覆功能层的方法、用粘合剂进行接合的方法、热压合的方法等。

[0037] 在本发明中，从获得良好的力学物性与内部电阻的观点出发，多孔基材的膜厚优选在 5 ～ 25μm 的范围。从防止电池短路、获得充分的离子透过性的观点出发，多孔基材的 Gurley 值（JISP8117）优选在 50 ～ 800 秒 /100cc 的范围内。从使制造成品率提高的观点出发，多孔基材的穿刺强度优选在 300g 以上。

[0038] 〔聚偏氟乙烯系树脂〕

[0039] 本发明的非水系二次电池用隔膜中，优选使用重均分子量为 10 万～ 300 万的聚偏氟乙烯系树脂。若应用重均分子量小于 10 万的聚偏氟乙烯树脂，则与电极的粘合力弱，因此不适宜。从粘合力的观点出发，重均分子量进一步优选在 50 万以上。另外，若重均分子量大于 300 万，则成型时的粘度高，成型变得困难，或者无法在得到由聚偏氟乙烯系树脂形成的多孔结构时形成充分的晶体，因此不适宜。从这样的成型性的观点出发，重均分子量更优选在 200 万以下，进一步优选在 120 万以下。在此，聚偏氟乙烯系树脂的重均分子量可利用凝胶渗透色谱法（GPC 法）求得。

[0040] 在本发明中，作为聚偏氟乙烯系树脂，可使用偏氟乙烯的均聚物（即聚偏氟乙烯）、偏氟乙烯与其它能够共聚的单体的共聚物，或者它们的混合物。作为能够与偏氟乙烯共聚的单体，例如可使用四氟乙烯、六氟丙烯、三氟乙烯、三氯乙烯或者氟乙烯等的一种或两种以上。聚偏氟乙烯系树脂优选含有 70mol% 以上的作为构成单元的偏氟乙烯。进而，从在与电极的接合工序中确保充分的力学物性的观点出发，优选含有 98mol% 以上的偏氟乙烯的聚偏氟乙烯树脂。

[0041] 上述分子量较高的聚偏氟乙烯系树脂可优选通过乳液聚合或者悬浮聚合、特别优选通过悬浮聚合获得。

[0042] 〔粘合性多孔层〕

[0043] 在本发明的非水系二次电池用隔膜中，有必要使由聚偏氟乙烯系树脂构成的粘合性多孔层的结晶度为 20 ～ 35%。在此，所谓粘合性多孔层是指如下多孔层：含有聚偏氟乙烯系树脂，为内部具有多个微孔且这些微孔连接的结构，气体或者液体可从一面流通到另一面。另外，结晶度可由通过 X 射线衍射法得到的衍射峰的积分强度求得。

[0044] 若该结晶度小于 20%，则难以在与电极粘合后维持粘合性多孔层的多孔结构，非水系二次电池的负荷特性、循环特性等电池特性会下降。若该结晶度大于 35%，则与电极的粘合性不充分，因而不适宜。

[0045] 据认为，该聚偏氟乙烯系树脂的非晶部分对粘合性多孔层与电极的粘合作出贡献，从该观点出发，结晶度低的粘合性多孔层与结晶度高的粘合性多孔层相比，与电极的粘合性良好。特别是在本发明中，通过使粘合性多孔层的结晶度在 20 ～ 35% 的范围内，则即使在热压条件弱的情况下也可确保充分的与电极的粘合性，不论电极的粘合树脂、电解液的种类如何，都能显示出良好的粘合性，在这点上存在很大的有利之处。若即使热压条件弱也可确保充分的粘合力，则粘合性多孔层的多孔结构不会由于热压而被破坏，能够防止粘合性多孔层熔融、从电极与聚烯烃微多孔膜的界面被挤出、或因堵塞而导致粘合后的离子透过性受到阻碍的情况。另外，若能够不论电极的粘合树脂、电解液的种类如何，都能够得到良好的粘合性，则电池的构成材料的选项、组合变宽，能够制作多种多样的非水系二次电

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池。

[0046] 控制粘合性多孔层的结晶度的方法可举出若干方法。例如，形成粘合性多孔层时的凝固工序的温度为一种因素，存在越降低该温度，则结晶度越下降的倾向。另外，聚偏氟乙烯系树脂的选择也为一种重要的因素。存在该聚偏氟乙烯系树脂的分子量高时结晶度变低的倾向，若使用重均分子量为 50 万以上的聚偏氟乙烯系树脂，则容易形成本发明中的恰当的结晶度。另外，越向聚偏氟乙烯添加共聚成分，结晶性越下降。从聚合物的结构这样的观点出发，无规排列有 CF_2 和 CH_2 的聚偏氟乙烯的结晶性低，就这样的聚合物而言，与悬浮聚合相比，容易通过乳液聚合制得。另外，有成长的分支结构的聚偏氟乙烯存在难以结晶化的倾向，分子量分布宽的聚偏氟乙烯，结晶性低。此外，涂布液组成也为一种控制结晶性的因素，存在向涂布液中添加的相分离剂越少，则结晶性越下降的倾向。这些控制因素也为有助于多孔结构形成的因素，从结晶性控制的观点出发来控制并不适宜。优选从结晶性、及多孔结构两方的观点将前述控制因素进行组合使用。当然，视所选择的树脂，涂布液组成、凝固温度等各条件的优选范围会发生变化，因此，各条件的优选范围不能一概而论。

[0047] 在本发明中，对于粘合性多孔层，出于改善隔膜的滑动性、耐热性的目的，也可加入由无机物或者有机物构成的填料、其它添加物。在该情况下，其含量和粒子尺寸应不影响本发明的效果。作为无机填料，可使用上述金属氧化物、金属氢氧化物等。作为有机填料，例如可使用丙烯酸类树脂等。

[0048] 〔非水系二次电池用隔膜〕

[0049] 如上所述，本发明的非水系二次电池用隔膜具备多孔基材、以及在多孔基材的至少一面形成的含有聚偏氟乙烯系树脂的粘合性多孔层。在此，粘合性多孔层为在含有电解液的状态下通过热压与电极粘合的粘合层，因此有必要作为隔膜的最外层而存在。当然，从循环寿命的观点出发，优选使正极及负极两者与隔膜进行粘合，因此优选在多孔基材的表面和背面形成粘合性多孔层。

[0050] 在本发明中，从离子透过性的观点出发，粘合性多孔层优选为充分多孔化的结构。具体而言，从形成有粘合性多孔层的状态的非水系二次电池用隔膜的 Gurley 值减去多孔基材的 Gurley 值而得的值优选在 300 秒 /100cc 以下，进一步优选在 150 秒 /100cc 以下，尤其优选在 100 秒 /100cc 以下。在该差高于 300 秒 /100cc 的情况下，有时粘合性多孔层过于致密而阻碍离子透过，不能得到充分的电池特性。

[0051] 从获得充分的电池性能的观点出发，本发明的非水系二次电池用隔膜的 Gurley 值优选在 50 秒 /100cc ～ 800 秒 /100cc 的范围内。

[0052] 从良好地获得本发明的效果与隔膜的力学物性的观点出发，非水系二次电池用隔膜的空孔率宜在 30% ～ 60% 的范围内。

[0053] 该聚偏氟乙烯系树脂在一个表面上的重量优选在 0.5 ～ 1.5g/m^2 的范围内。若少于 0.5g/m^2，则有时与电极的粘合性会不充分。而若多于 1.5g/m^2，则存在阻碍离子透过性、使电池负荷特性下降的倾向，因此不适宜。在由该聚偏氟乙烯系树脂构成的多孔层形成在表背两面的情况下，聚偏氟乙烯系树脂的重量优选为 1.0 ～ 3.0g/m^2。

[0054] 在本发明中，在将粘合性多孔层形成在多孔基材的两面的情况下，其表面和背面的重量差也是重要的。具体而言，优选在多孔基材的表面和背面形成的粘合性多孔层的两面的总重量为 1.0 ～ 3.0g/m^2，粘合性多孔层的一面侧的重量与另一面侧的重量差相对于两

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面总重量在20%以下。若超过20%，则有时翘曲会变得显著，还会存在影响操作、或循环特性下降的情况。

[0055] 〔非水系二次电池用隔膜的制造方法〕

[0056] 上述本发明的非水系二次电池用隔膜能够通过如下方法制作，即，将含有聚偏氟乙烯系树脂的溶液直接涂布于多孔基材上，使聚偏氟乙烯系树脂固化，从而将粘合性多孔层一体地形成在多孔基材上。

[0057] 具体而言，首先，将聚偏氟乙烯系树脂溶解于溶剂中，制作涂布液。将该涂布液涂布在多孔基材上，浸渍于恰当的凝固液中。由此，在诱发相分离现象的同时，使聚偏氟乙烯系树脂固化。在该工序中，由聚偏氟乙烯系树脂构成的层成为多孔结构。然后，通过水洗除去凝固液，再进行干燥，从而可将粘合性多孔层一体地形成在多孔基材上。

[0058] 作为上述涂布液，可使用将聚偏氟乙烯系树脂溶解的良溶剂。作为这样的良溶剂，例如，可优选使用N-甲基吡咯烷酮、二甲基乙酰胺、二甲基甲酰胺、二甲基甲酰胺等极性酰胺溶剂。从形成良好的多孔结构的观点出发，优选在上述良溶剂的基础上混合诱发相分离的相分离剂。作为这样的相分离剂，可举出水、甲醇、乙醇、丙醇、丁醇、丁二醇、乙二醇、丙二醇、或者三丙二醇等。这样的相分离剂优选在能够确保适于涂布的粘度的范围内进行添加。另外，在将填料、其它添加物加入粘合性多孔层的情况下，使它们混合或溶解在上述涂布液中即可。

[0059] 在涂布液的组成中，优选以3～10重量%的浓度含有聚偏氟乙烯系树脂。作为溶剂，从形成适宜的多孔结构以及控制结晶度的观点出发，优选使用含有60重量%以上的良溶剂、40重量%以下的相分离剂的混合溶剂。

[0060] 作为凝固液，可使用水，水与上述良溶剂的混合溶剂，或者水、上述良溶剂与上述相分离剂的混合溶剂。特别优选水、良溶剂与相分离剂的混合溶剂，在该情况下，从生产率的观点出发，良溶剂与相分离剂的混合比优选与用于溶解聚偏氟乙烯系树脂的混合溶剂的混合比相适应。从形成良好的多孔结构、使生产率提高的观点出发，水的浓度优选为40～90重量%。从控制结晶度的观点出发，凝固温度优选在-20～60℃左右。

[0061] 涂布液对多孔基材的涂布可应用迈耶棒、模涂布机、逆辊涂布机、凹版涂布机等以往的涂布方式。在将粘合性多孔层形成于多孔基材的两面的情况下，也可将涂布液一个单面一个单面地涂布后进行凝固、水洗及干燥，但是从生产率的观点出发，优选将涂布液同时涂布于多孔基材两面后进行凝固、水洗及干燥。

[0062] 就本发明的隔膜而言，除了上述湿式涂布法以外，也可用干式涂布法进行制造。在此，所谓干式涂布法是指如下方法：将含有聚偏氟乙烯系树脂与溶剂的涂布液涂布于多孔基材上，将其干燥，从而挥发除去溶剂，由此得到多孔膜。但是，在干式涂布法的情况下，与湿式涂布法相比，涂布膜易于成为致密膜，若不在涂布液中添加填料等，则几乎不可能得到多孔层。另外，即使添加这样的填料等，也难以得到良好的多孔结构。由此，若从这样的观点出发，则在本发明中优选使用湿式涂布法。

[0063] 另外，本发明的隔膜也可通过预先分别制作粘合性多孔层与多孔基材、将这些片材重合并用热压合、粘合剂进行复合化的方法等来制作。作为以独立片材的方式得到粘合性多孔层的方法，可举出将涂布液涂布于剥离片材上、使用上述湿式涂布法或者干式涂布法来形成粘合性多孔层、仅剥离粘合性多孔层的方法等。

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[0064] 〔非水系二次电池〕

[0065] 本发明的非水系二次电池的特征在于使用上述本发明的隔膜。

[0066] 在本发明中，非水系二次电池为如下构成：隔膜配置在正极及负极之间，这些电池元件与电解液一起被封入外包装内。作为非水系二次电池，优选锂离子二次电池。

[0067] 作为正极，可采用将由正极活性物质、粘合树脂及导电助剂构成的电极层形成于正极集电体上的构成。作为正极活性物质，例如可举出钴酸锂、镍酸锂、尖晶石结构的锰酸锂、或者橄榄石结构的磷酸铁锂等。在本发明中，在将隔膜的粘合性多孔层配置于正极侧的情况下，由于聚偏氟乙烯系树脂的耐酸化性优异，因此还具有如下优点：易于使用能够在4.2V以上的高电压下工作的$LiMn_{1/2}Ni_{1/2}O_2$、$LiCo_{1/3}Mn_{1/3}Ni_{1/3}O_2$之类的正极活性物质。作为粘合树脂，例如可列举出聚偏氟乙烯系树脂等。作为导电助剂，例如可举出乙炔黑、科琴黑、石墨粉末等。作为集电体，例如可举出厚度为5～20μm的铝箔等。

[0068] 作为负极，可采用将由负极活性物质和粘合树脂构成的电极层形成于负极集电体上的构成，根据需要，可在电极层中添加导电助剂。作为负极活性物质，例如可使用能够将锂以电化学方式进行吸留的碳材料、硅或者锡等与锂合金化的材料等。作为粘合树脂，例如可举出聚偏氟乙烯系树脂、丁烯－苯乙烯橡胶等。在使用本发明的非水系二次电池用隔膜的情况下，粘合性良好，因此不仅在使用聚偏氟乙烯系树脂作为负极粘结剂的情况下可确保充分的粘合性，在使用丁烯－苯乙烯橡胶作为负极粘结剂的情况下也可确保充分的粘合性。另外，作为导电助剂，例如可举出乙炔黑，科琴黑，石墨粉末等。作为集电体，例如可举出厚度为5～20μm的铜箔等。另外，也可使用金属锂箔作为负极来代替上述负极。

[0069] 电解液为将锂盐溶于适宜溶剂的构成。作为锂盐，例如可举出$LiPF_6$、$LiBF_4$、$LiClO_4$等。作为溶剂，例如可优选使用碳酸亚乙酯、碳酸亚丙酯、氟代碳酸亚乙酯、二氟代碳酸亚乙酯等环状碳酸酯，碳酸二甲酯、碳酸二乙酯、碳酸甲乙酯及其氟取代物等链状碳酸酯，γ－丁内酯、γ－戊内酯等环状酯，或者它们的混合溶剂。特别优选将0.5～1.5M的锂盐溶解于环状碳酸酯／链状碳酸酯=20～40/80～60重量比的溶剂中而得的电解液。此外，具备以往的粘合性多孔层的隔膜有时会有由于使用的电解液的种类而难以发挥与电极的粘合性的情况，但是，若利用本发明的隔膜，则还具有不论电解液种类如何，都能发挥良好的粘合性这样的很大的优点。

[0070] 本发明的非水系二次电池用隔膜还可适用于金属罐外包装的电池，由于与电极的粘合性良好，可良好地用于铝复合膜外包装的软包装电池。制作这样的电池的方法是，使上述正极及负极介由隔膜而接合，加入电解液，再封入铝复合膜内。通过将其热压，能够得到非水系二次电池。通过这样的本发明的构成，可得到能够使电极与隔膜良好地粘合、循环寿命优异的非水系二次电池。另外，由于电极与隔膜的粘合性良好，电池的安全性也优异。电极与隔膜的接合方法有使电极与隔膜层叠的堆叠方式、将电极与隔膜一起卷绕的方式等，本发明可应用任一种方法。

[0071] 实施例

[0072] 以下，通过实施例来说明本发明。但是，本发明并不由以下实施例所限定。

[0073] 〔测定方法〕

[0074] （由聚偏氟乙烯系树脂构成的多孔层的结晶度的测定方法）

[0075] 将从隔膜剥取的聚偏氟乙烯系树脂作为试样，用X射线衍射法求得其结晶度。在

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测定中使用“NANO-Viewer”(Rigaku 公司产品),在 25℃下用透射法进行,用成像板进行检测。将由成像板得到的二维数据转换成 2θ 图,将 2θ=8 ～ 30° 的范围进行曲线拟合(高斯函数 / 洛伦兹函数 =50/50),求出峰的来自晶体成分的积分强度 Ic、来自非晶成分的积分强度 Ia。结晶度 Xc (%) 通过下式 1 算出。

[0076] $Xc=\{Ic/(Ic+Ia)\}\times 100\cdots(1)$

[0077] (膜厚的测定方法)

[0078] 用接触式厚度计(LITEMATIC,Mitutoyo 公司产品)进行测定。测定端子为直径 5mm 的圆柱状端子,在荷重调整为 7g 的条件下进行测定。

[0079] (单位面积重量)

[0080] 将样品切出 10cm×10cm,测定其重量。通过将重量除以面积而求出单位面积重量。

[0081] (聚偏氟乙烯系树脂的重量)

[0082] 使用能量分散型荧光 X 射线分析装置(EDX-800HS 岛津制作所),从 FKα 的光谱强度测出聚偏氟乙烯系树脂的重量。在该测定中,测定 X 射线所照射的面上的聚偏氟乙烯系树脂的重量。由此,在将由聚偏氟乙烯系树脂构成的多孔层形成于表面和背面两面的情况下,通过对表面和背面分别进行测定,测出表面和背面各自的聚偏氟乙烯系树脂的重量,再将其统合,从而可测出表面和背面的总重量。

[0083] (空孔率)

[0084] 复合隔膜的空孔率 ε (%) 由以下式 2 算出。

[0085] $E=\{1-(Wa/0.95+Wb/1.78)/t\}\times 100\cdots(2)$

[0086] 在此,Wa 为基材的单位面积重量(g/m^2),Wb 为聚偏氟乙烯系树脂的重量(g/m^2),t 为膜厚(μm)。

[0087] (Gurley 值)

[0088] 按照 JISP8117,用 Gurley 式 Densometer (G-B2C,东洋精机公司产品)进行测定。

[0089] 〔实施例 1〕

[0090] 作为聚偏氟乙烯系树脂,使用 ARKEM 公司生产的偏氟乙烯 - 六氟丙烯共聚物 KYNAR2851。将该聚偏氟乙烯系树脂以 8 重量 % 溶解于二甲基乙酰胺 / 三丙二醇 =7/3 重量比的混合溶剂中,制作涂布液。将其等量涂布于膜厚 9μm、Gurley 值 160 秒 /100cc、空孔率 43% 的聚乙烯微多孔膜(TN0901:SK 公司产品)的两面,浸渍于水 / 二甲基乙酰胺 / 三丙二醇 =57/30/13 重量比的凝固液(10℃)中,使之固化。将其水洗、干燥,得到聚烯烃系微多孔膜的表背两面形成有由聚偏氟乙烯系树脂构成的多孔层的本发明的非水系二次电池用隔膜。测定该隔膜的粘合性多孔层的结晶度(PVdF 系树脂的结晶度)、隔膜的膜厚、单位面积重量及空孔率、粘合性多孔层的重量(两面总重量、表面的重量,背面的重量、表面侧的重量与背面侧的重量之差相对于两面总重量的比例)、及隔膜的 Gurley 值,测定结果示于表 1 中。将以下的实施例及比较例的隔膜的结果也一并示于表 1 中。

[0091] 〔实施例 2〕

[0092] 作为聚偏氟乙烯系树脂,使用 Solvay 公司生产的通过乳液聚合而得到的聚偏氟乙烯 Hylar460,将凝固液的温度设定于 40℃,除此以外,与实施例 1 同样进行,制作本发明的非水系二次电池用隔膜。

[0093] 〔实施例 3〕

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[0094] 作为聚偏氟乙烯系树脂，使用 Solvay 公司生产的重均分子量 573×10^3 的聚偏氟乙烯 Solef1015，除此以外，与实施例 1 同样进行，制作非水系二次电池用隔膜。

[0095] 〔实施例 4〕

[0096] 通过乳液聚合来制作共聚组成为偏氟乙烯 / 六氟丙烯 / 氯三氟乙烯 = 88.0/6.5/5.5 重量比的聚偏氟乙烯系树脂。该聚偏氟乙烯系树脂的重均分子量为 41 万。将该聚偏氟乙烯以 8 重量 % 溶解于二甲基乙酰胺 / 三丙二醇 = 55/45 重量比的混合溶剂中，制作涂布液。将其等量涂布于膜厚 9μm、Gurley 值 160 秒 /100cc、空孔率 43% 的聚乙烯微多孔膜（TN0901:SK 公司产品）的两面，浸渍于水 / 二甲基乙酰胺 / 三丙二醇 = 50/30/20 重量比的凝固液（20℃）中，使之固化。将其水洗、干燥，得到聚烯烃系微多孔膜的表面和背面两面形成有由聚偏氟乙烯系树脂构成的多孔层的本发明的非水系二次电池用隔膜。

[0097] 〔实施例 5 ～ 8〕

[0098] 使用与实施例 1 同样的涂布液、以及聚乙烯微多孔膜，用同样的方法，如表 1 所示仅使涂布量变化，得到本发明的非水系二次电池用隔膜。

[0099] 〔实施例 9、10〕

[0100] 使用与实施例 1 同样的涂布液、以及聚乙烯微多孔膜，用同样的方法，如表 1 所示仅使表面和背面的涂布量变化，得到本发明的非水系二次电池用隔膜。

[0101] 〔实施例 11〕

[0102] 将由聚丙烯 / 聚乙烯 / 聚丙烯的 3 层结构构成的膜厚 12μm、Gurley 值 425 秒 /100cc、空孔率 38% 的聚烯烃微多孔膜（M824，Celgard 公司）用作聚烯烃微多孔膜，除此以外，与实施例 1 同样进行，得到本发明的非水系二次电池用隔膜。

[0103] 〔比较例 1〕

[0104] 将凝固液的温度设为 40℃，除此以外，与实施例 1 同样进行，制作非水系二次电池用隔膜。

[0105] 〔比较例 2〕

[0106] 作为聚偏氟乙烯系树脂，使用 ARKEM 公司生产的通过悬浮聚合得到的聚偏氟乙烯 KYNAR741，除此以外，与实施例 2 同样进行，制作非水系二次电池用隔膜。

[0107] 〔比较例 3〕

[0108] 作为聚偏氟乙烯系树脂，使用 Solvay 公司生产的重均分子量 244×10^3 的聚偏氟乙烯 Solef1008，除此以外，与实施例 3 同样进行，制作非水系二次电池用隔膜。

[0109] 〔比较例 4〕

[0110] 通过乳液聚合来制作共聚组成为偏氟乙烯 / 六氟丙烯 / 氯三氟乙烯 = 96.0/2.5/1.5 重量比的聚偏氟乙烯系树脂。该聚偏氟乙烯系树脂的重均分子量为 41 万。使用该聚偏氟乙烯，除此以外，与实施例 4 同样进行，得到非水系二次电池用隔膜。

[0111] 〔比较例 5〕

[0112] 通过乳液聚合来制作共聚组成为偏氟乙烯 / 六氟丙烯 / 氯三氟乙烯 = 61.0/20.0/19.0 重量比的聚偏氟乙烯系树脂。该聚偏氟乙烯系树脂的重均分子量为 41 万。使用该聚偏氟乙烯，将凝固液的温度设定于 0℃，除此以外，与实施例 4 同样进行，得到非水系二次电池用隔膜。

[0113] 〔比较例 6〕

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[0114] 通过乳液聚合来制作共聚组成为偏氟乙烯/六氟丙烯/氯三氟乙烯=92.0/4.5/3.5重量比的聚偏氟乙烯系树脂。该聚偏氟乙烯系树脂的重均分子量为41万。将该聚偏氟乙烯以12重量%溶解于二甲基乙酰胺/三丙二醇=60/40重量比的混合溶剂中,制作涂布液。将其等量涂布于膜厚9μm、Gurley值160秒/100cc、空孔率43%的聚乙烯微多孔膜(TN0901:SK公司产品)的两面,浸渍于水/二甲基乙酰胺/三丙二醇=50/30/20重量比的凝固液(40℃)中,使之固化,将其水洗、干燥,得到聚烯烃系微多孔膜上形成有由聚偏氟乙烯系树脂构成的多孔层的非水系二次电池用隔膜。

[0115] 〔比较例7〕

[0116] 将偏氟乙烯/六氟丙烯共聚物(Kureha化学公司生产的#8500)的3质量%碳酸二甲酯溶液等量涂布于膜厚9μm、Gurley值160秒/100cc、空孔率43%的聚乙烯微多孔膜(TN0901:SK公司产品)的两面,将其进行干燥。然而,所得到的涂布膜为致密膜,得不到具备粘合性多孔层的非水系二次电池用隔膜。测定该复合膜的Gurley值,结果为2000秒/100cc以上,透过性显著差。

[0117] 〔与电极的粘合性试验〕

[0118] (负极的制作)

[0119] 将作为负极活性物质的人造石墨(MCMB25-28,Osaka Gas Chemicals公司产品)300g、作为粘结剂的日本Zeon公司生产的"BM-400B"(含有40重量%的苯乙烯-丁二烯共聚物改性体的水溶性分散液)7.5g、作为增粘剂的羧甲基纤维素3g、适量的水用双臂式混合机搅拌,制作负极用浆料。将该负极用浆料涂布于作为负极集电体的厚度10μm的铜箔上,将所得到的涂膜干燥,加压,制成具有负极活性物质层的负极。

[0120] (正极的制作)

[0121] 将作为正极活性物质的钴酸锂(Cellseed C,日本化学工业公司产品)粉末89.5g、作为导电助剂的乙炔黑(Denkablack,电气化学工业公司产品)4.5g、在NMP中溶解作为粘结剂的聚偏氟乙烯(KF聚合物W#1100,Kureha化学公司产品)6.0g而得的溶液用双臂式混合机进行搅拌,制作聚偏氟乙烯为6重量%的正极用浆料。将该正极用浆料涂布于作为正极集电体的厚度20μm的铝箔,将所得到的涂膜进行干燥、加压,制成具有正极活性物质层的正极。

[0122] (粘合性试验的方法)

[0123] 使上述制成的正极与负极介由隔膜进行接合,使电解液浸入其中,将该电池元件用真空封口机封入铝复合包装,制成试验电池。在此,电解液使用1M $LiPF_6$碳酸亚乙酯/碳酸甲乙酯(3/7重量比)。将该试验电池用热压机压制后,将电池拆解,测定剥离强度,评价粘合性。在2个压制条件下进行了试验,第一个条件(粘合性试验1)是在电极每1cm^2上施加20kg的荷重,温度为90℃,时间为2分钟。第二个条件(粘合性试验2)是在电极每1cm^2上施加20kg的荷重,温度为70℃,时间为2分。

[0124] 〔粘合性多孔层的结晶度与粘合性的关系〕

[0125] 对实施例1～4、比较例1～6进行上述粘合性试验。结果以在使用实施例1的隔膜的情况下的剥离强度设为100时的相对值在表2中示出。由表2可知,与电极的粘合性在正负极中均依存于聚偏氟乙烯系树脂的结晶度,该倾向在使用苯乙烯-丁二烯橡胶作为粘合树脂的负极侧特别显著。由该表2的结果可判断:聚偏氟乙烯系树脂的结晶度为35%

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以下时，与电极的粘合性良好。

[0126] 〔粘合性多孔层的结晶度与粘合后的离子透过性的关系〕

[0127] 对于各样品，为了评价粘合后的离子透过性，如下进行电池负荷特性试验。首先，按照与在上述“与电极的粘合性试验”中使用的电极同样的方法制作正极与负极。将引线极耳（lead tab）焊接在该正极与负极上，介由隔膜，使这些正负极接合，使电解液浸入，用真空封口机封入铝包装中。在此，电解液使用 1M $LiPF_6$ 碳酸亚乙酯 / 碳酸甲乙酯（3/7 重量比）。将其用热压机在电极每 $1cm^2$ 上施加 20kg 的荷重，进行 90℃、2 分钟的热压，制成试验电池。对于电池的负荷特性，在 25℃下测定以 0.2C 的放电容量为基准的 2C 的相对放电容量，将其作为粘合后的离子透过性的指标。

[0128] 对使用实施例 1 ～ 4、比较例 1 ～ 6 的隔膜的电池进行上述电池负荷特性试验，结果示于表 2 中。由表 2 的结果可知，在使用本发明的隔膜的情况下，即使在用热压机粘合电极与隔膜后，粘合性多孔层的多孔结构仍得到维持，可获得良好的负荷特性。即，上述结果表明：通过使聚偏氟乙烯系树脂多孔层的结晶度为 20 ～ 35%，与电极粘合后的离子透过性也变得良好。

[0129] 〔粘合性多孔层的结晶度与循环特性的关系〕

[0130] 对于各样品，如下进行电池循环试验。首先，按照与上述“与电极的粘合性试验”中使用的电极同样的方法，制作正极与负极。将引线极耳焊接在该正极与负极上，介由隔膜，使这些正负极接合，使电解液浸入，用真空封口机封入铝包装中。在此，电解液使用 1M $LiPF_6$ 碳酸亚乙酯 / 碳酸甲乙酯（3/7 重量比）。将其用热压机在电极每 $1cm^2$ 上施加 20kg 的荷重，进行 90℃、2 分钟的热压，制成试验电池。充电条件设为 1C、4.2V 的恒定电流恒定电压充电，放电条件设为 1C、2.75V 截止的恒定电流放电，实施电池循环试验。在此，循环特性的指标设为 100 个循环后的容量维持率。

[0131] 对使用实施例 1 ～ 4、比较例 1 ～ 6 的隔膜的电池进行上述电池循环试验。结果示于表 2。使用粘合性不充分的比较例 1 ～ 4 的隔膜的电池的循环特性与使用实施例 1 ～ 4 的隔膜的电池相比，显著地差。由此可知，从电池的循环寿命这样的观点出发，粘合性是重要的。比较例 5 的隔膜虽然粘合性良好，但是使用它的电池的循环特性不理想。这可能是由于该隔膜的 Gurley 值高、离子透过性不理想因而得不到充分的循环特性。Gurley 值变高是由于由聚偏氟乙烯系树脂构成的多孔层的多孔化不充分的缘故，得不到充分的多孔结构的原因是由于结晶度过小，从而在成型时难以维持其结构的缘故。

[0132] 〔聚偏氟乙烯系树脂重量与粘合性的关系〕

[0133] 对实施例 1 及 5 ～ 8 也实施与上述同样的电极的粘合性试验 1。结果以在使用实施例 1 的隔膜的情况下的剥离强度设为 100 时的相对值在表 3 中示出。表 3 结果表明：虽然结晶度没有影响，但聚偏氟乙烯系树脂的重量也对粘合性造成影响，确认了若单面的重量小于 $0.5g/m^2$，则粘合性存在下降的倾向。由此，从确保充分的粘合性的观点出发，单面的聚偏氟乙烯系树脂的重量更优选为 $0.5g/m^2$ 以上。

[0134] 〔聚偏氟乙烯系树脂重量与负荷特性的关系〕

[0135] 对实施例 1 及 5 ～ 8 进行上述电池负荷特性试验。将以 0.2C 放电容量为基准的 2C 的相对放电容量作为指标，将其结果示于表 3 中。确认了若聚偏氟乙烯系树脂重量变多，则放电性存在下降的倾向，这是由于由聚偏氟乙烯系树脂构成的多孔层导致电池的内部电

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阻增加的缘故。若单面的聚偏氟乙烯系树脂的重量大于 1.5g/m^2，则放电性的下降稍微变大，因此作为单面的聚偏氟乙烯系树脂的重量，特别优选在 1.5g/m^2 以下。

[0136] 〔聚偏氟乙烯系树脂在表面和背面的重量差与循环特性的关系〕

[0137] 对于使用实施例 1、9、10 的隔膜的电池，按照上述方法进行循环特性评价。将其结果示于表 4 中。由表 4 可知，若聚偏氟乙烯系树脂重量在表面和背面之差变大，则循环特性下降。这可能是由于粘合性、离子的移动性在表面和背面不同，因此，一重复循环，其对不均匀性的影响就会出现。另外，实施例 9、10 的隔膜存在稍微翘曲的倾向，还存在这样的力学应变也造成影响的可能性。从这样的观点出发，上述结果表明，聚偏氟乙烯系树脂重量在表面和背面之差在以 {| 表面的重量 - 背面的重量 |} / 总计重量 } × 100 为指标的情况下更优选在 20% 以下。

[0138] 〔耐热性评价〕

[0139] 将实施例 1 的隔膜与实施例 11 的隔膜耐热性通过热机械物性测定（TMA）进行比较。具体而言，将各个隔膜以宽度 4mm 切出并用夹具固定，使夹具间距离为 10mm。使施加荷重为 10mN，以升温速度 10℃ /min 使之升温，测定隔膜断裂时的温度。实施例 1 的隔膜被确认在 155℃断裂，而实施例 11 的隔膜被确认在 180℃断裂。由此可知，从耐热性的观点出发，优选使用含有聚丙烯的聚乙烯微多孔膜。

[0140] 〔电解液的种类与粘合性〕

[0141] 对于实施例 1 与比较例 1 ～ 6 的隔膜，使用各种电解液，与上述同样进行，实施与电极的粘合性试验 1。作为电解液 A，使用 1M $LiPF_6$ 碳酸亚乙酯 / 碳酸甲乙酯（3/7 重量比），作为电解液 B，使用 1M $LiPF_6$ 碳酸亚乙酯 / 碳酸亚丙酯 / 碳酸甲乙酯（3/2/5 重量比），作为电解液 C，使用 1M $LiPF_6$ 碳酸亚乙酯 / 碳酸亚丙酯（1/1 重量比）。结果示于表 5。表 5 中，以由实施例 1 的隔膜的在正极、负极各侧得到的剥离强度设为 100 时的剥离强度的相对值表示，对于正极与负极的剥离强度的平均值在 70 以上的，记为○，对于 50 以上且不足 70 的，记为△，不足 50 的记为 ×。

[0142] 表 1

[0143]

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	PVdF系树脂的结晶度（%）	膜厚（μm）	单位面积重量（g/m²）	空孔率（%）	PVdF系树脂的重量（g/m²）				Gurley值（秒/100cc）
					总计	表面	表面	表面背面差	
实施例1	30	12	7.5	40	2.0	1.0	1.0	0%	255
实施例2	31	12	7.5	41	2.0	1.0	1.0	0%	241
实施例3	33	12	7.5	41	2.0	1.0	1.0	0%	235
实施例4	29	12	7.5	41	2.0	1.0	1.0	0%	248
实施例5	30	11	6.3	41	0.8	0.4	0.4	0%	232
实施例6	30	11	6.7	41	1.2	0.6	0.6	0%	243
实施例7	30	12	8.3	40	2.8	1.4	1.4	0%	271
实施例8	30	13	8.7	40	3.2	1.6	1.6	0%	295
实施例9	30	12	7.7	40	2.2	1.3	0.9	18%	260
实施例10	30	12	7.7	40	2.2	1.6	0.6	45%	259
实施例11	30	14	9.6	35	2.0	1.0	1.0	0%	510
比较例1	41	14	7.5	51	2.0	1.0	1.0	0%	200
比较例2	43	14	7.5	52	2.0	1.0	1.0	0%	196
比较例3	46	14	7.5	49	2.0	1.0	1.0	0%	197
比较例4	40	14	7.5	52	2.0	1.0	1.0	0%	205
比较例5	5	11	7.5	38	2.0	1.0	1.0	0%	1000
比较例6	39	14	7.5	50	2.0	1.0	1.0	0%	211

[0144] 表 2

[0145]

	粘合性试验1		粘合性试验2		电极负荷特性试验	电池循环试验
	正极侧	负极侧	正极侧	负极侧		
实施例1	100	100	100	100	96%	97%
实施例2	98	97	99	98	95%	96%
实施例3	97	90	95	89	96%	95%
实施例4	102	105	100	100	96%	97%
比较例1	50	10	40	5	70%	73%
比较例2	44	8	35	1	63%	71%
比较例3	40	6	35	4	55%	71%
比较例4	60	12	58	10	66%	75%
比较例5	110	120	110	115	15%	50%
比较例6	61	15	60	12	65%	73%

[0146] 表 3

[0147]

	粘合性试验		电池负荷特性试验
	正极侧	负极侧	
实施例1	100	100	96%
实施例5	90	86	99%
实施例6	96	95	98%
实施例7	108	115	95%
实施例8	110	120	87%

[0148] 表 4

[0149]

	电池循环试验
实施例 1	97%

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实施例 9	97%
实施例 10	93%

[0150] 表 5

[0151]

	粘合性		
	电解液A	电解液B	电解液C
实施例1	○	○	○
比较例1	×	△	○
比较例2	×	×	○
比较例3	×	×	○
比较例4	×	△	○
比较例5	○	○	○
比较例6	×	△	○

[0152] 产业上的可利用性

[0153] 本发明的非水系二次电池隔膜可适用于非水系二次电池，特别适于与电极的接合重要的铝复合外包装的非水系二次电池。

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APPLICATION NUMBER	FILING OR 371(C) DATE	FIRST NAMED APPLICANT	ATTY. DOCKET NO./TITLE
16/013,887	06/20/2018	Jianjian Yi	DEHE-1806-USPT

CONFIRMATION NO. 3106

129752
BYIP
9622 Landmark Place
Frisco, TX 75035

PUBLICATION NOTICE



Title:SEPARATOR AND ENERGY STORAGE DEVICE

Publication No.US-2019-0319243-A1
Publication Date:10/17/2019

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.

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www.uspto.gov

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
16/013,887	06/20/2018	Jianjian Yi	DEHE-1806-USPT	3106

129752 7590 11/07/2019

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EXAMINER
CHMIELECKI, SCOTT J

ART UNIT	PAPER NUMBER
1729	

NOTIFICATION DATE	DELIVERY MODE
11/07/2019	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):

charles_ho@barron-young.com
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cho@barron-young.com

Office Action Summary	**Application No.** 16/013,887	**Applicant(s)** Yi et al.	
	Examiner SCOTT J CHMIELECKI	**Art Unit** 1729	**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 20 June 2018.

☐ 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) 1-17 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) 1-17 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

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

1. Restriction to one of the following inventions is required under 35 U.S.C. § 121:

I. Claims 1-10, drawn to a separator, classified in H01M 2/1686.

II. Claims 11-17, drawn to a method of making a separator, classified in H01M 2/145.

2. The inventions are independent or distinct, each from the other because:

Inventions Group II and Group I are related as process of making and product made. The inventions are distinct if either or both of the following can be shown: (1) that the process as claimed can be used to make another and materially different product or (2) that the product as claimed can be made by another and materially different process (MPEP § 806.05(f)). In the instant case the process as claimed can be used to make a catalytic layer comprising inorganic particles suspended in a film.

3. Restriction for examination purposes as indicated is proper because all the inventions listed in this action are independent or distinct for the reasons given above and there would be a serious search and/or examination burden if restriction were not required because one or more of the following reasons apply:

a) each Group possesses a separate classification as set forth above; and

b) each Group requires a separate field of search to find relevant prior art (see MPEP § 808.02).

Applicant is advised that the reply to this requirement to be complete must

include (i) an election of an invention to be examined even though the requirement may be traversed (37 CFR 1.143) **and (ii) identification of the claims encompassing the elected invention**.

The election of an invention may be made with or without traverse. To reserve a right to petition, the election must be made with traverse. If the reply does not distinctly and specifically point out supposed errors in the restriction requirement, the election shall be treated as an election without traverse. Traversal must be presented at the time of election in order to be considered timely. Failure to timely traverse the requirement will result in the loss of right to petition under 37 CFR 1.144. If claims are added after the election, applicant must indicate which of these claims are readable upon the elected invention.

Should applicant traverse on the ground that the inventions are not patentably distinct, applicant should submit evidence or identify such evidence now of record showing the inventions to be obvious variants or clearly admit on the record that this is the case. In either instance, if the examiner finds one of the inventions unpatentable over the prior art, the evidence or admission may be used in a rejection under 35 U.S.C. § 103 or pre-AIA 35 U.S.C. § 103(a) of the other invention.

4. 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).

5. 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).

Conclusion

Any inquiry concerning this communication or earlier communications from the examiner should be directed to SCOTT J CHMIELECKI whose telephone number is (571)270-5591. The examiner can normally be reached on M-F 8:30 am to 5 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, Ula Ruddock can be reached on 5712721481. 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 http://pair-direct.uspto.gov. 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.

/SCOTT J. CHMIELECKI/
Primary Examiner, Art Unit 1729

Electronic Acknowledgement Receipt	
EFS ID:	38191730
Application Number:	16013887
International Application Number:	
Confirmation Number:	3106
Title of Invention:	SEPARATOR AND ENERGY STORAGE DEVICE
First Named Inventor/Applicant Name:	Jianjian Yi
Customer Number:	129752
Filer:	Charles S. Ho/Ethan Huang
Filer Authorized By:	Charles S. Ho
Attorney Docket Number:	DEHE-1806-USPT
Receipt Date:	03-JAN-2020
Filing Date:	20-JUN-2018
Time Stamp:	02:44:16
Application Type:	Utility under 35 USC 111(a)

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	Response_to_restriction_OA_DEHE-1806-USPT.PDF	113051 3101c755282ad56ac29416a5d2660aecc84d4189	no	6
Warnings:					

Information:	
Total Files Size (in bytes):	113051

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.

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Application of: NINGDE AMPEREX TECHNOLOGY LIMITED
Application No.: 16/013,887

Filing Date: June 20, 2018

Entitled: SEPARATOR AND ENERGY STORAGE DEVICE

RESPONSE TO RESTRICTION REQUIREMENT

This paper is submitted in response to the Restriction Requirement mailed on November 7, 2019.

Listing of Claims begin on page **2** of this paper.

Remarks begin on page **6** of this paper.

Listing of Claims

This listing of claims will replace all prior versions, and listings, of claims in the application:

1. (Original)A separator, comprising:

a porous substrate; and

a porous layer arranged on a surface of the porous substrate, wherein the porous layer comprises inorganic particles and a binder, and a ratio of Dv90 of the inorganic particles to the thickness of the porous layer is in a range from 0.3 to 3.0.

2. (Original)The separator according to claim 1, wherein the porous layer has a thickness of 0.2 μm to 10 μm.

3. (Original)The separator according to claim 1, wherein the porous layer has pores formed by the binder, and the pores at least comprises a part of the inorganic particles.

4. (Original)The separator according to claim 3, wherein the pores have an average pore size of 0.3 μm to 20 μm.

5. (Original)The separator according to claim 1, wherein a volume ratio of the inorganic particles to the binder is in a range from 0.2 to 3.0.

6. (Original)The separator according to claim 1, wherein the porous layer has a porosity of 20% to 90%.

CosMX Exhibit 1002, Page 171 of 334

7. (Original)The separator according to claim 1, wherein the inorganic particles are one or more selected from the group consisting of alumina, silica, magnesia, titanium oxide, hafnium dioxide, tin oxide, zirconia, cerium dioxide, nickel oxide, zinc oxide, calcium oxide, boehmite, aluminum hydroxide, magnesium hydroxide, calcium hydroxide, and barium sulfate.

8. (Original)The separator according to claim 1, wherein the binder is one or more selected from the group consisting of polyvinylidene fluoride, vinylidene fluoride-hexafluoropropylene copolymer, polyamide, polyacrylonitrile, polyacrylate, polyacrylic acid, polyacrylates, sodium carboxymethylcellulose, polyvinylpyrrolidone, polyvinyl ether, polymethyl methacrylate, polytetrafluoroethylene and polyhexafluoropropylene.

9. (Original)An energy storage device, comprising the separator according to claim 1.

10. (Original)The energy storage device according to claim 9, wherein the energy storage device is a lithium-ion battery.

11. (withdrawn)A method for preparing a separator, wherein the method comprises steps of:

mixing inorganic particles with a binder to generate a mixture;

adding a first solvent into the mixture;

stirring the mixture with the first solvent to obtain a uniform coating solution;

coating the uniform coating solution onto a surface of a porous substrate to form a wet film;

immersing the wet film into a coagulating solution for phase transformation; and drying the phase-transformed wet film to obtain the separator.

12. (withdrawn)The method according to claim 11, wherein the solid content in the coating solution is in a range from 7% to 25%.

13. (withdrawn)The method according to claim 11, wherein the coagulating solution comprises a second solvent and a third solvent, and the second solvent has a mass percentage of 20% to 60%.

14. (withdrawn)The method according to claim 11, wherein the first solvent is one or more independently selected from the group consisting of N-methylpyrrolidone , dimethylacetamide and dimethylformamide.

15. (withdrawn)The method according to claim 11, wherein the porous substrate comprises a polymer film, a multilayer polymer film, or a non-woven fabric formed by any one or more of the following polymers: polyethylene, polypropylene, polyethylene terephthalate, polyphthaloyl diamine, polybutylene terephthalate, polyester, polyacetal, polyamide, polyimide, polyetheretherketone , polyaryletherketone, polyetherimide, polyamide imide, polybenzimidazole, polyethersulfone, polyphenylene oxide, cycloolefin copolymer, polyphenylene sulfide, and polyethylene naphthalene.

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16. (withdrawn)The method according to claim 15, wherein the polyethylene is at least one selected from the group consisting of high density polyethylene, low density polyethylene, and ultrahigh molecular weight polyethylene.

17. (withdrawn)The method according to claim 13, wherein the second solvent is one or more independently selected from the group consisting of N-methylpyrrolidone, dimethylacetamide and dimethylformamide, and the third solvent is one or more selected from the group consisting of deionized water, ethanol, propanol, acetone, dimethyl carbonate and diethyl carbonate.

CosMX Exhibit 1002, Page 174 of 334

REMARKS

Claims 1-17 were originally filed in the present application, of which claims 11-17 have been withdraw without prejudice or disclaimer. Consideration and allowance of pending claims 1-10 is respectfully requested.

The Examiner has identified two inventions for restriction:

I. Claims 1-10, drawn to a separator, classified in H01M 2/1686.

II. Claims 11-17, drawn to a method of making a separator, classified in H01M 2/145.

Applicants provisionally elect, without traverse, Group I, which includes claims 1-10.

Applicant respectfully requests an early action on the merits.

Respectfully submitted,

Dated: Jan. 3, 2020

By: /charles ho/

Charles S. Ho, Reg. No. 51807

Charles_ho@barron-young.com

PTO/SB/06 (09-11)
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PATENT APPLICATION FEE DETERMINATION RECORD Substitute for Form PTO-875	Application or Docket Number 16/013,887	Filing Date 06/20/2018	☐ To be Mailed

ENTITY: ☑ LARGE ☐ SMALL ☐ MICRO

APPLICATION AS FILED - PART I

FOR	(Column 1) NUMBER FILED	(Column 2) 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

AMENDMENT	01/03/2020	(Column 1) CLAIMS REMAINING AFTER AMENDMENT		(Column 2) HIGHEST NUMBER PREVIOUSLY PAID FOR	(Column 3) PRESENT EXTRA		RATE ($)	ADDITIONAL FEE ($)
	Total (37 CFR 1.16(i))	* 17	Minus	** 20	= 0		x $100 =	0
	Independent (37 CFR 1.16(h))	* 2	Minus	*** 3	= 0		x $460 =	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

AMENDMENT		(Column 1) CLAIMS REMAINING AFTER AMENDMENT		(Column 2) HIGHEST NUMBER PREVIOUSLY PAID FOR	(Column 3) 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".	/SUSAN A HAY/
*** 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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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
16/013,887	06/20/2018	Jianjian Yi	DEHE-1806-USPT	3106

129752 7590 01/15/2020

BYIP LTD.
5700 Granite Parkway, Suite 200
Plano, TX 75024

EXAMINER
CHMIELECKI, SCOTT J

ART UNIT	PAPER NUMBER
1729	

NOTIFICATION DATE	DELIVERY MODE
01/15/2020	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):

charles_ho@barron-young.com
charlesho@barron-young.com
cho@barron-young.com

Office Action Summary	**Application No.** 16/013,887	**Applicant(s)** Yi et al.	
	Examiner SCOTT J CHMIELECKI	**Art Unit** 1729	**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 3 January 2020.

☐ 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) 1-17 is/are pending in the application.

5a) Of the above claim(s) 11-17 is/are withdrawn from consideration.

6) ☐ Claim(s) _____ is/are allowed.

7) ☑ Claim(s) 1-10 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 20 June 2018 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 07/16/2018; 08/05/2019.

3) ☐ Interview Summary (PTO-413) Paper No(s)/Mail Date _____.

4) ☐ Other: _____.

DETAILED ACTION

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/Restrictions

1. Applicant's election without traverse of Group I, claims 1-10, in the reply filed on January 3, 2020 is acknowledged. Claims 11-17 are withdrawn from further consideration pursuant to 37 CFR 1.142(b) as being drawn to a nonelected Group, there being no allowable generic or linking claim.

Claim Rejections - 35 USC § 103

2. In the event the determination of the status of the application as subject to AIA 35 U.S.C. §§ 102 and 103 (or as subject to pre-AIA 35 U.S.C. §§ 102 and 103) is incorrect, any correction of the statutory basis for the rejection will not be considered a new ground of rejection if the prior art relied upon, and the rationale supporting the rejection, would be the same under either status.

3. The following is a quotation of 35 U.S.C. § 103 which forms the basis for all obviousness rejections set forth in this Office action:

> A patent for a claimed invention may not be obtained, notwithstanding that the claimed invention is not identically disclosed as set forth in section 102, if the differences between the claimed invention and the prior art are such that the claimed invention as a whole would have been obvious before the effective filing date of the claimed invention to a person having ordinary skill in the art to which the claimed invention pertains. Patentability shall not be negated by the manner in which the invention was made.

4. Claims 1-10 are rejected under 35 U.S.C. § 103 as being unpatentable over Nam et al (US 2019/0355953 A1), hereinafter "Nam," in view of Shimura et al (US 2019/0123319 A1), hereinafter "Shimura."

5. Regarding claim 1, Nam teaches a separator comprising:

a porous substrate, in this case the porous polyolefin substrate (¶ 0026);

a porous layer arranged on a surface of the porous substrate comprising inorganic particles and a binder, in this case the organic-inorganic hybrid porous coating layer (¶ 0026).

Nam does not teach the ratio of the inorganic particles' Dv90 value to the porous layer's thickness. However, Shimura teaches a separator comprising inorganic particles and a binder wherein the inorganic particle size may be adjusted to provide appropriate Gurley and porosity values (¶ 0028). One with ordinary skill in the art would realize that Dv90 is dependent on particle size and adjusting the ratio of the inorganic particles Dv90 value to the porous layer's thickness to be 0.3 to 3.0 would ensure that the separator possessed the appropriate Gurley and porosity values (see ¶ 0028), thereby facilitating improved separator performance. Therefore, it would have been obvious to have made the Dv90 to thickness ratio to be 0.3 to 3.0 in order to facilitate improved separator performance.

6. Regarding claim 2, Nam further teaches that the porous layer's thickness is 0.2 μm to 10 μm, in this case the coating thickness is 3 μm (¶ 0057).

7. Regarding claim 3, Nam further teaches that the porous layer has pores formed by the binder and comprise at least a part of the inorganic particle, in this case the porous structure is formed due to the interstitial volume between the inorganic particles and the binder (¶ 0027) which results in the claimed structure.

8. Regarding claim 4, Nam further teaches that the average pore size is 0.3 μm to 20 μm, in this case 0.5 μm (¶ 0057).

9. Regarding claim 5, Nam does not teach the volume ratio of the inorganic particles to that of the binder. However, Shimura teaches that the volume % of the inorganic particles in the binder is 2 vol % to 40 % or less (¶ 0027), which overlaps with the claimed ratio of 0.2 to 3.0. One with ordinary skill in the art would realize that making the volume ratio of inorganic particles to binder to be 0.2 to 3.0 would yield a separator with the desired heat resistance and short circuit prevention (see ¶ 0005), thereby facilitating improved separator performance and safety. Therefore, it would have been obvious to have mad the volume ratio of inorganic particles to binder to be 0.2 to 3.0 in order to facilitate improved separator performance and safety.

10. Regarding claim 6, Nam further teaches that the porous layer's porosity is 20% to 90%, in this case 45% (¶ 0057).

11. Regarding claim 7, Nam further teaches that the inorganic particles are selected from alumina, titanium oxide, zinc oxide, calcium oxide, nickel oxide, and others (¶ 0030).

12. Regarding claim 8, Nam further teaches that the binder is selected from polyvinylidene fluoride hexafluoropropylene copolymer, polyacrylonitrile, polyvinylpyrrolidone, and others (¶ 0028 & 0049).

13. Regarding claim 9, Nam further teaches an energy storage device comprising the separator, in this case a lithium secondary battery (¶ 0012 & 0029).

14. Regarding claim 10, Nam further teaches that the energy storage device is a lithium-ion battery, in this case a lithium secondary battery. (¶ 0012 & 0029).

Conclusion

Any inquiry concerning this communication or earlier communications from the

examiner should be directed to SCOTT J CHMIELECKI whose telephone number is (571)270-5591. The examiner can normally be reached on M-F 8:30 am to 5 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, Ula Ruddock can be reached on 5712721481. 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.

/SCOTT J. CHMIELECKI/
Primary Examiner, Art Unit 1729

Notice of References Cited	Application/Control No. 16/013,887	Applicant(s)/Patent Under Reexamination Yi et al.	
	Examiner SCOTT J CHMIELECKI	Art Unit 1729	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-20190355953-A1	11-2019	NAM; Kwan Woo	H01M2/1686	1/1
*	B	US-20190123319-A1	04-2019	SHIMURA; Kenichi	H01M2/16	1/1
	C					
	D					
	E					
	F					
	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
	16/013,887	Yi et al.
	Examiner	Art Unit
	SCOTT J CHMIELECKI	1729

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
Reviewed IDS documents, performed EAST text search for relevant prior art, & conducted Google Scholar search for relevant prior art; conducted inventor & assignee search.	01/08/2020	SJC

Interference Search			
US Class/CPC Symbol	US Subclass/CPC Group	Date	Examiner

/SCOTT J. CHMIELECKI/ Primary Examiner, Art Unit 1729	

Index of Claims	Application/Control No.	Applicant(s)/Patent Under Reexamination
	16/013,887	Yi et al.
	Examiner	Art Unit
	SCOTT J CHMIELECKI	1729

✓	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	11/07/2019	01/08/2020							
	1	÷	✓							
	2	÷	✓							
	3	÷	✓							
	4	÷	✓							
	5	÷	✓							
	6	÷	✓							
	7	÷	✓							
	8	÷	✓							
	9	÷	✓							
	10	÷	✓							
	11	÷	N							
	12	÷	N							
	13	÷	N							
	14	÷	N							
	15	÷	N							
	16	÷	N							
	17	÷	N							

EAST Search History

EAST Search History (Prior Art)

Ref #	Hits	Search Query	DBs	Default Operator	Plurals	Time Stamp
L1	245	separator WITH binder WITH inorganic ADJ particle AND inorganic ADJ particle SAME (alumina silica magnesia (titanium hafnium tin zirconia nickel zinc calcium) ADJ oxide cerium ADJ dioxide boehmite (aluminum magnesium calcium) ADJ hydroxide barium ADJ sulfate) AND binder SAME (polyvinylidene ADJ fluoride pvdf vinylidene ADJ fluoride ADJ hexafluoroproyplene polyamide polyacrylonitrile polyacrylate polyacrylic ADJ acid sodium ADJ carboxymethylcellulose polyvinylpyrrolidone polyvinyl ADJ ether polymethyl ADJ methacrylate polytetrafluoroethylene ptfe polyhexafluoropropylene)	US-PGPUB; USPAT	OR	ON	2020/01/08 17:46
L2	166	L1 AND porous ADJ (substrate layer film base)	US-PGPUB; USPAT	OR	ON	2020/01/08 17:47
L3	3	L2 AND "dv90"	US-PGPUB; USPAT	OR	ON	2020/01/08 18:22
L5	0	L1 AND "dv90" NOT L3	US-PGPUB; USPAT	OR	ON	2020/01/08 18:23
L6	0	separator WITH binder WITH inorganic ADJ particle AND inorganic ADJ particle SAME (alumina silica magnesia (titanium hafnium tin zirconia nickel zinc calcium) ADJ oxide cerium ADJ dioxide boehmite (aluminum magnesium calcium) ADJ hydroxide barium ADJ sulfate) AND binder SAME (polyvinylidene ADJ fluoride pvdf vinylidene ADJ fluoride ADJ hexafluoroproyplene polyamide polyacrylonitrile polyacrylate polyacrylic ADJ acid sodium ADJ carboxymethylcellulose polyvinylpyrrolidone polyvinyl ADJ ether polymethyl ADJ methacrylate polytetrafluoroethylene ptfe polyhexafluoropropylene)	FPRS; EPO; JPO	OR	ON	2020/01/08 18:31
L7	1	separator WITH binder WITH inorganic ADJ particle AND "dv90"	FPRS; EPO; JPO	OR	ON	2020/01/08 18:32
L8	3	separator WITH binder WITH inorganic ADJ particle AND "dv90"	US-PGPUB; USPAT	OR	ON	2020/01/08 18:32
L9	127	L2 AND particle ADJ size	US-PGPUB; USPAT	OR	ON	2020/01/08 18:39
L10	100	L2 AND particle ADJ size WITH inorganic	US-PGPUB; USPAT	OR	ON	2020/01/08 18:40
L11	1	(ningde ADJ amperex.AS. (yi zhang wei	US-	OR	ON	2020/01/08

		tao).IN.) AND (inorganic ADJ particle WITH porous ADJ substrate WITH porous ADJ layer WITH "dv90").CLM.	PGPUB; USPAT			20:08

EAST Search History (Interference)

< This search history is empty>

1/ 8/ 2020 8:09:16 PM
C:\ Users\ schmielecki\ Documents\ EAST\ Workspaces\ 16\ 013887.wsp

Doc code: IDS
Doc description: Information Disclosure Statement (IDS) Filed

PTO/SB/08a (02-18)
Approved for use through 11/30/2020. 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	16013887
Filing Date	2018-06-20
First Named Inventor	Jianjian Yi
Art Unit	1729
Examiner Name	Chmielecki, Scott J.
Attorney Docket Number	DEHE-1806-USPT

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
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Examiner Initial*	Cite No	Foreign Document Number[3]	Country Code[2] i	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]
/S.J.C./	1	1882436	CN	A	2006-12-20	Tonen Sekiyukagaku KK		☓
/S.J.C./	2	103155217	CN	A	2013-06-12	Teijin Limited		☒

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	First Named Inventor	Jianjian Yi
	Art Unit	1729
	Examiner Name	Chmielecki, Scott J.
	Attorney Docket Number	DEHE-1806-USPT

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		

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Examiner Signature	/SCOTT J. CHMIELECKI/	Date Considered	01/08/2020

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[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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	Art Unit	1729
	Examiner Name	Chmielecki, Scott J.
	Attorney Docket Number	DEHE-1806-USPT

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	/Charles Ho/	Date (YYYY-MM-DD)	2019-08-05
Name/Print	Charles Ho	Registration Number	51,807

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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.

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Bibliographic Data

Application No: 16/013,887

Foreign Priority claimed: (•) Yes ( ) No

35 USC 119 (a-d) conditions met: [✓] Yes [ ] No [ ] Met After Allowance

Verified and Acknowledged: /SCOTT J. CHMIELECKI/ Examiner's Signature [ ] Initials

Title: SEPARATOR AND ENERGY STORAGE DEVICE

FILING or 371(c) DATE	CLASS	GROUP ART UNIT	ATTORNEY DOCKET NO.
06/20/2018	429	1729	DEHE-1806-USPT
RULE			

APPLICANTS

Ningde Amperex Technology Limited, Ningde, CHINA

INVENTORS

Jianjian Yi Ningde, CHINA

Xinzhi Zhang Ningde, CHINA

Zengbin Wei Ningde, CHINA

Xinghua Tao Ningde, CHINA

CONTINUING DATA

FOREIGN APPLICATIONS

CHINA 201810321779.5 04/11/2018

IF REQUIRED, FOREIGN LICENSE GRANTED**

07/09/2018

STATE OR COUNTRY

CHINA

ADDRESS

BYIP LTD.
5700 Granite Parkway, Suite 200
Plano, TX 75024
UNITED STATES

FILING FEE RECEIVED

$1,720

Doc code: IDS
Doc description: Information Disclosure Statement (IDS) Filed

PTO/SB/08a (02-18)
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Application Number	16013887
Filing Date	2018-06-20
First Named Inventor	Jianjian Yi
Art Unit	1726
Examiner Name	Not Yet Assigned
Attorney Docket Number	DEHE-1806-USPT

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/S.J.C./	1	103474602	CN	A	2013-12-25	Shenzhen Taibai Technology Co., Ltd		☒
/S.J.C./	2	205004376	CN	U	2016-01-27	Shenzhen Hongtai Battery Technology Co., Ltd		☒

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	Examiner Name	Not Yet Assigned
	Attorney Docket Number	DEHE-1806-USPT

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]
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Signature	/Charles Ho/	Date (YYYY-MM-DD)	2018-07-13
Name/Print	Charles Ho	Registration Number	51,807

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Electronic Acknowledgement Receipt	
EFS ID:	39120604
Application Number:	16013887
International Application Number:	
Confirmation Number:	3106
Title of Invention:	SEPARATOR AND ENERGY STORAGE DEVICE
First Named Inventor/Applicant Name:	Jianjian Yi
Customer Number:	129752
Filer:	Charles S. Ho/Ethan Huang
Filer Authorized By:	Charles S. Ho
Attorney Docket Number:	DEHE-1806-USPT
Receipt Date:	10-APR-2020
Filing Date:	20-JUN-2018
Time Stamp:	10:03:48
Application Type:	Utility under 35 USC 111(a)

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	Amendment/Req. Reconsideration-After Non-Final Reject	Response_to_nonfinal_OA_DEHE-1806-USPT.PDF	110396 f2181f31ecd9159139a95972e78d52da280df380	no	4
Warnings:					

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IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Application of: Jianjian Yi

Application No.:16/013,887

Filing Date: June 20, 2018

Entitled: SEPARATOR AND ENERGY STORAGE DEVICE

Attorney Docket No.: DEHE-1806-USPT

RESPONSE TO NON-FINAL OFFICE ACTION

Dear Sir:

The present paper is being submitted in response to the Non-Final Office Action mailed January 15, 2020.

Remarks begin on page 2 of this paper.

CosMX Exhibit 1002, Page 199 of 334

Remarks

Claims 1-17 are pending in the present application, of which claims 11-17 are withdrawn from consideration. By this paper, no claims are amended. Applicant respectfully requests reconsideration of the pending claims in view of the following remarks.

Rejection Under 35 U.S.C. §103

Claims 1-10 are rejected under 35 U.S.C. 103 as being unpatentable over Nam *et al.* (US2019/0355953A1, hereafter "Nam"), in view of Shimura *et al.*(US2019/0123319A1, hereafter "Shimura").

Applicants respectfully disagrees for the below reasons.

Claim1 recites:

> [a] a ratio of Dv90 of the inorganic particles to the thickness of the porous layer arranged on a surface of the porous substrate is in a range from 0.3 to 3.0.

The examiner deems that Nam dose not disclose or teach "ratio of Dv90 of the inorganic particles to the thickness of the porous layer", but Shimura teaches. Applicant respectfully disagrees.

Firstly, the Shimura's separator comprising: "**a base material resin having voids**; and an inorganic particle having a surface (A) facing the void and a surface (B) in contact with the resin, wherein the length of the surface (A) is 50% or more of the length of the outer periphery of the particle in a cross-sectional SEM photograph of the separator (*see claim1 and para.0018*)". Thus, in Shimura, the separator comprises **"the base material resin" having void**, *NOT* "***the porous layer***" *arranged on a surface of "the base material resin"* which is a different matter, this is because there is no porous layer at all. Based on this, it is impossible for Shimura to think that a porous layer having voids is disposed on the base material. Furthermore, it is also impossible for Shimura to think of the correlation between Dv90 of the inorganic ions and the thickness of the

porous layer. Thus, Shimura fails to disclose the porous layer which the office action relied on to anticipate the original claims 1. Therefore, Shimura fails to disclose or teach "a ratio of Dv90 of the inorganic particles to the thickness of the porous layer arranged on a surface of the porous substrate is in a range from 0.3 to 3.0" as recited in claim 1.

Secondly, even though Shimura disclosed that the inorganic particle size can be adjusted to adjust the porosity (see para.0028) and air-permeability (see para.0036), the relationship between Dv90 and the thickness of the porous layer is not easy for those skilled in the art to conceived. The specific reasons are as follows:

i) As can be seen from the para.0028 of Shimura "…*the particle size of the inorganic particles is not particularly limited…the particle size may be adjusted such that separator characteristics, such as Gurley value and porosity, become appropriate values…*", so the inorganic particle size is adjusted to affect the size of the pores formed between the inorganic particles, thereby affecting the porosity and air-permeability of the separator in Shimura. However, the feature "ratio of Dv90 of the inorganic particles to the thickness of the porous layer" recited in claim 1 is used to make the separator and the electrode have excellent adhesion, to ensure that the battery has good safety performances, which is different from the porosity and air-permeability.

ii) There are many parameters that represent the inorganic particle size, such as Dv10, Dv50, Dv99, etc. Generally, it is more preferred to use Dv50, which is the average particle size, to more truly reflect the overall situation of inorganic particle distribution for those skilled in the art, such as "the mode diameter" disclosed by Shimura, represents the diameter of the largest proportion of particles, and its physical meaning is close to the average particle size. Therefore, even if the relationship between the size of the inorganic particles and the thickness of the porous layer is conceived, the ratio of the average particle size of the inorganic particles to the thickness of the porous layer can be only considered by those skilled in the art, but not the relationship between the Dv90 of inorganic particles and the thickness of the porous layer.

Based on the above, it is nonobvious for one with ordinary skill in the art to have the feature "a ratio of Dv90 of the inorganic particles to the thickness of the porous layer arranged on a surface of the porous substrate is in a range from 0.3 to 3.0" as recited in claim 1.

In summary, applicant respectfully submits that the cited references, either individually or in combination, fail to disclose or teach the features "a ratio of Dv90 of the inorganic particles to the thickness of the porous layer arranged on a surface of the porous substrate is in a range from 0.3 to 3.0" as recited in claim 1.

Accordingly, for at least the above reason, withdrawal of the rejection of claim 1 is respectfully requested. Claims 2-8 which depend upon claim 1 are patentably distinct over the cited prior art due to their dependence upon claim1 and also due to their own limitations.

Claim 9 recites an energy storage device, comprising the separator according to claim 1, thus also patentable. Similarly Claim 10, which depend upon claim 9 are patentably distinct over the cited prior art due to their dependence upon claim 9 and also due to their own limitations.

Conclusion:

For at least the above reasons, the claims currently under consideration are believed to be in condition for allowance. While this response sets forth arguments against certain made by the office action, Applicant does not concede to the validity of other allegations not argued in this response.

The Commissioner is hereby authorized to charge any additional fees which may be required, or credit any overpayment to Deposit Account No. 50-5658.

Respectfully submitted,

Dated: April 10, 2020

By: /charles ho/

Charles S. Ho, Reg. No. 51807
Charles_ho@barron-young.com

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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
16/013,887	06/20/2018	Jianjian Yi	DEHE-1806-USPT	3106

129752 7590 04/20/2020

BYIP LTD.
5700 Granite Parkway, Suite 200
Plano, TX 75024

EXAMINER
CHMIELECKI, SCOTT J

ART UNIT	PAPER NUMBER
1729	

NOTIFICATION DATE	DELIVERY MODE
04/20/2020	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):

charles_ho@barron-young.com
charlesho@barron-young.com
cho@barron-young.com

Office Action Summary	**Application No.** 16/013,887	**Applicant(s)** Yi et al.	
	Examiner SCOTT J CHMIELECKI	**Art Unit** 1729	**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 10 April 2020.

☐ 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) 1-17 is/are pending in the application.

5a) Of the above claim(s) 11-17 is/are withdrawn from consideration.

6) ☐ Claim(s) _____ is/are allowed.

7) ☑ Claim(s) 1-10 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 20 June 2018 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

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. The text of those sections of Title 35, U.S. Code not included in this action can be found in a prior Office action.

Claim Rejections - 35 USC § 103

1. The rejection of claims 1-10 under 35 U.S.C. § 103 as being unpatentable over Nam et al (US 2019/0355953 A1), hereinafter "Nam," in view of Shimura et al (US 2019/0123319 A1), hereinafter "Shimura," is maintained as set forth below.

2. Regarding claim 1, Nam teaches a separator comprising:

a porous substrate, in this case the porous polyolefin substrate (¶ 0026);

a porous layer arranged on a surface of the porous substrate comprising inorganic particles and a binder, in this case the organic-inorganic hybrid porous coating layer (¶ 0026).

Nam does not teach the ratio of the inorganic particles' Dv90 value to the porous layer's thickness. However, Shimura teaches a separator comprising inorganic particles and a binder wherein the inorganic particle size may be adjusted to provide appropriate Gurley and porosity values (¶ 0028). One with ordinary skill in the art would realize that Dv90 is dependent on particle size and adjusting the ratio of the inorganic particles Dv90 value to the porous layer's thickness to be 0.3 to 3.0 would ensure that the separator possessed the appropriate Gurley and porosity values (see ¶ 0028), thereby facilitating improved separator performance. Therefore, it would have been obvious to have made the Dv90 to thickness ratio to be 0.3 to 3.0 in order to facilitate improved

separator performance.

3. Regarding claim 2, Nam further teaches that the porous layer's thickness is 0.2 μm to 10 μm, in this case the coating thickness is 3 μm (¶ 0057).

4. Regarding claim 3, Nam further teaches that the porous layer has pores formed by the binder and comprise at least a part of the inorganic particle, in this case the porous structure is formed due to the interstitial volume between the inorganic particles and the binder (¶ 0027) which results in the claimed structure.

5. Regarding claim 4, Nam further teaches that the average pore size is 0.3 μm to 20 μm, in this case 0.5 μm (¶ 0057).

6. Regarding claim 5, Nam does not teach the volume ratio of the inorganic particles to that of the binder. However, Shimura teaches that the volume % of the inorganic particles in the binder is 2 vol % to 40 % or less (¶ 0027), which overlaps with the claimed ratio of 0.2 to 3.0. One with ordinary skill in the art would realize that making the volume ratio of inorganic particles to binder to be 0.2 to 3.0 would yield a separator with the desired heat resistance and short circuit prevention (see ¶ 0005), thereby facilitating improved separator performance and safety. Therefore, it would have been obvious to have mad the volume ratio of inorganic particles to binder to be 0.2 to 3.0 in order to facilitate improved separator performance and safety.

7. Regarding claim 6, Nam further teaches that the porous layer's porosity is 20% to 90%, in this case 45% (¶ 0057).

8. Regarding claim 7, Nam further teaches that the inorganic particles are selected from alumina, titanium oxide, zinc oxide, calcium oxide, nickel oxide, and others (¶ 0030).

9. Regarding claim 8, Nam further teaches that the binder is selected from polyvinylidene fluoride hexafluoropropylene copolymer, polyacrylonitrile, polyvinylpyrrolidone, and others (¶ 0028 & 0049).

10. Regarding claim 9, Nam further teaches an energy storage device comprising the separator, in this case a lithium secondary battery (¶ 0012 & 0029).

11. Regarding claim 10, Nam further teaches that the energy storage device is a lithium-ion battery, in this case a lithium secondary battery. (¶ 0012 & 0029).

Response to Arguments

12. Applicant's arguments filed April 10, 2020 have been fully considered but they are not persuasive. Applicant argues that the claimed apparatus is not taught by the cited prior art.

13. In response to applicant's arguments against the references individually, one cannot show nonobviousness by attacking references individually where the rejections are based on combinations of references (see *In re Keller*, 642 F.2d 413, 208 USPQ 871 (CCPA 1981); *In re Merck & Co.,* 800 F.2d 1091, 231 USPQ 375 (Fed. Cir. 1986)). Particularly, Applicant's argument that certain features are not taught by Shimura are unpersuasive because Nam teaches these features as discussed in the rejection of claims, above.

14. Applicant's arguments fail to comply with 37 CFR 1.111(b) because they amount to a general allegation that the claims define a patentable invention without specifically pointing out how the language of the claims patentably distinguishes them from the references. While Applicant is correct that neither reference explicitly recites the Dv90 value, Applicant fails to address Shimura's teaching that adjusting particle size results in

achieving desired Gurley and porosity values (see ¶ 0028). Again, since Dv90 is a description of particle size one with ordinary skill in the art would understand to adjust this value in order to obtain a separator with the appropriate Gurley and porosity values to ensure proper separator functionality. Furthermore, Applicant fails to provide any evidence or reasoning as to why the Dv90 value is significant or provides unexpected results. Therefore, Applicant's argument is unpersuasive.

Conclusion

THIS ACTION IS MADE FINAL. Applicant is reminded of the extension of time policy as set forth in 37 CFR 1.136(a).

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 mailing date of this final action.

Any inquiry concerning this communication or earlier communications from the examiner should be directed to SCOTT J CHMIELECKI whose telephone number is (571)270-5591. The examiner can normally be reached on M-F 8:30 am to 5 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, Ula Ruddock can be reached on 5712721481. 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.

/SCOTT J. CHMIELECKI/
Primary Examiner, Art Unit 1729

Search Notes	Application/Control No.	Applicant(s)/Patent Under Reexamination
	16/013,887	Yi et al.
	Examiner	Art Unit
	SCOTT J CHMIELECKI	1729

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
Reviewed IDS documents, performed EAST text search for relevant prior art, & conducted Google Scholar search for relevant prior art; conducted inventor & assignee search.	01/08/2020	SJC
Reviewed previous prior art search.	04/16/2020	SJC

Interference Search			
US Class/CPC Symbol	US Subclass/CPC Group	Date	Examiner

/SCOTT J. CHMIELECKI/ Primary Examiner, Art Unit 1729	

CosMX Exhibit 1002, Page 210 of 334

Index of Claims	Application/Control No.	Applicant(s)/Patent Under Reexamination
	16/013,887	Yi et al.
	Examiner	Art Unit
	SCOTT J CHMIELECKI	1729

✓	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	11/07/2019	01/08/2020	04/16/2020						
	1	÷	✓	✓						
	2	÷	✓	✓						
	3	÷	✓	✓						
	4	÷	✓	✓						
	5	÷	✓	✓						
	6	÷	✓	✓						
	7	÷	✓	✓						
	8	÷	✓	✓						
	9	÷	✓	✓						
	10	÷	✓	✓						
	11	÷	N	N						
	12	÷	N	N						
	13	÷	N	N						
	14	÷	N	N						
	15	÷	N	N						
	16	÷	N	N						
	17	÷	N	N						

CosMX Exhibit 1002, Page 211 of 334

Electronic Acknowledgement Receipt	
EFS ID:	39767965
Application Number:	16013887
International Application Number:	
Confirmation Number:	3106
Title of Invention:	SEPARATOR AND ENERGY STORAGE DEVICE
First Named Inventor/Applicant Name:	Jianjian Yi
Customer Number:	129752
Filer:	Charles S. Ho/Ethan Huang
Filer Authorized By:	Charles S. Ho
Attorney Docket Number:	DEHE-1806-USPT
Receipt Date:	19-JUN-2020
Filing Date:	20-JUN-2018
Time Stamp:	00:06:41
Application Type:	Utility under 35 USC 111(a)

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 After Final Action	Response_to_final_OA_DEHE-1806-USPT.PDF	248749 7817b71826c0aab29d4c9c2a4f88d1427aa4b2a2	no	7
Warnings:					

Information:	
Total Files Size (in bytes):	248749

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.

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Application of: NINGDE AMPEREX TECHNOLOGY LIMITED

Application No.:16/013,887

Filing Date: June 20, 2018

Entitled: SEPARATOR AND ENERGY STORAGE DEVICE

Attorney Docket No.: DEHE-1806-USPT

RESPONSE TO FINAL OFFICE ACTION MAILED APRIL 20, 2020

Dear Sir:

The present paper is being submitted in response to the Final Office Action mailed April 20, 2020.

Listing of Claims begins on page 2 of this paper.

Remarks begin on page 5 of this paper.

Amendments to the Claims:

This listing of claims will replace all prior versions, and listings, of claims in the application:

1. (Currently Amended) A separator, comprising:

a porous substrate; and

a porous layer arranged on a surface of the porous substrate, wherein the porous layer comprises inorganic particles and a binder, and a ratio of Dv90 of the inorganic particles to the thickness of the porous layer is in a range from 0.3 to 3.0,

wherein the porous layer has pores formed by the binder, and the pores at least comprises a part of the inorganic particles.

2. (Original) The separator according to claim 1, wherein the porous layer has a thickness of 0.2 μm to 10 μm.

3. (Canceled).

4. (Currently Amended) The separator according to claim [[3]] 1, wherein the pores have an average pore size of 0.3 μm to 20 μm.

5. (Original) The separator according to claim 1, wherein a volume ratio of the inorganic particles to the binder is in a range from 0.2 to 3.0.

6. (Original) The separator according to claim 1, wherein the porous layer has a porosity of 20% to 90%.

7. (Original) The separator according to claim 1, wherein the inorganic particles are one or more selected from the group consisting of alumina, silica, magnesia, titanium oxide, hafnium dioxide, tin oxide, zirconia, cerium dioxide, nickel oxide, zinc oxide, calcium oxide, boehmite, aluminum hydroxide, magnesium hydroxide, calcium hydroxide, and barium sulfate.

CosMX Exhibit 1002, Page 215 of 334

8. (Original) The separator according to claim 1, wherein the binder is one or more selected from the group consisting of polyvinylidene fluoride, vinylidene fluoride-hexafluoropropylene copolymer, polyamide, polyacrylonitrile, polyacrylate, polyacrylic acid, polyacrylates, sodium carboxymethylcellulose, polyvinylpyrrolidone, polyvinyl ether, polymethyl methacrylate, polytetrafluoroethylene and polyhexafluoropropylene.

9. (Original) An energy storage device, comprising the separator according to claim 1.

10. (Original) The energy storage device according to claim 9, wherein the energy storage device is a lithium-ion battery.

11. (withdrawn)A method for preparing a separator, wherein the method comprises steps of:

mixing inorganic particles with a binder to generate a mixture;

adding a first solvent into the mixture;

stirring the mixture with the first solvent to obtain a uniform coating solution;

coating the uniform coating solution onto a surface of a porous substrate to form a wet film;

immersing the wet film into a coagulating solution for phase transformation; and

drying the phase-transformed wet film to obtain the separator.

12. (withdrawn)The method according to claim 11, wherein the solid content in the coating solution is in a range from 7% to 25%.

13. (withdrawn)The method according to claim 11, wherein the coagulating solution comprises a second solvent and a third solvent, and the second solvent has a mass percentage of 20% to 60%.

14. (withdrawn)The method according to claim 11, wherein the first solvent is one or more independently selected from the group consisting of N-methylpyrrolidone, dimethylacetamide and dimethylformamide.

15. (withdrawn)The method according to claim 11, wherein the porous substrate comprises a polymer film, a multilayer polymer film, or a non-woven fabric formed by any one or more of the following polymers: polyethylene, polypropylene, polyethylene terephthalate, polyphthaloyl diamine, polybutylene terephthalate, polyester, polyacetal, polyamide, polyimide, polyetheretherketone , polyaryletherketone, polyetherimide, polyamide imide, polybenzimidazole, polyethersulfone, polyphenylene oxide, cycloolefin copolymer, polyphenylene sulfide, and polyethylene naphthalene.

16. (withdrawn)The method according to claim 15, wherein the polyethylene is at least one selected from the group consisting of high density polyethylene, low density polyethylene, and ultrahigh molecular weight polyethylene.

17. (withdrawn)The method according to claim 13, wherein the second solvent is one or more independently selected from the group consisting of N-methylpyrrolidone, dimethylacetamide and dimethylformamide, and the third solvent is one or more selected from the group consisting of deionized water, ethanol, propanol, acetone, dimethyl carbonate and diethyl carbonate.

Remarks

Claims 1-10 were previously pending in the present application. By this paper, claims 1 and 4 are amended without introducing new matter; claim 3 is canceled without prejudice or disclaimer. Applicant respectfully requests reconsideration of the pending claims in view of the above amendments and the following remarks.

Rejection Under 35 U.S.C. §103

Claims 1-10 are rejected under 35 U.S.C. 103 as being unpatentable over Nam *et al.* (US2019/0355953A1, hereafter "Nam"), in view of Shimura *et al.*(US2019/0123319A1, hereafter "Shimura").

Applicants respectfully disagrees for the below reasons.

Amended claim1 recites:

> [a] the porous layer has pores formed by the binder, and the pores at least comprises a part of the inorganic particles.

The examiner deems that Nam teaches "the porous layer has pores formed by the binder, and the pores at least comprises a part of the inorganic particles". Applicant respectfully disagrees.

In Nam, the battery separator, comprises: (a) a polyolefin-based substrate; and (b) an active layer comprising a mixture of inorganic particles and a binder, wherein the inorganic particles in the active layer are connected and fixed to each other by the binder, and a porous structure is formed due to an interstitial volume between the inorganic particles (see claim1 and para.0027). The figure is introduced as follows:

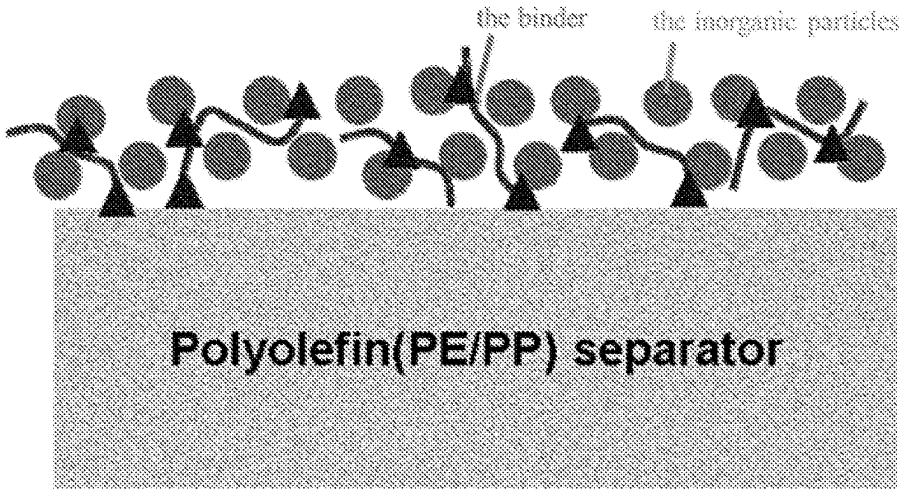


Fig.8 of Nam

As can been seen from the above and the para.0054, the binder according to the Nam is able to retain strong hydrogen bonding due to the —O/—OH group, in the above figure, the triangular shape denotes a hydroxyl group or a hydrophilic group, and the circle denotes inorganic particles. Thus, in Nam, **the binder is only used to connect and fix the inorganic particles in the active layer to each other, and the porous structure is formed by the inorganic particles**.

Based on this, in the case where Nam tends to form inorganic particles into a porous structure with a binder, it is impossible to have pores formed by the binder, and it is impossible to include inorganic particles in the pores formed by the binder. In comparison, current claim 1 discloses that the inorganic particles is located in the pores formed by the binder, which is quite different from Nam. Therefore, Nam is completely opposite to the technical feature "the porous layer has pores formed by the binder, and the pores at least comprises a part of the inorganic particles" as recited in claim 1.

In Shimura, the separator comprises: "**a base material resin having voids**; and an inorganic particle having a surface (A) facing the void and a surface (B) in contact with the resin (*see claim1 and para.0018*). However, Shimura fails to disclose or teach "the porous layer has pores formed by the binder, and the pores at least comprises a part of the inorganic particles" as recited in claim 1.

Based on the above, it is nonobvious for one with ordinary skill in the art to have the feature "the porous layer has pores formed by the binder, and the pores at least comprises a part of the inorganic particles" as recited in claim 1 on the basis of Nam and Shimura.

In summary, applicant respectfully submits that the cited references, either individually or in combination, fail to disclose or teach the features "the porous layer has pores formed by the binder, and the pores at least comprises a part of the inorganic particles" as recited in claim 1.

Accordingly, for at least the above reason, withdrawal of the rejection of claim 1 is respectfully requested. Claims 2 and 4-8 which depend upon claim 1 are patentably distinct over the cited prior art due to their dependence upon claim1 and also due to their own limitations.

Claim 9 recites an energy storage device, comprising the separator according to claim 1, thus also patentable. Similarly Claim 10, which depend upon claim 9 are patentably distinct over the cited prior art due to their dependence upon claim 9 and also due to their own limitations.

Conclusion:

For at least the above reasons, the claims currently under consideration are believed to be in condition for allowance. While this response sets forth arguments against certain made by the office action, Applicant does not concede to the validity of other allegations not argued in this response.

The Commissioner is hereby authorized to charge any additional fees which may be required, or credit any overpayment to Deposit Account No. 50-5658.

Respectfully submitted,

Dated: June 18, 2020

By: /charles ho/

Charles S. Ho, Reg. No. 51807
Charles_ho@barron-young.com

PTO/SB/06 (09-11)
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U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE
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PATENT APPLICATION FEE DETERMINATION RECORD Substitute for Form PTO-875	Application or Docket Number 16/013,887	Filing Date 06/20/2018	☐ To be Mailed

ENTITY: ☑ LARGE ☐ SMALL ☐ MICRO

APPLICATION AS FILED - PART I

FOR	(Column 1) NUMBER FILED	(Column 2) 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

AMENDMENT	06/19/2020	(Column 1) CLAIMS REMAINING AFTER AMENDMENT		(Column 2) HIGHEST NUMBER PREVIOUSLY PAID FOR	(Column 3) PRESENT EXTRA		RATE ($)	ADDITIONAL FEE ($)
	Total (37 CFR 1.16(i))	* 16	Minus	** 20	= 0		x $100 =	0
	Independent (37 CFR 1.16(h))	* 2	Minus	*** 3	= 0		x $460 =	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

AMENDMENT		(Column 1) CLAIMS REMAINING AFTER AMENDMENT		(Column 2) HIGHEST NUMBER PREVIOUSLY PAID FOR	(Column 3) 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".	/TERESA J JACKSON WOODRUFF/
*** 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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UNITED STATES DEPARTMENT OF COMMERCE
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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.
16/013,887	06/20/2018	Jianjian Yi	DEHE-1806-USPT	3106

129752 7590 06/29/2020

BYIP LTD.
5700 Granite Parkway, Suite 200
Plano, TX 75024

EXAMINER
CHMIELECKI, SCOTT J

ART UNIT	PAPER NUMBER
1729	

NOTIFICATION DATE	DELIVERY MODE
06/29/2020	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):

charles_ho@barron-young.com
charlesho@barron-young.com
cho@barron-young.com

PTOL-90A (Rev. 04/07)

DETAILED ACTION

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. The text of those sections of Title 35, U.S. Code not included in this action can be found in a prior Office action.

Response to Arguments

1. Applicant's arguments filed June 19, 2020 have been fully considered but they are not persuasive. Applicant argues that the claimed separator is not taught by the cited prior art.

2. In response to Applicant's argument that "pores formed by the binder, and the pores at least comprises a part of the inorganic particles" is not taught by Nam et al (US 2019/0355953 A1), hereinafter "Nam," Nam clearly depicts this feature in figure 8. As seen in the figure, the pores (see annotated fig. 8, shaded area) are "formed" by the gaps between the particles (see annotated fig. 8, items 1 and 2) and the binder (see annotated fig. 8, item 3). In other words, the pore has walls defined by the adjacent particles and binder. Thus the pore is indeed "formed by the binder" and "comprises a part of the inorganic particle." Therefore, Applicant's argument is unpersuasive.

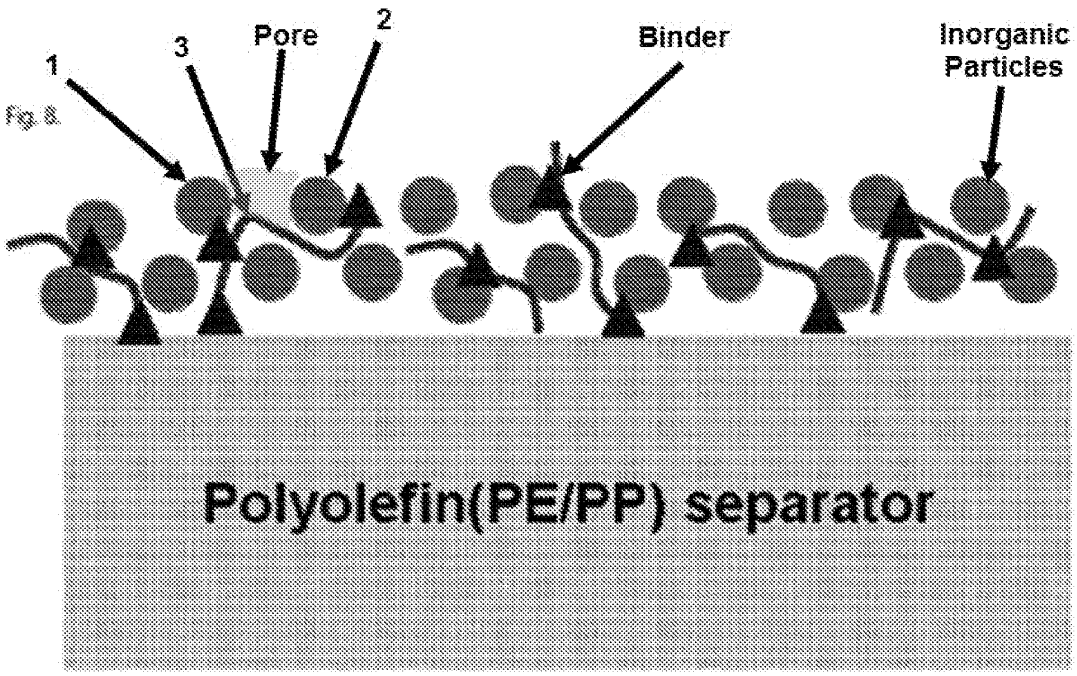


Fig. 8.

3. Applicant's argument regarding Shimura et al (US 2019/0123319 A1), hereinafter "Shimura," is irrelevant as the claim limitation at issue is clearly taught by Nam.

Conclusion

Any inquiry concerning this communication or earlier communications from the examiner should be directed to SCOTT J CHMIELECKI whose telephone number is (571)270-5591. The examiner can normally be reached on M-F 8:30 am to 5 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, Ula Ruddock can be reached on 5712721481. 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.

/SCOTT J. CHMIELECKI/
Primary Examiner, Art Unit 1729

Advisory Action Before the Filing of an Appeal Brief	**Application No.** 16/013,887	**Applicant(s)** Yi et al.	
	Examiner SCOTT J CHMIELECKI	**Art Unit** 1729	**AIA (FITF) Status** Yes

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

THE REPLY FILED 19 June 2020 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 ____ 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 37CFR 1.116 and 41.33(a)).
4. ☐ The amendments are not in compliance with 37CFR 1.121. See attached Notice of Non-Compliant Amendment (PTOL-324).
5. ☐ Applicants reply has overcome the following rejection(s): _____
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 attached.
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:1-10.
    Claim(s) withdrawn from consideration:_____.

/SCOTT J. CHMIELECKI/ Primary Examiner, Art Unit 1729	

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Application of: NINGDE AMPEREX TECHNOLOGY LIMITED

Application No.:16/013,887

Filing Date: June 20, 2018

Entitled: SEPARATOR AND ENERGY STORAGE DEVICE

Attorney Docket No.: DEHE-1806-USPT

RESPONSE TO FINAL OFFICE ACTION MAILED APRIL 20, 2020

Dear Sir:

The present paper is being submitted in response to the Final Office Action mailed April 20, 2020.

Listing of Claims begins on page 2 of this paper.

Remarks begin on page 5 of this paper.

DO NOT ENTER: /S.J.C./

06/23/2020

Doc code: RCEX
Doc description: Request for Continued Examination (RCE)

PTO/SB/30EFS (07-09)
Approved for use through 07/31/2012. 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	16/013,887	Filing Date	2018-06-20	Docket Number (if applicable)	DEHE-1806-USPT	Art Unit	1729
First Named Inventor	Jianjian Yi			Examiner Name	CHMIELECKI, SCOTT J		

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 _____

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 _____

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 505658

SIGNATURE OF APPLICANT, ATTORNEY, OR AGENT REQUIRED

X Patent Practitioner Signature

Applicant Signature

EFS - Web 2.1.15

PTO/SB/30EFS (07-09)
Approved for use through 07/31/2012. 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	/charles ho/	Date (YYYY-MM-DD)	2020-07-20
Name	Charles S. Ho	Registration Number	51807

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.

Electronic Patent Application Fee Transmittal	
Application Number:	16013887
Filing Date:	20-Jun-2018
Title of Invention:	SEPARATOR AND ENERGY STORAGE DEVICE
First Named Inventor/Applicant Name:	Jianjian Yi
Filer:	Charles S. Ho/Ethan Huang
Attorney Docket Number:	DEHE-1806-USPT
Filed as Large Entity	
Filing Fees for Utility under 35 USC 111(a)	

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($)
Miscellaneous:				
RCE- 1ST REQUEST	1801	1	1300	1300
		Total in USD ($)		**1300**

Electronic Acknowledgement Receipt	
EFS ID:	40042055
Application Number:	16013887
International Application Number:	
Confirmation Number:	3106
Title of Invention:	SEPARATOR AND ENERGY STORAGE DEVICE
First Named Inventor/Applicant Name:	Jianjian Yi
Customer Number:	129752
Filer:	Charles S. Ho/Ethan Huang
Filer Authorized By:	Charles S. Ho
Attorney Docket Number:	DEHE-1806-USPT
Receipt Date:	20-JUL-2020
Filing Date:	20-JUN-2018
Time Stamp:	05:10:48
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	yes
Payment Type	CARD
Payment was successfully received in RAM	$1300
RAM confirmation Number	E20207J611265231
Deposit Account	
Authorized User	
The Director of the USPTO is hereby authorized to charge indicated fees and credit any overpayment as follows:	

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1	Request for Continued Examination (RCE)	RCE_Transmittal_DEHE-1806-USPT.PDF	697662 fe22c1cd9b3bcc66d70b2fbc8fdf65f0ad4489b7	no	3
Warnings:					
Information:					
2	Amendment Submitted/Entered with Filing of CPA/RCE	Response_filed_with_RCE_DEHE-1806-USPT.PDF	954293 6e04fd9b7b622048f7b714014311c22f9d35f4f2	no	8
Warnings:					
Information:					
3	Fee Worksheet (SB06)	fee-info.pdf	29962 29e1bdc9a532766ac6776b77b8c1b27882dee956	no	2
Warnings:					
Information:					
		Total Files Size (in bytes):	1681917		

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.

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Application of: NINGDE AMPEREX TECHNOLOGY LIMITED

Application No.:16/013,887

Filing Date: June 20, 2018

Entitled: SEPARATOR AND ENERGY STORAGE DEVICE

RESPONSE FILED WITH RCE

Dear Sir:

The present paper is being submitted along with RCE.

Listing of Claims begins on page 2 of this paper.

Remarks begin on page 5 of this paper.

Amendments to the Claims:

This listing of claims will replace all prior versions, and listings, of claims in the application:

1. (Currently Amended) A separator, comprising:

a porous substrate; and

a porous layer arranged on a surface of the porous substrate, wherein the porous layer comprises inorganic particles and a binder, and a ratio of Dv90 of the inorganic particles to the thickness of the porous layer is in a range from 0.3 to 3.0,

wherein the porous layer has pores formed by the binder, at least a part of the inorganic particles are embedded in the pores, and the pores each has an opening oriented in the thickness direction of the porous layer.

2. (Original) The separator according to claim 1, wherein the porous layer has a thickness of 0.2 μm to 10 μm.

3. (Canceled).

4. (Currently Amended) The separator according to claim [[3]]1, wherein the pores have an average pore size of 0.3 μm to 20 μm.

5. (Original) The separator according to claim 1, wherein a volume ratio of the inorganic particles to the binder is in a range from 0.2 to 3.0.

6. (Original) The separator according to claim 1, wherein the porous layer has a porosity of 20% to 90%.

7. (Original) The separator according to claim 1, wherein the inorganic particles are one or more selected from the group consisting of alumina, silica, magnesia, titanium oxide, hafnium dioxide, tin oxide, zirconia, cerium dioxide, nickel oxide, zinc oxide, calcium oxide, boehmite, aluminum hydroxide, magnesium hydroxide, calcium hydroxide, and barium sulfate.

8. (Original) The separator according to claim 1, wherein the binder is one or more selected from the group consisting of polyvinylidene fluoride, vinylidene fluoride-hexafluoropropylene copolymer, polyamide, polyacrylonitrile, polyacrylate, polyacrylic acid, polyacrylates, sodium carboxymethylcellulose, polyvinylpyrrolidone, polyvinyl ether, polymethyl methacrylate, polytetrafluoroethylene and polyhexafluoropropylene.

9. (Original) An energy storage device, comprising the separator according to claim 1.

10. (Original) The energy storage device according to claim 9, wherein the energy storage device is a lithium-ion battery.

11. (Withdrawn) A method for preparing a separator, wherein the method comprises steps of:

mixing inorganic particles with a binder to generate a mixture;

adding a first solvent into the mixture;

stirring the mixture with the first solvent to obtain a uniform coating solution;

coating the uniform coating solution onto a surface of a porous substrate to form a wet film;

immersing the wet film into a coagulating solution for phase transformation; and

drying the phase-transformed wet film to obtain the separator.

12. (Withdrawn) The method according to claim 11, wherein the solid content in the coating solution is in a range from 7% to 25%.

13. (Withdrawn) The method according to claim 11, wherein the coagulating solution comprises a second solvent and a third solvent, and the second solvent has a mass percentage of 20% to 60%.

14. (Withdrawn) The method according to claim 11, wherein the first solvent is one or more independently selected from the group consisting of N-methylpyrrolidone , dimethylacetamide and dimethylformamide.

15. (Withdrawn) The method according to claim 11, wherein the porous substrate comprises a polymer film, a multilayer polymer film, or a non-woven fabric formed by any one or more of the following polymers: polyethylene, polypropylene, polyethylene terephthalate, polyphthaloyl diamine, polybutylene terephthalate, polyester, polyacetal, polyamide, polyimide, polyetheretherketone , polyaryletherketone, polyetherimide, polyamide imide, polybenzimidazole, polyethersulfone, polyphenylene oxide, cycloolefin copolymer, polyphenylene sulfide, and polyethylene naphthalene.

16. (Withdrawn) The method according to claim 15, wherein the polyethylene is at least one selected from the group consisting of high density polyethylene, low density polyethylene, and ultrahigh molecular weight polyethylene.

17. (Withdrawn) The method according to claim 13, wherein the second solvent is one or more independently selected from the group consisting of N-methylpyrrolidone, dimethylacetamide and dimethylformamide, and the third solvent is one or more selected from the group consisting of deionized water, ethanol, propanol, acetone, dimethyl carbonate and diethyl carbonate.

Remarks

Claims 1-10 were previously pending in the present application. By this paper, claim 1 is amended, the amendments are derived from fig.1, without introducing new matter. Applicant respectfully requests reconsideration of the pending claims in view of the above amendments and the following remarks.

Rejection Under 35 U.S.C. §103

Claims 1-10 are rejected under 35 U.S.C. 103 as being unpatentable over Nam *et al.* (US2019/0355953A1, hereafter "Nam"), in view of Shimura *et al.*(US2019/0123319A1, hereafter "Shimura").

Applicants respectfully disagrees for the below reasons.

Amended claim 1 recites:

> [a] at least a part of the inorganic particles are embedded in the pores formed by the binder, and the pores each has an opening oriented in the thickness direction of the porous layer.

Firstly, in the present application, at least a part of the inorganic particles are fully embedded in the pores formed by the binder, which can be used to support the skeleton of the porous layer, improve the mechanical properties of the porous layer, prevent the porous layer from being compressed and blocked during the preparation and circulation of the energy storage device, and improve the rate performance and cycle performance of the energy storage device.

But in Nam, see the para.0054, the binder in the battery separator is used to retain strong hydrogen bonding due to the —O/—OH group, see the figure as follows, the triangular shape denotes a hydroxyl group or a hydrophilic group, and the circle denotes inorganic particles.

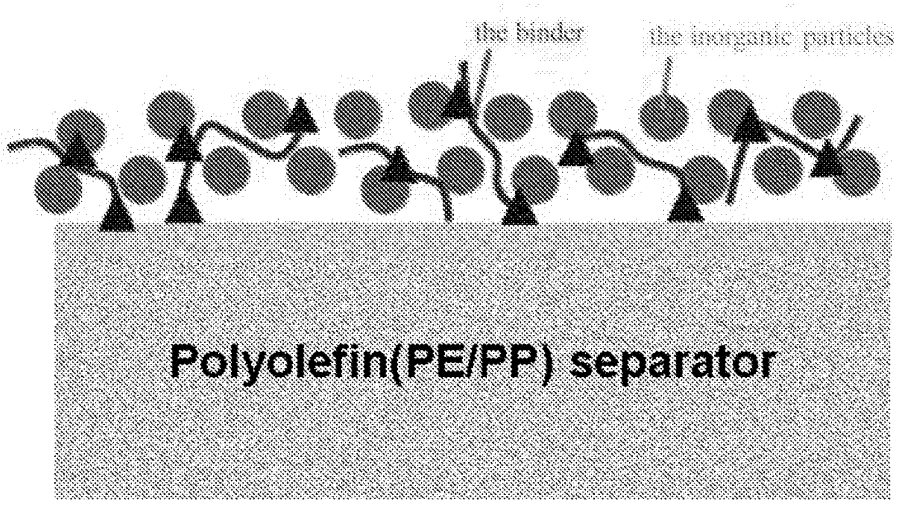


Fig.8 of Nam

Thus, in Nam, **the binder is only used to connect and fix the inorganic particles in the active layer to each other, and the porous structure is formed by the inorganic particles**. Thus, in the case where the binder is only used to connect the inorganic particles**, it is impossible to embed at least a part of the inorganic particles in the pores formed by the binder, since it is in conflict with itself**.

Secondly, in the present application, the pores each has an opening oriented in the thickness direction of the porous layer. This orientation shortens the transmission distance of lithium ions between the positive and negative electrodes, thereby increasing the shuttle rate of lithium ions between the positive and negative electrodes, thereby the separator would exhibit high ionic conductivity, and the rate performance and cycle performance of the energy storage device are greatly improved.

But in Nam, it is impossible to orient the formed holes in a certain direction when the binder is used to connect inorganic particles, as the binder is intended to connecting the inorganic particles, not to accommodate, thus the holes in Nam cannot be oriented, even if the holes are formed by the binder, which is conflict with its own role.

Therefore, Nam fails to disclose or suggest the technical feature "at least a part of the inorganic particles are embedded in the pores formed by the binder, and the pores each has an opening oriented in the thickness direction of the porous layer" as recited in claim 1.

In Shimura, the separator comprises: "**a base material resin having voids**; and an inorganic particle having a surface (A) facing the void and a surface (B) in contact with the resin (*see claim1 and para.0018*). However, Shimura fails to disclose or teach "at least a part of the inorganic particles are embedded in the pores formed by the binder, and the pores each has an opening oriented in the thickness direction of the porous layer" as recited in claim 1.

Thus, it is nonobvious for one with ordinary skill in the art to have the feature "at least a part of the inorganic particles are embedded in the pores formed by the binder, and the pores each has an opening oriented in the thickness direction of the porous layer" as recited in claim 1 on the basis of Nam and Shimura.

In summary, applicant respectfully submits that the cited references, either individually or in combination, fail to disclose or teach the features "at least a part of the inorganic particles are embedded in the pores formed by the binder, and the pores each has an opening oriented in the thickness direction of the porous layer" as recited in claim 1.

Accordingly, for at least the above reason, withdrawal of the rejection of claim 1 is respectfully requested. Claims 2 and 4-8 which depend upon claim 1 are patentably distinct over the cited prior art due to their dependence upon claim1 and also due to their own limitations.

Claim 9 recites an energy storage device, comprising the separator according to claim 1, thus also patentable. Similarly Claim 10, which depend upon claim 9 are patentably distinct over the cited prior art due to their dependence upon claim 9 and also due to their own limitations.

Conclusion:

For at least the above reasons, the claims currently under consideration are believed to be in condition for allowance. While this response sets forth arguments against certain made by the office action, Applicant does not concede to the validity of other allegations not argued in this response.

The Commissioner is hereby authorized to charge any additional fees which may be required, or credit any overpayment to Deposit Account No. 50-5658.

Respectfully submitted,

Dated: July 20, 2020

By: /charles ho/

Charles S. Ho, Reg. No. 51807
Charles_ho@barron-young.com

PTO/SB/06 (09-11)
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PATENT APPLICATION FEE DETERMINATION RECORD Substitute for Form PTO-875	Application or Docket Number 16/013,887	Filing Date 06/20/2018	☐ To be Mailed

ENTITY: ☑ LARGE ☐ SMALL ☐ MICRO

APPLICATION AS FILED - PART I

FOR	(Column 1) NUMBER FILED	(Column 2) 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

AMENDMENT	07/20/2020	(Column 1) CLAIMS REMAINING AFTER AMENDMENT		(Column 2) HIGHEST NUMBER PREVIOUSLY PAID FOR	(Column 3) PRESENT EXTRA		RATE ($)	ADDITIONAL FEE ($)
	Total (37 CFR 1.16(i))	* 16	Minus	** 20	= 0		x $100 =	0
	Independent (37 CFR 1.16(h))	* 2	Minus	*** 3	= 0		x $460 =	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

AMENDMENT		(Column 1) CLAIMS REMAINING AFTER AMENDMENT		(Column 2) HIGHEST NUMBER PREVIOUSLY PAID FOR	(Column 3) 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".	/KAREN T WASHINGTON/
*** 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.**

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

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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
16/013,887	06/20/2018	Jianjian Yi	DEHE-1806-USPT	3106

129752 7590 08/04/2020

BYIP LTD.
5700 Granite Parkway, Suite 200
Plano, TX 75024

EXAMINER
CHMIELECKI, SCOTT J

ART UNIT	PAPER NUMBER
1729	

NOTIFICATION DATE	DELIVERY MODE
08/04/2020	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):

charles_ho@barron-young.com
charlesho@barron-young.com
cho@barron-young.com

Office Action Summary	**Application No.** 16/013,887	**Applicant(s)** Yi et al.	
	Examiner SCOTT J CHMIELECKI	**Art Unit** 1729	**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 20 July 2020.

☐ 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) 1-2 and 4-17 is/are pending in the application.

5a) Of the above claim(s) 11-17 is/are withdrawn from consideration.

6) ☐ Claim(s) _____ is/are allowed.

7) ☑ Claim(s) 1-2 and 4-10 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 _____.

3) ☐ Interview Summary (PTO-413) Paper No(s)/Mail Date _____.

4) ☐ Other: _____.

DETAILED ACTION

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. The text of those sections of Title 35, U.S. Code not included in this action can be found in a prior Office action.

Continued Examination Under 37 CFR 1.114

1. 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 July 20, 2020 has been entered.

Claim Rejections - 35 USC § 112

2. The following is a quotation of the first paragraph of 35 U.S.C. § 112(a):

> (a) IN GENERAL.—The specification shall contain a written description of the invention, and of the manner and process of making and using it, in such full, clear, concise, and exact terms as to enable any person skilled in the art to which it pertains, or with which it is most nearly connected, to make and use the same, and shall set forth the best mode contemplated by the inventor or joint inventor of carrying out the invention.

The following is a quotation of the first paragraph of pre-AIA 35 U.S.C. § 112:

> The specification shall contain a written description of the invention, and of the manner and process of making and using it, in such full, clear, concise, and exact terms as to enable any person skilled in the art to which it pertains, or with which it is most nearly connected, to make and use the same, and shall set forth the best mode contemplated by the inventor of carrying out his invention.

3. Claims 1, 2, and 4-10 are rejected under 35 U.S.C. § 112(a) or 35 U.S.C. § 112 (pre-AIA), first paragraph, as failing to comply with the written description requirement. The claims contain subject matter which was not described in the specification in such a

way as to reasonably convey to one skilled in the relevant art that the inventor or a joint inventor, or for pre-AIA the inventors, at the time the application was filed, had possession of the claimed invention. Particularly, claim 1 includes the limitation "the pores each has an opening oriented in the thickness direction of the porous layer," which lacks textual support in the specification as filed. Likewise, none of the drawings appear to show any particular pore "orientation." Therefore the limitation introduces new matter.

4. 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.

The following is a quotation of 35 U.S.C. § 112 (pre-AIA), second paragraph:

> The specification shall conclude with one or more claims particularly pointing out and distinctly claiming the subject matter which the applicant regards as his invention.

5. Claims 1, 2, and 4-10 are rejected under 35 U.S.C. § 112(b) or 35 U.S.C. § 112 (pre-AIA), second paragraph, as being indefinite for failing to particularly point out and distinctly claim the subject matter which the inventor or a joint inventor, or for pre-AIA the applicant regards as the invention. Particularly, claim 1 includes the limitation "the pores each has an opening oriented in the thickness direction of the porous layer," rendering the claims indefinite. It is unclear how the pore openings must be "oriented" in order to meet this claim limitation. For example, a pore opening that is perpendicular to the thickness direction is no less "oriented" in the thickness direction than is a pore opening that is parallel to the thickness direction. In other words, Applicant has provided a frame of reference to determine the desired direction of the pore openings, but has failed to provide the desired direction. For the purposes of examination, the limitation will be held to require that the pore openings be perpendicular to the thickness direction.

Claim Rejections - 35 USC § 103

6. The rejection of claims 1, 2, and 4-10 under 35 U.S.C. § 103 as being unpatentable over Nam et al (US 2019/0355953 A1), hereinafter "Nam," in view of Shimura et al (US 2019/0123319 A1), hereinafter "Shimura," is maintained as set forth below.

7. Regarding claim 1, Nam teaches a separator comprising:

a porous substrate, in this case the porous polyolefin substrate (¶ 0026);

a porous layer arranged on a surface of the porous substrate comprising inorganic particles and a binder, in this case the organic-inorganic hybrid porous coating layer (¶ 0026); and

wherein the porous layer has pores formed by the binder, at least a part of the inorganic particles are embedded in the pores, in this case the porous structure is formed due to the interstitial volume between the inorganic particles and the binder (¶ 0027; see annotated fig. 8) which results in at least a part of the inorganic particles being "embedded" in the pore (see annotated fig. 8, items 1 & 2) or wholly "embedded" in the pore (see annotated fig. 8, item 4), and the pores each have an opening oriented in the thickness direction, in this case the pores open on the surface of the inorganic particles and binder opposite the polyolefin separator and are thus "oriented" in the thickness direction (see fig. 8).

Nam does not teach the ratio of the inorganic particles' Dv90 value to the porous layer's thickness. However, Shimura teaches a separator comprising inorganic particles and a binder wherein the inorganic particle size may be adjusted to provide appropriate Gurley and porosity values (¶ 0028). One with ordinary skill in the art would realize that

Dv90 is dependent on particle size and adjusting the ratio of the inorganic particles Dv90 value to the porous layer's thickness to be 0.3 to 3.0 would ensure that the separator possessed the appropriate Gurley and porosity values (see ¶ 0028), thereby facilitating improved separator performance. Therefore, it would have been obvious to have made the Dv90 to thickness ratio to be 0.3 to 3.0 in order to facilitate improved separator performance.

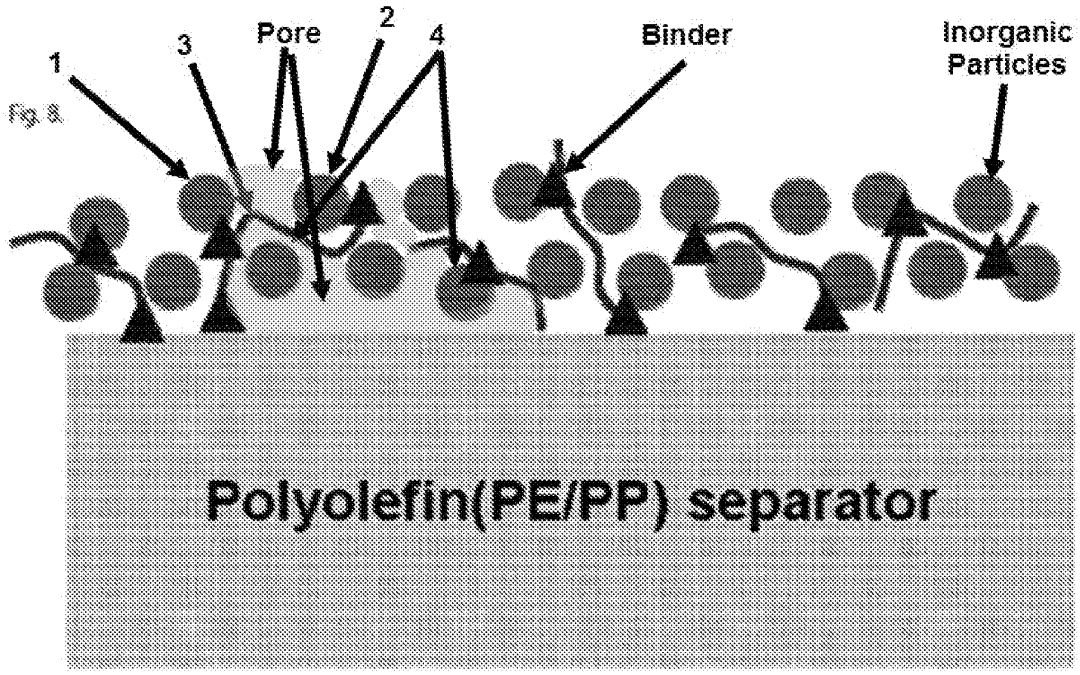


Fig. 8

8. Regarding claim 2, Nam further teaches that the porous layer's thickness is 0.2 μm to 10 μm, in this case the coating thickness is 3 μm (¶ 0057).

9. Regarding claim 4, Nam further teaches that the average pore size is 0.3 μm to 20 μm, in this case 0.5 μm (¶ 0057).

10. Regarding claim 5, Nam does not teach the volume ratio of the inorganic particles to that of the binder. However, Shimura teaches that the volume % of the

inorganic particles in the binder is 2 vol % to 40 % or less (¶ 0027), which overlaps with the claimed ratio of 0.2 to 3.0. One with ordinary skill in the art would realize that making the volume ratio of inorganic particles to binder to be 0.2 to 3.0 would yield a separator with the desired heat resistance and short circuit prevention (see ¶ 0005), thereby facilitating improved separator performance and safety. Therefore, it would have been obvious to have mad the volume ratio of inorganic particles to binder to be 0.2 to 3.0 in order to facilitate improved separator performance and safety.

11. Regarding claim 6, Nam further teaches that the porous layer's porosity is 20% to 90%, in this case 45% (¶ 0057).

12. Regarding claim 7, Nam further teaches that the inorganic particles are selected from alumina, titanium oxide, zinc oxide, calcium oxide, nickel oxide, and others (¶ 0030).

13. Regarding claim 8, Nam further teaches that the binder is selected from polyvinylidene fluoride hexafluoropropylene copolymer, polyacrylonitrile, polyvinylpyrrolidone, and others (¶ 0028 & 0049).

14. Regarding claim 9, Nam further teaches an energy storage device comprising the separator, in this case a lithium secondary battery (¶ 0012 & 0029).

15. Regarding claim 10, Nam further teaches that the energy storage device is a lithium-ion battery, in this case a lithium secondary battery (¶ 0012 & 0029).

Response to Arguments

16. Applicant's arguments filed July 20, 2020 have been fully considered but they are not persuasive. Applicant argues that the claimed structure is not taught by the cited prior art.

17. In response to Applicant's argument that the pores being formed by the binder is not taught by Nam, Nam clearly shows that the binder forms at least a portion of the pores (see annotated fig. 8, item 3 & shaded area). Furthermore, Nam clearly shows inorganic particles entirely within the pore (see annotated fig. 8, item 4). Thus the pores are formed in least in part by the binder and the particles can be considered to be "embedded" within the pores. In other words, Applicant's claim language fails to distinguish the claimed structure from that taught by Nam. Therefore, Applicant's argument is unpersuasive.

18. In response to Applicant's argument regarding the pore opening orientation, the pores open on the surface of the inorganic particles and binder opposite the polyolefin separator and are thus "oriented" in the thickness direction (see fig. 8). In other words the pore openings are "oriented" orthogonally to the thickness direction. Therefore, Applicant's argument is unpersuasive.

Conclusion

Any inquiry concerning this communication or earlier communications from the examiner should be directed to SCOTT J CHMIELECKI whose telephone number is (571)270-5591. The examiner can normally be reached on M-F 8:30 am to 5 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, Ula Ruddock can be reached on 5712721481. 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.

/SCOTT J. CHMIELECKI/
Primary Examiner, Art Unit 1729

Search Notes	Application/Control No.	Applicant(s)/Patent Under Reexamination
	16/013,887	Yi et al.
	Examiner	Art Unit
	SCOTT J CHMIELECKI	1729

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
Reviewed IDS documents, performed EAST text search for relevant prior art, & conducted Google Scholar search for relevant prior art; conducted inventor & assignee search.	01/08/2020	SJC
Reviewed previous prior art search.	04/16/2020	SJC
Reviewed previous prior art search.	07/30/2020	SJC

Interference Search			
US Class/CPC Symbol	US Subclass/CPC Group	Date	Examiner

/SCOTT J. CHMIELECKI/ Primary Examiner, Art Unit 1729	

CosMX Exhibit 1002, Page 253 of 334

Index of Claims	Application/Control No.	Applicant(s)/Patent Under Reexamination
	16/013,887	Yi et al.
	Examiner	Art Unit
	SCOTT J CHMIELECKI	1729

✓	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	11/07/2019	01/08/2020	04/16/2020	07/30/2020					
	1	÷	✓	✓	✓					
	2	÷	✓	✓	✓					
	3	÷	✓	✓	-					
	4	÷	✓	✓	✓					
	5	÷	✓	✓	✓					
	6	÷	✓	✓	✓					
	7	÷	✓	✓	✓					
	8	÷	✓	✓	✓					
	9	÷	✓	✓	✓					
	10	÷	✓	✓	✓					
	11	÷	N	N	N					
	12	÷	N	N	N					
	13	÷	N	N	N					
	14	÷	N	N	N					
	15	÷	N	N	N					
	16	÷	N	N	N					
	17	÷	N	N	N					

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

PTO/AIA/82B (07-13)
Approved for use through 03/31/2021. OMB 0651-0035
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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: 155692

OR

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Country					
Telephone		Email			

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

Ningde Amperex Technology Limited

☐ 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		Date (Optional)	January 19, 2020
Name	Liangxin Yang		
Title	IP Manager		

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: PA..
Document Description: Power of Attorney

PTO/AIA/82A (07-13)
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TRANSMITTAL FOR POWER OF ATTORNEY TO ONE OR MORE REGISTERED PRACTITIONERS

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	16/013,887
Filing Date	2018-06-20
First Named Inventor	Jianjian Yi
Title	SEPARATOR AND ENERGY STORAGE
Art Unit	1729
Examiner Name	CHMIELECKI, SCOTT J
Attorney Docket Number	76604-1012

SIGNATURE of Applicant or Patent Practitioner

Signature	/zhaoyang li/	Date (Optional)	
Name	Zhaoyang Li	Registration Number	46872
Title (if Applicant is a juristic entity)	Patent Practitioner		
Applicant Name (if Applicant is a juristic entity)	Ningde Amperex Technology Limited		

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.

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

PTO/AIA/82B (07-13)
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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:

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:

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):

☐ 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		Date (Optional)	
Name			
Title			

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.**

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POWER OF ATTORNEY BY APPLICANT

No more than ten (10) patent practitioners total may be appointed as set forth below by name and registration number. This page need not be submitted if appointing the Patent Practitioner(s) associated with a Customer Number (see form PTO/AIA/82B):

Name	Registration 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 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.

PTO/AIA/96 (08-12)
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STATEMENT UNDER 37 CFR 3.73(c)

Applicant/Patent Owner: NINGDE AMPEREX TECHNOLOGY LIMITED

Application No./Patent No.: 16/013,887 Filed/Issue Date: June 20, 2018

Titled: SEPARATOR AND ENERGY STORAGE DEVICE

NINGDE AMPEREX TECHNOLOGY LIMITED, a Foreign For Profit

(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 046171, Frame 0539, 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: _____ To: _____

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

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

   2. 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.

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 01/31/2013. OMB 0651-0031
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE
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STATEMENT UNDER 37 CFR 3.73(c)

3. 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.

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

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

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.

/zhaoyang li/	2020-10-02
Signature	Date
Zhaoyang Li	46872
Printed or Typed Name	Title or Registration 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.

Electronic Acknowledgement Receipt	
EFS ID:	40752646
Application Number:	16013887
International Application Number:	
Confirmation Number:	3106
Title of Invention:	SEPARATOR AND ENERGY STORAGE DEVICE
First Named Inventor/Applicant Name:	Jianjian Yi
Customer Number:	129752
Filer:	Zhaoyang Li
Filer Authorized By:	
Attorney Docket Number:	DEHE-1806-USPT
Receipt Date:	02-OCT-2020
Filing Date:	20-JUN-2018
Time Stamp:	20:36:53
Application Type:	Utility under 35 USC 111(a)

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	Power of Attorney	01857839.PDF	343894 475069fad07ed38d0cc02dba5d8e9d42957cdb32	no	1
Warnings:					

Information:					
2	Power of Attorney	01857435.PDF	221449 01114ccc1034aba44509a65e71c86009a9a8bfe4	no	4
Warnings:					
Information:					
3	Assignee showing of ownership per 37 CFR 3.73	01857236.PDF	118224 7fa470b0e2be80b66504bc04f0ceebd28735118f	no	3
Warnings:					
Information:					
		Total Files Size (in bytes):	683567		

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.

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
16/013,887	06/20/2018	Jianjian Yi	DEHE-1806-USPT

CONFIRMATION NO. 3106

129752
BYIP LTD.
5700 Granite Parkway, Suite 200
Plano, TX 75024

POWER OF ATTORNEY NOTICE

OC000000120420436

Date Mailed: 10/07/2020

NOTICE REGARDING CHANGE OF POWER OF ATTORNEY

This is in response to the Power of Attorney filed 10/02/2020.

- The Power of Attorney to you in this application has been revoked by the applicant. Future correspondence will be mailed to the new address of record(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**.

/dtdinh/

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
16/013,887	06/20/2018	Jianjian Yi	76604-1012

CONFIRMATION NO. 3106

155692
Taylor English Duma LLP - Remote
1600 Parkwood Circle, Suite 200
Atlanta, GA 30339

POA ACCEPTANCE LETTER

OC000000120420465

Date Mailed: 10/07/2020

NOTICE OF ACCEPTANCE OF POWER OF ATTORNEY

This is in response to the Power of Attorney filed 10/02/2020.

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**.

/dtdinh/

PTO/SB/06 (09-11)
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PATENT APPLICATION FEE DETERMINATION RECORD Substitute for Form PTO-875	Application or Docket Number 16/013,887	Filing Date 06/20/2018	☐ To be Mailed

ENTITY: ☑ LARGE ☐ SMALL ☐ MICRO

APPLICATION AS FILED - PART I

FOR	(Column 1) NUMBER FILED	(Column 2) 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

AMENDMENT	11/04/2020	(Column 1) CLAIMS REMAINING AFTER AMENDMENT		(Column 2) HIGHEST NUMBER PREVIOUSLY PAID FOR	(Column 3) PRESENT EXTRA		RATE ($)	ADDITIONAL FEE ($)
	Total (37 CFR 1.16(i))	* 16	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

AMENDMENT		(Column 1) CLAIMS REMAINING AFTER AMENDMENT		(Column 2) HIGHEST NUMBER PREVIOUSLY PAID FOR	(Column 3) 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	

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Electronic Acknowledgement Receipt	
EFS ID:	41039960
Application Number:	16013887
International Application Number:	
Confirmation Number:	3106
Title of Invention:	SEPARATOR AND ENERGY STORAGE DEVICE
First Named Inventor/Applicant Name:	Jianjian Yi
Customer Number:	155692
Filer:	Zhaoyang Li
Filer Authorized By:	
Attorney Docket Number:	76604-1012
Receipt Date:	04-NOV-2020
Filing Date:	20-JUN-2018
Time Stamp:	23:28:21
Application Type:	Utility under 35 USC 111(a)

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	Amendment/Req. Reconsideration-After Non-Final Reject	01886585.PDF	175228 cd4a35b7312e9a61d56a73f9acf38d6370518d4a	no	11
Warnings:					

Information:	
Total Files Size (in bytes):	175228

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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.

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Application of: NINGDE AMPEREX TECHNOLOGY LIMITED	Examiner: CHMIELECKI. SCOTT J
Serial No.: 16/013,887	Group Art Unit: 1729
Filing Date: June 20, 2018	Confirmation No.: 3106
For: SEPARATOR AND ENERGY STORAGE DEVICE	Customer No.: 155692

MAIL STOP: **Submitted via EFS**
Commissioner for Patents
P.O. Box 1450
Alexandria, Virginia 22313-1450

AMENDMENT AND RESPONSE TO NON-FINAL OFFICE ACTION

Dear Examiner:

In response to the Non-final Office Action mailed August 4, 2020 (hereinafter "NFOA"), please consider the amendment to claims and remarks as follows.

Claims are reflected in the Listing of Claims that begins at page 2.

Remarks begin on page 5 of this paper.

LISTING OF THE CLAIMS

The following listing of claims will replace all prior versions, and listings, of claims in the present application:

1. (Currently Amended) A separator, comprising: a porous substrate; and

a porous layer arranged on a surface of the porous substrate, wherein the porous layer comprises inorganic particles and a binder, and a ratio of Dv90 of the inorganic particles to the thickness of the porous layer is in a range from 0.3 to 3.0~~,~~

~~wherein the porous layer has pores formed by the binder, at least a part of the inorganic particles are embedded in the pores, and the pores each has an opening oriented in the thickness direction of the porous layer~~.

2. (Original) The separator according to claim 1, wherein the porous layer has a thickness of 0.2 μm to 10 μm.

3. (Canceled).

4. (Previously Presented) The separator according to claim 1, wherein the pores have an average pore size of 0.3 μm to 20 μm.

5. (Original) The separator according to claim 1, wherein a volume ratio of the inorganic particles to the binder is in a range from 0.2 to 3.0.

6. (Original) The separator according to claim 1, wherein the porous layer has a porosity of 20% to 90%.

7. (Original) The separator according to claim 1, wherein the inorganic particles are one or more selected from the group consisting of alumina, silica, magnesia, titanium oxide, hafnium dioxide, tin oxide, zirconia, cerium dioxide, nickel oxide, zinc oxide, calcium oxide, boehmite, aluminum hydroxide, magnesium hydroxide, calcium hydroxide, and barium sulfate.

8. (Original) The separator according to claim 1, wherein the binder is one or more selected from the group consisting of polyvinylidene fluoride, vinylidene fluoride-hexafluoropropylene copolymer, polyamide, polyacrylonitrile, polyacrylate, polyacrylic acid, polyacrylates, sodium carboxymethylcellulose, polyvinylpyrrolidone, polyvinyl ether, polymethyl methacrylate, polytetrafluoroethylene and polyhexafluoropropylene.

9. (Original) An energy storage device, comprising the separator according to claim 1.

10. (Original) The energy storage device according to claim 9, wherein the energy storage device is a lithium-ion battery.

11. (Withdrawn-Currently Amended) A method for preparing [[a]]the separator of claim 1, wherein the method comprises steps of:

mixing inorganic particles with a binder to generate a mixture;

adding a first solvent into the mixture;

stirring the mixture with the first solvent to obtain a uniform coating solution; coating the uniform coating solution onto a surface of a porous substrate to form a wet film;

the coating solution is in a range from 7% to 25%.

13. (Withdrawn) The method according to claim 11, wherein the coagulating

solution comprises a second solvent and a third solvent, and the second solvent has a mass percentage of 20% to 60%.

14. (Withdrawn) The method according to claim 11, wherein the first solvent is one or more independently selected from the group consisting of N-methylpyrrolidone , dimethylacetamide and dimethylformamide.

15. (Withdrawn) The method according to claim 11, wherein the porous substrate comprises a polymer film, a multilayer polymer film, or a non-woven fabric formed by any one or more of the following polymers: polyethylene, polypropylene, polyethylene terephthalate, polyphthaloyl diamine, polybutylene terephthalate, polyester, polyacetal, polyamide, polyimide, polyetheretherketone , polyaryletherketone, polyetherimide, polyamide imide, polybenzimidazole, polyethersulfone, polyphenylene oxide, cycloolefin copolymer, polyphenylene sulfide, and polyethylene naphthalene.

16. (Withdrawn) The method according to claim 15, wherein the polyethylene is at least one selected from the group consisting of high density polyethylene, low density polyethylene, and ultrahigh molecular weight polyethylene.

17. (Withdrawn) The method according to claim 13, wherein the second solvent is one or more independently selected from the group consisting of N-methylpyrrolidone, dimethylacetamide

and dimethylformamide, and the third solvent is one or more selected from the group consisting of deionized water, ethanol, propanol, acetone, dimethyl carbonate and diethyl carbonate.

18. (New) The separator according to claim 1, wherein the porous layer has pores formed by the binder, at least a part of the inorganic particles are embedded in the pores.

REMARKS

Claims 1-2, and 4-17 are currently pending. Claim 18 is newly added.

Claim 3 was previously canceled.

Claims 11-17 were withdrawn.

Claim 1 is amended to obviate the new matter issue. No new matter is introduced.

Withdrawn claim 11 is amended to correct a typographic error.

Applicant respectfully requests reconsideration of the pending claims in view of the above amendments and the following remarks.

Rejection Under 35 U.S.C. §112

Claims 1, 2 and 4-10 are rejected under 35 U.S.C. 112(a) or 35 U.S.C. 112(pre-AIA), first paragraph, as failing to comply with the written description requirement. Applicant believes the amendment to claim 1 obviates the rejections.

Claims 1, 2 and 4-10 are rejected under 35 U.S.C. 112(b) or 35 U.S.C. 112(pre-AIA), second paragraph, as being indefinite. Applicant believes the amendment to claim 1 obviates the rejection.

Claim Rejections under 35 U.S.C. 103

Claims 1, 2 and 4-10 are rejected under 35 U.S.C. 103 as allegedly being obvious over Nam *et al.* (US2019/0355953A1, hereinafter "Nam") in view of Shimura *et al.* (US2019/0123319A1, hereinafter "Shimura"). Applicant respectfully traverses the rejections if they are applied to claims as amended.

The claimed invention

Claim 1, from which claims 2 and 4-10 depend or ultimately depend, defines a separator as comprising:

a porous substrate; and

a porous layer arranged on a surface of the porous substrate,

wherein the porous layer comprises inorganic particles and a binder, and a ratio of Dv90 of the inorganic particles to the thickness of the porous layer is in a range from 0.3 to 3.0.

It is important to emphasize that the technical feature, a ratio of Dv90 of the inorganic particles to the thickness of the porous layer being in a range from 0.3 to 3.0 is a key feature of claimed separator. The As a person of ordinary skill in the art would appreciate, a properly designed and effective separator in a lithium-based secondary battery serves as separation of the electrodes, and in the meanwhile, as channels for electrolytes, and sometimes, air molecules, to pass through. Due to the various procedures and processes in the manufacture process and use -- charging-recharging -- of the battery, the separator is exposed to various damaging impacts, e.g., temperature increase to cause the separator sheet/pores thereof to shrink, and mechanical impact, which would cause the pore structure to collapse.

The key role of this technical feature plays in maintaining the separator pore structure is explained in detail at paragraph [0037] of the instant application:

> … By increasing the ratio of Dv90 of the inorganic particles to the thickness of the porous layer, the mechanical strength of the porous layer is increased, and the porous layer is prevented from undergoing pore blockage due to compression in the preparation or cycle process of the energy storage device (such as a lithium-ion battery), thereby increasing the rate performance of the energy storage device (such as a lithium-ion battery). Conversely, the mechanical properties of the porous layer may be reduced by reducing the ratio of Dv90 of inorganic particles to the thickness of the porous layer, leading to pore blockage of the porous layer due to compression in the preparation and cycle processes of the energy storage device (such as a lithium-ion battery), and the rate performance of the energy storage device (such as a lithium-ion battery) is reduced. In addition, if the ratio of the Dv90 of the inorganic particles to the thickness of the porous layer is too high, the pore size distribution of the porous layer tends to be non-uniform, resulting in a non-uniform surface of the porous layer, which further makes the porous layer easy to detach from the surface of the porous substrate and forms defects in the energy storage device (such as a lithium-ion battery). Moreover, if the ratio of Dv90 of the inorganic particles to the thickness of the porous layer is too high, the adhesive force of the porous layer is reduced, affecting the safety performance of the energy storage device (such as a lithium-ion battery). If the ratio of Dv90 of the inorganic particles to the thickness of the porous layer is too low, the inorganic p311icles cannot be effectively exposed on the surface of the porous layer, which does not facilitate an exchange between the first solvent in the coating solution and the third solvent in the coagulating solution in the preparation of the porous layer, therefore cannot enhance diffusion, and is not

advantageous for the development of the pores.

Paragraph [0037] of the instant application. The claimed range of the ratio of Dv90 of the inorganic particles to the thickness of the porous layer being in a range from 0.3 to 3.0 is therefore a key element in maintaining the pore structure of the separator as defined in claim 1 and thus shall not be ignored. Note, a person of ordinary skill in the art would not be able to provide the ratio from the parameter of Dv90 or thickness of the porous layer alone – one would need both parameters to provide the ratio.

Nam and Shimura

Nam discloses a separator having a porous layer formed from a binder and inorganic particles. So does Shimura. Both Nam and Shimura tried to provide a separator having proper porosity. Nam and Shimura are not directed to maintaining, or fail to see how to maintain, the pore structure on the separator. It is one thing to create a desirable pore structure on a separator, but it is quite another to maintain the pore structure.

The Office acknowledges that Nam fails to disclose a key feature of the instant application, that is, to provide a porous layer formed from a binder and inorganic particles where the size of the inorganic particles and the thickness of the porous layer can play a key role in maintaining the pore structure, that is, a ratio of Dv90 of the inorganic particles to the thickness of the porous layer being in a range from 0.3 to 3.0.

The Office alleges that Shimura would make up the deficiencies of Nam with respect to the claimed invention. Applicant respectfully disagrees. Shimura discloses achieving a porosity and Curley value (measurement of air permeability) of the separator. However, contrary to the Office's assertion, Shimura fails to teach how to maintain the porosity and Curley value of the separator as does the claimed invention (see Background section, paragraphs [0035] and [0036], and the Examples of the instant application). To be clear, Applicant copies and pastes below paragraph [0028] of Shimura below, which reads:

> The particle size of the inorganic particles is not particularly limited. The particle size may be adjusted such that separator characteristics, such as Gurley value and porosity, become appropriate values. In the first embodi-ment, the upper limit of the mode diameter of the inorganic particles (1), the inorganic particles (2) and the inorganic particles (3) is preferably 2 μm or less and more

> preferably 1 μm or less, and the lower limit thereof is preferably 0.1 μm or more and more preferably 0.2 μm or more. In the second embodiment, the upper limit of the mode diameter of the inorganic particles (2) and the inorganic particles (3) is preferably 2 μm or less and more preferably 1 μm or less, and the lower limit thereof is preferably 0.1 μm or more and more preferably 0.2 μm or more. In the third embodiment, the upper limit of the mode diameter of the inorganic particles (3) is preferably 2 μm or less and more preferably 1 μm or less, and the lower limit thereof is preferably 0.1 μm or more and more preferably 0.2 μm or more. Herein, the mode diameter means the mode value of a particle size distribution. 50 inorganic particles selected randomly from cross-sectional SEM photographs of the separator may be considered as all of the inorganic particles to simplify the calculation of the mode diameter of the inorganic particles. Herein, the particle size means the distance of the longest line connecting two points on the outer circumference of a particle in SEM observation.

It is clear that Shimura at paragraph [0028] discloses only the diameter of the inorganic particles and nothing on the thickness of the porous layer, much less a ratio of the particle size to the thickness of the porous layer.

On a further note, Curley value by definition reflects the overall influences of factors on the air permeability of a porous layer, the factors being –

i) ratio of large pores in all the pores of the porous layer;

ii) pore size of single pore;

iii) tortuosity of pores in strata of the porous layer, e.g., gas permeability is higher in a straight pore, and pore of camber would cause an increase of gas travel resistance to cause an increase of time for a unit volume of gas to pass through the pore strata, so as to cause the Curley value to increase; and

iv) distribution of pore shape, e.g., if a pore has a small inlet or a small outlet, gas travel through the pore would be delayed, and if a pore on one side of the strata is large and another pore on another side of the strata is small, gas travel would be slow as rate of gas travel is limited by the smaller pore.

Therefore, Curley value is mainly about pore sizes and shapes and distributions of pores and not much about the thickness of the porous layer. As such, discussion of Curley values and pore sizes would not provide any motivation for a person of ordinary skill in the art to adjust the thickness of the porous layer and Dv90 value to reach the claimed ratio of Dv90 of the inorganic particles to the thickness of the porous layer, much less the ratio in a range from 0.3 to 3.0.

To sum, Neither Nam nor Shimura individually or in combination provide any guidance to a person having an ordinary skill in the art to modify the structure of Nam to have a ratio of Dv90 of the inorganic particles to the thickness of the porous layer in a range from 0.3 to 3.0 to achieve the desired results of maintaining the pore structure. Given the complexity of the technology and no guidance by the cited prior art references, a person having ordinary skill in the art will have to do undue experimentation to reach at the claimed feature of the invention and will not be possible without involving inventive skill. Therefore, Applicant respectfully states that a person having ordinary will not be motivated to modify Nam even in view of Shimura to reach at the invention as claimed in claim 1 of the instant application without applying inventive skill.

Thus, claim 1 is not obvious over Nam even in view of Shimura.

Applicant respectfully requests the Office to withdraw the rejections.

Claims 2 and 4-10 and newly added claim 18 depend directly or indirectly on claim 1 and are patentable at least for the same reasons.

Claim 5 additionally recites a volume ratio of the inorganic particles to the binder being in a range from 0.2 to 3.0. As fully explained at paragraph [00125] of the instant application, this feature is another key feature of the claimed invention. To be clear, paragraph [00125] is pasted below:

> As can be seen from the comparison among Example 3 and Examples 8-12, the volume ratio of inorganic particles to the binder has an effect on the rate performance and cycle performance of the lithium-ion battery. An increase of the volume ratio is advantageous for an exchange of the third solvent in the coagulating solution and the first solvent in the coating solution and the increase of the porosity of the porous layer. If the volume ratio of inorganic particles to the binder is too low, the porosity of the porous layer is decreased, the gas permeability of the separator deteriorates, and the rate performance of the lithium-ion battery is not significantly improved, which is not advantageous for the improvement of the rate performance and cycle performance. If the ratio of the volume ratio of the inorganic particles to the binder is too high, the adhesive force of the porous layer is reduced, gaps are easily formed between the separator and the electrodes, the hardness of the lithium-ion battery is reduced, and thus the rate performance and the cycle performance are not significantly improved.

Paragraph [00125] of the instant application.

It is clear that Nam and Shimura both fail to teach this feature. As such, claim 5 not only is non-obvious over Nam in view of Shimura for being a dependent claim of claim 1, but also is non-obvious over Nam in view of Shimura independently as it recites the volume ratio of the inorganic particles to the binder which Nam and Shimura fail to teach.

CONCLUSION

Applicant believes that pending claims are in condition for examination on the merit and respectfully request the same.

Applicants believe that no additional fees are required with this submission. However, if Applicants are incorrect, the undersigned authorizes the Commissioner to charge any fees that may be required, or credit any overpayment to be made, to the **Taylor English Duma LLP Deposit Account No. 50-5154.**

Should the Examiner have any questions regarding this communication, the Examiner is invited to contact the undersigned at the telephone number shown below.

Respectfully submitted

Taylor English Duma LLP

Date: November 4, 2020

By: /zhaoyang li/
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EXAMINER
CHMIELECKI, SCOTT J

ART UNIT	PAPER NUMBER
1729	

DATE MAILED: 12/18/2020

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
16/013,887	06/20/2018	Jianjian Yi	76604-1012	3106

TITLE OF INVENTION: SEPARATOR AND ENERGY STORAGE DEVICE

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	03/18/2021

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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.

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(Signature)
(Date)

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
16/013,887	06/20/2018	Jianjian Yi	76604-1012	3106

TITLE OF INVENTION: SEPARATOR AND ENERGY STORAGE DEVICE

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	03/18/2021

EXAMINER	ART UNIT	CLASS-SUBCLASS
CHMIELECKI, SCOTT J	1729	429-144000

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

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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

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❑ 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.

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CosMX Exhibit 1002, Page 282 of 334

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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
16/013,887	06/20/2018	Jianjian Yi	76604-1012	3106

155692 7590 12/18/2020

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EXAMINER	
CHMIELECKI, SCOTT J	

ART UNIT	PAPER NUMBER
1729	

DATE MAILED: 12/18/2020

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.

PTOL-85 (Rev. 02/11)

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. 16/013,887	Applicant(s) Yi et al.	
	Examiner SCOTT J CHMIELECKI	Art Unit 1729	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 Amendment filed 4 November 2020.
   ☐ 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 1-2 and 4-18 . 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. 20201215.
5. ☑ Examiner's Amendment/Comment
6. ☑ Examiner's Statement of Reasons for Allowance
7. ☐ Other _____.

/SCOTT J. CHMIELECKI/
Primary Examiner, Art Unit 1729

DETAILED ACTION

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. The text of those sections of Title 35, U.S. Code not included in this action can be found in a prior Office action.

Election/Restrictions

1. Claims 1, 2, 4-10, and 18 are allowable. The restriction requirement between Groups I and II, as set forth in the Office action mailed on November 7, 2019, has been reconsidered in view of the allowability of claims to the elected invention pursuant to MPEP § 821.04(a). **The restriction requirement is hereby withdrawn as to any claim that requires all the limitations of an allowable claim.** Specifically, the restriction requirement of November 7, 2019 is withdrawn. Claims 10-17, directed to a method of making a separator, are no longer withdrawn from consideration because the claims require all the limitations of an allowable claim.

In view of the above noted withdrawal of the restriction requirement, applicant is advised that if any claim presented in a continuation or divisional application is anticipated by, or includes all the limitations of, a claim that is allowable in the present application, such claim may be subject to provisional statutory and/or nonstatutory double patenting rejections over the claims of the instant application.

Once a restriction requirement is withdrawn, the provisions of 35 U.S.C. § 121 are no longer applicable (see *In re Ziegler*, 443 F.2d 1211, 1215, 170 USPQ 129, 131-32 (CCPA 1971); see also MPEP § 804.01).

Claim Rejections - 35 USC § 112

2. The rejection of claims 1, 2, and 4-10 under 35 U.S.C. § 112(a) or pre-AIA 35 U.S.C. § 112, first paragraph, is withdrawn because Applicant amended claim 1.

3. The rejection of claims 1, 2, and 4-10 under 35 U.S.C. § 112(b) or pre-AIA 35 U.S.C. § 112, second paragraph, is withdrawn because Applicant amended claim 1.

Claim Rejections - 35 USC § 103

4. The rejection of claims 1, 2, and 4-10 under 35 U.S.C. § 103 as being unpatentable over Nam et al (US 2019/0355959 A1), hereinafter "Nam," in view of Shimura et al (US 2019/0123319 A1), hereinafter "Shimura," is withdrawn because Applicant amended claim 1 and Applicant's argument with respect to the ratio of the inorganic particles' Dv90 value to the porous layer's thickness is persuasive.

EXAMINER'S AMENDMENT

5. An examiner's amendment to the record appears below. Should the changes and/or additions be unacceptable to applicant, an amendment may be filed as provided by 37 CFR 1.312. To ensure consideration of such an amendment, it MUST be submitted no later than the payment of the issue fee.

6. Authorization for this examiner's amendment was given in an interview with Zhaoyang Li on Tuesday December 15, 2020.

The application has been amended as follows:

11. (Amended) A method for preparing [[a]]the separator of claim 1, wherein the method comprises steps of:

mixing inorganic particles with a binder to generate a mixture;

adding a first solvent into the mixture;

stirring the mixture with the first solvent to obtain a uniform coating solution;

coating the uniform coating solution onto a surface of a porous substrate to form a wet film;

the coating solution is in a range from 7% to 25%; and

wherein a ratio of Dv90 of the inorganic particles to the thickness of the porous layer is in a range from 0.3 to 3.0.

Allowable Subject Matter

7. Claims 1, 2, and 4-18 are allowed.

8. The following is an examiner's statement of reasons for allowance: no prior art reference could be found that fairly teaches or suggests a separator comprising a porous layer including inorganic particles wherein the ratio of the Dv90 of the inorganic particles to the porous layer's thickness is 0.3 to 3.0.

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."

Conclusion

Any inquiry concerning this communication or earlier communications from the examiner should be directed to SCOTT J CHMIELECKI whose telephone number is (571)270-5591. The examiner can normally be reached on M-F 8:30 am to 5 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, Ula Ruddock can be reached on 5712721481. 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.

/SCOTT J. CHMIELECKI/
Primary Examiner, Art Unit 1729

Examiner-Initiated Interview Summary	**Application No.** 16/013,887	**Applicant(s)** Yi et al.		
	Examiner SCOTT J CHMIELECKI	**Art Unit** 1729	**AIA (First Inventor to File) Status** Yes	**Page** 1 of 1

All Participants (applicant, applicants representative, PTO personnel)	**Title**	**Type**
SCOTT J CHMIELECKI	Primary Examiner	Telephonic
ZHAOYANG LI	Attorney	

Date of Interview: 15 December 2020

Issues Discussed:

Election/Restriction

Received Applicant's permission to amend withdrawn claim 11 to include the allowable subject matter of claim 1 in order to place the application in condition for allowance.

/SCOTT J. CHMIELECKI/ Primary Examiner, Art Unit 1729	

Applicant is reminded that a complete written statement as to the substance of the interview must be made of record in the application file. It is the applicants responsibility to provide the written statement, unless the interview was initiated by the Examiner and the Examiner has indicated that a written summary will be provided. See MPEP 713.04
Please further see:
MPEP 713.04
Title 37 Code of Federal Regulations (CFR) § 1.133 Interviews, paragraph (b)
37 CFR § 1.2 Business to be transacted in writing

Applicant recordation instructions: It is not necessary for applicant to provide a separate record of the substance of interview.

Examiner recordation instructions: Examiners must summarize the substance of any interview of record. A complete and proper recordation of the substance of an interview should include the items listed in MPEP 713.04 for complete and proper recordation including the identification of the general thrust of each argument or issue discussed, a general indication of any other pertinent matters discussed regarding patentability and the general results or outcome of the interview, to include an indication as to whether or not agreement was reached on the issues raised.

Notice of References Cited	Application/Control No. 16/013,887	Applicant(s)/Patent Under Reexamination Yi et al.	
	Examiner SCOTT J CHMIELECKI	Art Unit 1729	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-20190355953-A1	11-2019	NAM; Kwan Woo	H01M2/1686	1/1
*	B	US-20180123107-A1	05-2018	Yu; Sung-Hoon	H01M4/505	1/1
*	C	US-20190305278-A1	10-2019	Saeki; Hiroyuki	H01M4/62	1/1
*	D	US-20190123319-A1	04-2019	SHIMURA; Kenichi	H01M2/1646	1/1
	E					
	F					
	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
	16/013,887	Yi et al.
	Examiner	Art Unit
	SCOTT J CHMIELECKI	1729

CPC - Searched*		
Symbol	Date	Examiner
H01M 2/14, 145, 16, 1646, 1653, 166, 1686; 10/0525; Y02E 60/10 (text limited)	12/15/2020	SJC

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
Reviewed IDS documents, performed EAST text search for relevant prior art, & conducted Google Scholar search for relevant prior art; conducted inventor & assignee search.	01/08/2020	SJC
Reviewed previous prior art search.	04/16/2020	SJC
Reviewed previous prior art search.	07/30/2020	SJC
Reviewed & updated previous prior art search.	12/15/2020	SJC

Interference Search			
US Class/CPC Symbol	US Subclass/CPC Group	Date	Examiner
H01M	2/14, 145, 16, 1646, 1653, 166, 1686; 10/0525	12/15/2020	SJC
Y02E	60/10	12/15/2020	SJC

/SCOTT J. CHMIELECKI/ Primary Examiner, Art Unit 1729	

Search Notes	Application/Control No.	Applicant(s)/Patent Under Reexamination
	16/013,887	Yi et al.
	Examiner	Art Unit
	SCOTT J CHMIELECKI	1729

/SCOTT J. CHMIELECKI/ Primary Examiner, Art Unit 1729	

Issue Classification	Application/Control No.	Applicant(s)/Patent Under Reexamination
	16/013,887	Yi et al.
	Examiner	Art Unit
	SCOTT J CHMIELECKI	1729

CPC								
Symbol							Type	Version
H01M	/	2	/	1686			F	2013-01-01
H01M	/	2	/	166			I	2013-01-01
H01M	/	2	/	145			I	2013-01-01
H01M	/	10	/	0525			I	2013-01-01
H01M	/	2	/	1653			I	2013-01-01

CPC Combination Sets								
Symbol					Type	Set	Ranking	Version
	/		/					

NONE		Total Claims Allowed:	
(Assistant Examiner)	(Date)	17	
/SCOTT J. CHMIELECKI/ Primary Examiner, Art Unit 1729	15 December 2020	O.G. Print Claim(s)	O.G. Print Figure
(Primary Examiner)	(Date)	1	1

U.S. Patent and Trademark Office — Part of Paper No.: 20201215

Issue Classification	Application/Control No.	Applicant(s)/Patent Under Reexamination
	16/013,887	Yi et al.
	Examiner	Art Unit
	SCOTT J CHMIELECKI	1729

INTERNATIONAL CLASSIFICATION				
CLAIMED				
H01M2/16	/	2	/	16
H01M2/14	/	2	/	14

NON-CLAIMED				
	/		/	

US ORIGINAL CLASSIFICATION	
CLASS	SUBCLASS

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

NONE		Total Claims Allowed:	
(Assistant Examiner)	(Date)	17	
/SCOTT J. CHMIELECKI/ Primary Examiner, Art Unit 1729	15 December 2020	O.G. Print Claim(s)	O.G. Print Figure
(Primary Examiner)	(Date)	1	1

U.S. Patent and Trademark Office — Part of Paper No.: 20201215

Issue Classification	Application/Control No.	Applicant(s)/Patent Under Reexamination
	16/013,887	Yi et al.
	Examiner	Art Unit
	SCOTT J CHMIELECKI	1729

☐ 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
1	1	9	10												
2	2	10	11												
-	3	11	12												
3	4	12	13												
4	5	13	14												
5	6	14	15												
6	7	15	16												
7	8	16	17												
8	9	17	18												

NONE		Total Claims Allowed:	
(Assistant Examiner)	(Date)	17	
/SCOTT J. CHMIELECKI/ Primary Examiner, Art Unit 1729	15 December 2020	O.G. Print Claim(s)	O.G. Print Figure
(Primary Examiner)	(Date)	1	1

U.S. Patent and Trademark Office Part of Paper No.: 20201215

EAST Search History

EAST Search History (Prior Art)

Ref #	Hits	Search Query	DBs	Default Operator	Plurals	Time Stamp
L4	2	inorganic ADJ particle NEAR3 (diameter radius "dv90" "d.sub.v90" size) WITH ratio WITH porous NEAR3 (layer film coat$3) WITH (depth thick$4)	FPRS; EPO; JPO	OR	ON	2020/12/15 11:05
L7	314	separator WITH binder WITH inorganic ADJ particle AND inorganic ADJ particle SAME (alumina silica magnesia (titanium hafnium tin zirconia nickel zinc calcium) ADJ oxide cerium ADJ dioxide boehmite (aluminum magnesium calcium) ADJ hydroxide barium ADJ sulfate) AND binder SAME (polyvinylidene ADJ fluoride pvdf vinylidene ADJ fluoride ADJ hexafluoroproyplene polyamide polyacrylonitrile polyacrylate polyacrylic ADJ acid sodium ADJ carboxymethylcellulose polyvinylpyrrolidone polyvinyl ADJ ether polymethyl ADJ methacrylate polytetrafluoroethylene ptfe polyhexafluoropropylene)	US-PGPUB; USPAT	OR	ON	2020/12/15 11:44
L8	4	L7 AND particle NEAR3 (diameter radius "dv90" "d.sub.v90" size) WITH ratio WITH porous NEAR3 (layer film coat$3) WITH (depth thick$4)	US-PGPUB; USPAT	OR	ON	2020/12/15 11:44
L9	39	(H01M2/1686 or H01M2/166 or H01M2/145 or H01M10/0525 or H01M2/1653 or Y02E60/10 or H01M2/16 or H01M2/14 or H01M2/1646).cpc. AND particle NEAR3 (diameter radius "dv90" "d.sub.v90" size) WITH ratio WITH porous NEAR3 (layer film coat$3) WITH (depth thick$4) NOT L8	US-PGPUB; USPAT	OR	ON	2020/12/15 11:44
S1	245	separator WITH binder WITH inorganic ADJ particle AND inorganic ADJ particle SAME (alumina silica magnesia (titanium hafnium tin zirconia nickel zinc calcium) ADJ oxide cerium ADJ dioxide boehmite (aluminum magnesium calcium) ADJ hydroxide barium ADJ sulfate) AND binder SAME (polyvinylidene ADJ fluoride pvdf vinylidene ADJ fluoride ADJ hexafluoroproyplene polyamide polyacrylonitrile polyacrylate polyacrylic ADJ acid sodium ADJ carboxymethylcellulose polyvinylpyrrolidone polyvinyl ADJ ether polymethyl ADJ methacrylate polytetrafluoroethylene ptfe polyhexafluoropropylene)	US-PGPUB; USPAT	OR	ON	2020/01/08 17:46

S2	166	S1 AND porous ADJ (substrate layer film base)	US-PGPUB; USPAT	OR	ON	2020/01/08 17:47
S3	3	S2 AND "dv90"	US-PGPUB; USPAT	OR	ON	2020/01/08 18:22
S4	0	S1 AND "dv90" NOT S3	US-PGPUB; USPAT	OR	ON	2020/01/08 18:23
S5	0	separator WITH binder WITH inorganic ADJ particle AND inorganic ADJ particle SAME (alumina silica magnesia (titanium hafnium tin zirconia nickel zinc calcium) ADJ oxide cerium ADJ dioxide boehmite (aluminum magnesium calcium) ADJ hydroxide barium ADJ sulfate) AND binder SAME (polyvinylidene ADJ fluoride pvdf vinylidene ADJ fluoride ADJ hexafluoroproyplene polyamide polyacrylonitrile polyacrylate polyacrylic ADJ acid sodium ADJ carboxymethylcellulose polyvinylpyrrolidone polyvinyl ADJ ether polymethyl ADJ methacrylate polytetrafluoroethylene ptfe polyhexafluoropropylene)	FPRS; EPO; JPO	OR	ON	2020/01/08 18:31
S6	1	separator WITH binder WITH inorganic ADJ particle AND "dv90"	FPRS; EPO; JPO	OR	ON	2020/01/08 18:32
S7	3	separator WITH binder WITH inorganic ADJ particle AND "dv90"	US-PGPUB; USPAT	OR	ON	2020/01/08 18:32
S8	127	S2 AND particle ADJ size	US-PGPUB; USPAT	OR	ON	2020/01/08 18:39
S9	100	S2 AND particle ADJ size WITH inorganic	US-PGPUB; USPAT	OR	ON	2020/01/08 18:40
S10	1	(ningde ADJ amperex.AS. (yi zhang wei tao).IN.) AND (inorganic ADJ particle WITH porous ADJ substrate WITH porous ADJ layer WITH "dv90").CLM.	US-PGPUB; USPAT	OR	ON	2020/01/08 20:08
S11	314	separator WITH binder WITH inorganic ADJ particle AND inorganic ADJ particle SAME (alumina silica magnesia (titanium hafnium tin zirconia nickel zinc calcium) ADJ oxide cerium ADJ dioxide boehmite (aluminum magnesium calcium) ADJ hydroxide barium ADJ sulfate) AND binder SAME (polyvinylidene ADJ fluoride pvdf vinylidene ADJ fluoride ADJ hexafluoroproyplene polyamide polyacrylonitrile polyacrylate polyacrylic ADJ acid sodium ADJ	US-PGPUB; USPAT	OR	ON	2020/12/15 09:30

		carboxymethylcellulose polyvinylpyrrolidone polyvinyl ADJ ether polymethyl ADJ methacrylate polytetrafluoroethylene ptfe polyhexafluoropropylene)				
S12	4	S11 AND particle NEAR3 (diameter radius "dv90" "d.sub.v90" size) WITH ratio WITH porous NEAR3 (layer film coat$3) WITH (depth thick$4)	US-PGPUB; USPAT	OR	ON	2020/12/15 09:30
S13	4	inorganic ADJ particle NEAR3 (diameter radius "dv90" "d.sub.v90" size) WITH ratio WITH porous NEAR3 (layer film coat$3) WITH (depth thick$4) NOT S12	US-PGPUB; USPAT	OR	ON	2020/12/15 09:54

12/15/2020 12:07:37 PM
C:\Users\schmielecki\Documents\EAST\Workspaces\16\013887.wsp

Electronic Acknowledgement Receipt	
EFS ID:	41667947
Application Number:	16013887
International Application Number:	
Confirmation Number:	3106
Title of Invention:	SEPARATOR AND ENERGY STORAGE DEVICE
First Named Inventor/Applicant Name:	Jianjian Yi
Customer Number:	155692
Filer:	Zhaoyang Li
Filer Authorized By:	
Attorney Docket Number:	76604-1012
Receipt Date:	16-JAN-2021
Filing Date:	20-JUN-2018
Time Stamp:	11:58:14
Application Type:	Utility under 35 USC 111(a)

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	Amendment after Notice of Allowance (Rule 312)	01938807.PDF	126530 90e427aa7156bf9c35c9240caf9ccbe94c47ee9c	no	6
Warnings:					

Information:	
Total Files Size (in bytes):	126530

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.

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Application of: NINGDE AMPEREX TECHNOLOGY LIMITED	Examiner: CHMIELECKI. SCOTT J
Serial No.: 16/013,887	Group Art Unit: 1729
Filing Date: June 20, 2018	Confirmation No.: 3106
For: SEPARATOR AND ENERGY STORAGE DEVICE	Customer No.: 155692

MAIL STOP: **Submitted via EFS**
Commissioner for Patents
P.O. Box 1450
Alexandria, Virginia 22313-1450

SUBMISSION UNDER 37 CFR 1.132

Dear Examiner:

This submission responds to the Notice of Allowance mailed on December 18, 2020 and the telephonic conversation on January 15, 2021, initiated by the Office. Please consider the amendment to claims and remarks as follows.

Claims are reflected in the Listing of Claims that begins at page 2.

Remarks begin on page 5 of this paper.

LISTING OF THE CLAIMS

The following listing of claims will replace all prior versions, and listings, of claims in the present application:

1. (Currently Amended) A separator, comprising: a porous substrate; and

a porous layer arranged on a surface of the porous substrate, wherein the porous layer comprises inorganic particles and a binder, and a ratio of Dv90 of the inorganic particles to the thickness of the porous layer is in a range from 0.3 to 3.0.

2. (Original) The separator according to claim 1, wherein the porous layer has a thickness of 0.2 μm to 10 μm.

3. (Canceled).

4. (Previously Presented) The separator according to claim 1, wherein the pores have an average pore size of 0.3 μm to 20 μm.

5. (Original) The separator according to claim 1, wherein a volume ratio of the inorganic particles to the binder is in a range from 0.2 to 3.0.

6. (Original) The separator according to claim 1, wherein the porous layer has a porosity of 20% to 90%.

7. (Original) The separator according to claim 1, wherein the inorganic particles are one or more selected from the group consisting of alumina, silica, magnesia, titanium oxide, hafnium dioxide, tin oxide, zirconia, cerium dioxide, nickel oxide, zinc oxide, calcium oxide, boehmite, aluminum hydroxide, magnesium hydroxide, calcium hydroxide, and barium sulfate.

8. (Original) The separator according to claim 1, wherein the binder is one or more selected from the group consisting of polyvinylidene fluoride, vinylidene fluoride-hexafluoropropylene copolymer, polyamide, polyacrylonitrile, polyacrylate, polyacrylic acid, polyacrylates, sodium carboxymethylcellulose, polyvinylpyrrolidone, polyvinyl ether, polymethyl methacrylate, polytetrafluoroethylene and polyhexafluoropropylene.

9. (Original) An energy storage device, comprising the separator according to claim 1.

10. (Original) The energy storage device according to claim 9, wherein the energy storage device

is a lithium-ion battery.

11. (Withdrawn-Previously presented) A method for preparing the separator of claim 1, wherein the method comprises steps of:

mixing inorganic particles with a binder to generate a mixture;

adding a first solvent into the mixture;

stirring the mixture with the first solvent to obtain a uniform coating solution; coating the uniform coating solution onto a surface of a porous substrate to form a wet film;

the coating solution is in a range from 7% to 25%; and

wherein a ratio of Dv90 of the inorganic particles to the thickness of the porous layer is in a range from 0.3 to 3.0.

12. (Withdrawn) The method according to claim 11, wherein the solid content in the coating solution is in a range from 7% to 25%.

13. (Withdrawn) The method according to claim 11, wherein the coagulating

solution comprises a second solvent and a third solvent, and the second solvent has a mass percentage of 20% to 60%.

14. (Withdrawn) The method according to claim 11, wherein the first solvent is one or more independently selected from the group consisting of N-methylpyrrolidone , dimethylacetamide and dimethylformamide.

15. (Withdrawn) The method according to claim 11, wherein the porous substrate comprises a polymer film, a multilayer polymer film, or a non-woven fabric formed by any one or more of the following polymers: polyethylene, polypropylene, polyethylene terephthalate, polyphthaloyl diamine, polybutylene terephthalate, polyester, polyacetal, polyamide, polyimide, polyetheretherketone , polyaryletherketone, polyetherimide, polyamide imide, polybenzimidazole, polyethersulfone, polyphenylene oxide, cycloolefin copolymer, polyphenylene sulfide, and polyethylene naphthalene.

16. (Withdrawn) The method according to claim 15, wherein the polyethylene is at least one selected from the group consisting of high density polyethylene, low density polyethylene, and ultrahigh molecular weight polyethylene.

17. (Withdrawn) The method according to claim 13, wherein the second solvent is one or more independently selected from the group consisting of N-methylpyrrolidone, dimethylacetamide and dimethylformamide, and the third solvent is one or more selected from the group consisting of deionized water, ethanol, propanol, acetone, dimethyl carbonate and diethyl carbonate.

18. (Previously presented) The separator according to claim 1, wherein the porous layer has pores formed by the binder, at least a part of the inorganic particles are embedded in the pores.

REMARKS

Claims 1-2, and 4-18 are currently pending.

Withdrawn claims 11-17 were previously rejoined.

Claims 1-2, 4-10 and 18 are allowed.

This paper is submitted to provide the listing of claim 12, which was missing from the listing of claims in the previous submission.

Applicant gratefully appreciates the Examiner's guidance.

CONCLUSION

All claims are allowed. Applicants believe that no additional fees are required with this submission. However, if Applicants are incorrect, the undersigned authorizes the Commissioner to charge any fees that may be required, or credit any overpayment to be made, to the **Taylor English Duma LLP Deposit Account No. 50-5154.**

Should the Examiner have any questions regarding this communication, the Examiner is invited to contact the undersigned at the telephone number shown below.

Respectfully submitted

Taylor English Duma LLP

Date: January 16, 2021

By: /zhaoyang li/
Zhaoyang Li, Ph.D.
Reg. No. 46,872
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Atlanta, Georgia 30339
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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.
16/013,887	06/20/2018	Jianjian Yi	76604-1012	3106

155692 7590 01/22/2021

Taylor English Duma LLP - Remote
1600 Parkwood Circle, Suite 200
Atlanta, GA 30339

EXAMINER	
AMPONSAH, OSEI K	

ART UNIT	PAPER NUMBER
1729	

NOTIFICATION DATE	DELIVERY MODE
01/22/2021	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):

rdocketing@taylorenglish.com

Notice of Allowability	Application No. 16/013,887	Applicant(s) Yi et al.	
	Examiner OSEI K AMPONSAH	Art Unit 1729	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 Response filed 16 January 2021.
   ☐ 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 1-2 and 4-18 . 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 _____.

/OSEI K AMPONSAH/
Primary Examiner, Art Unit 1729

DETAILED ACTION

Response to Arguments

This communication is in responsive to the Response filed **01-16-2021**. Claims 1-2 and 4-18 are currently pending.

Election/Restrictions

Claims 1, 2, 4-10, and 18 are allowable. The restriction requirement between Groups I and II, as set forth in the Office action mailed on November 7, 2019, has been reconsidered in view of the allowability of claims to the elected invention pursuant to MPEP § 821.04(a). **The restriction requirement is hereby withdrawn as to any claim that requires all the limitations of an allowable claim.** Specifically, the restriction requirement of November 7, 2019 is withdrawn. Claims 11-17, directed to a method of making a separator, are no longer withdrawn from consideration because the claims require all the limitations of an allowable claim.

In view of the above noted withdrawal of the restriction requirement, applicant is advised that if any claim presented in a continuation or divisional application is anticipated by, or includes all the limitations of, a claim that is allowable in the present application, such claim may be subject to provisional statutory and/or nonstatutory double patenting rejections over the claims of the instant application.

Once a restriction requirement is withdrawn, the provisions of 35 U.S.C. § 121 are no longer applicable (see *In re Ziegler*, 443 F.2d 1211, 1215, 170 USPQ 129, 131-32 (CCPA 1971); see also MPEP § 804.01).

Claim Rejections - 35 USC § 112

The rejection of claims 1, 2, and 4-10 under 35 U.S.C. § 112(a) or pre-AIA 35 U.S.C. § 112, first paragraph, is withdrawn because Applicant amended claim 1.

The rejection of claims 1, 2, and 4-10 under 35 U.S.C. § 112(b) or pre-AIA 35 U.S.C. § 112, second paragraph, is withdrawn because Applicant amended claim 1.

Claim Rejections - 35 USC § 103

The rejection of claims 1, 2, and 4-10 under 35 U.S.C. § 103 as being unpatentable over Nam et al (US 2019/0355959 A1), hereinafter "Nam," in view of Shimura et al (US 2019/0123319 A1), hereinafter "Shimura," is withdrawn because Applicant amended claim 1 and Applicant's argument with respect to the ratio of the inorganic particles' Dv90 value to the porous layer's thickness is persuasive.

EXAMINER'S AMENDMENT

An examiner's amendment to the record appears below. Should the changes and/or additions be unacceptable to applicant, an amendment may be filed as provided by 37 CFR 1.312. To ensure consideration of such an amendment, it MUST be submitted no later than the payment of the issue fee.

Authorization for this examiner's amendment was given in an interview with Zhaoyang Li on Tuesday December 15, 2020.

The application has been amended as follows:

11. (Amended) A method for preparing [[a]]the separator of claim 1, wherein the method

comprises steps of:

mixing inorganic particles with a binder to generate a mixture;

adding a first solvent into the mixture;

stirring the mixture with the first solvent to obtain a uniform coating solution; coating the uniform coating solution onto a surface of a porous substrate to form a wet film;

the coating solution is in a range from 7% to 25%; and

wherein a ratio of Dv90 of the inorganic particles to the thickness of the porous layer is in a range from 0.3 to 3.0.

Allowable Subject Matter

Claims 1, 2, and 4-18 are allowed.

The following is an examiner's statement of reasons for allowance: no prior art reference could be found that fairly teaches or suggests a separator comprising a porous layer including inorganic particles wherein the ratio of the Dv90 of the inorganic particles to the porous layer's thickness is 0.3 to 3.0.

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."

Conclusion

Any inquiry concerning this communication or earlier communications from the examiner should be directed to OSEI K AMPONSAH whose telephone number is (571)270-3446. The examiner can normally be reached on Monday - Friday, 8:00 am - 5:00 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, Ula C Ruddock can be reached on (571)272-1481. 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.

/OSEI K AMPONSAH/
Primary Examiner, Art Unit 1729

Issue Classification	Application/Control No.	Applicant(s)/Patent Under Reexamination
	16/013,887	Yi et al.
	Examiner	Art Unit
	OSEI K AMPONSAH	1729

CPC								
Symbol							Type	Version
H01M	/	50	/	449			F	2021-01-01
H01M	/	10	/	0525			I	2013-01-01
H01M	/	50	/	403			I	2021-01-01
H01M	/	50	/	411			I	2021-01-01
H01M	/	50	/	446			I	2021-01-01

CPC Combination Sets								
Symbol							Type	Set	Ranking	Version
	/		/							

NONE		Total Claims Allowed:	
(Assistant Examiner)	(Date)	17	
/OSEI K AMPONSAH/ Primary Examiner, Art Unit 1729	16 January 2021	O.G. Print Claim(s)	O.G. Print Figure
(Primary Examiner)	(Date)	1	1

U.S. Patent and Trademark Office — Part of Paper No.: 20210116

Issue Classification	Application/Control No.	Applicant(s)/Patent Under Reexamination
	16/013,887	Yi et al.
	Examiner	Art Unit
	OSEI K AMPONSAH	1729

INTERNATIONAL CLASSIFICATION				
CLAIMED				
H01M2/16	/	2	/	16
H01M2/14	/	2	/	14

NON-CLAIMED				
	/		/	

US ORIGINAL CLASSIFICATION	
CLASS	SUBCLASS

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

NONE		Total Claims Allowed:	
(Assistant Examiner)	(Date)	17	
/OSEI K AMPONSAH/ Primary Examiner, Art Unit 1729	16 January 2021	O.G. Print Claim(s)	O.G. Print Figure
(Primary Examiner)	(Date)	1	1

U.S. Patent and Trademark Office

Part of Paper No.: 20210116

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	OSEI K AMPONSAH	1729

☐ 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
1	1	9	10												
2	2	10	11												
-	3	11	12												
3	4	12	13												
4	5	13	14												
5	6	14	15												
6	7	15	16												
7	8	16	17												
8	9	17	18												

NONE		Total Claims Allowed:	
(Assistant Examiner)	(Date)	17	
/OSEI K AMPONSAH/ Primary Examiner, Art Unit 1729	16 January 2021	O.G. Print Claim(s)	O.G. Print Figure
(Primary Examiner)	(Date)	1	1

U.S. Patent and Trademark Office Part of Paper No.: 20210116

Index of Claims	Application/Control No.	Applicant(s)/Patent Under Reexamination
	16/013,887	Yi et al.
	Examiner	Art Unit
	OSEI K AMPONSAH	1729

✓	Rejected	-	Cancelled	N	Non-Elected	A	Appeal
=	Allowed	÷	Restricted	I	Interference	O	Objected

CLAIMS

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CLAIM		DATE								
Final	Original	11/07/2019	01/08/2020	04/16/2020	07/30/2020	01/16/2021				
1	1	÷	✓	✓	✓	=				
2	2	÷	✓	✓	✓	=				
-	3	÷	✓	✓	-	-				
3	4	÷	✓	✓	✓	=				
4	5	÷	✓	✓	✓	=				
5	6	÷	✓	✓	✓	=				
6	7	÷	✓	✓	✓	=				
7	8	÷	✓	✓	✓	=				
8	9	÷	✓	✓	✓	=				
9	10	÷	✓	✓	✓	=				
10	11	÷	N	N	N	=				
11	12	÷	N	N	N	=				
12	13	÷	N	N	N	=				
13	14	÷	N	N	N	=				
14	15	÷	N	N	N	=				
15	16	÷	N	N	N	=				
16	17	÷	N	N	N	=				
17	18					=				

Search Notes	Application/Control No.	Applicant(s)/Patent Under Reexamination
	16/013,887	Yi et al.
	Examiner	Art Unit
	OSEI K AMPONSAH	1729

CPC - Searched*		
Symbol	Date	Examiner
H01M 2/14, 145, 16, 1646, 1653, 166, 1686; 10/0525; Y02E 60/10 (text limited)	12/15/2020	SJC

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
Reviewed IDS documents, performed EAST text search for relevant prior art, & conducted Google Scholar search for relevant prior art; conducted inventor & assignee search.	01/08/2020	SJC
Reviewed previous prior art search.	04/16/2020	SJC
Reviewed previous prior art search.	07/30/2020	SJC
Reviewed & updated previous prior art search.	12/15/2020	SJC

Interference Search			
US Class/CPC Symbol	US Subclass/CPC Group	Date	Examiner
H01M	2/14, 145, 16, 1646, 1653, 166, 1686; 10/0525	12/15/2020	SJC
Y02E	60/10	12/15/2020	SJC

/OSEI K AMPONSAH/ Primary Examiner, Art Unit 1729	

Search Notes	Application/Control No.	Applicant(s)/Patent Under Reexamination
	16/013,887	Yi et al.
	Examiner	Art Unit
	OSEI K AMPONSAH	1729

/OSEI K AMPONSAH/ Primary Examiner, Art Unit 1729	

OK TO ENTER: /O.K.A/

Attorney Docket No.: 76604-1012 01/16/2021 Application No. 16/013,887

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Application of: NINGDE AMPEREX TECHNOLOGY LIMITED	Examiner: CHMIELECKI. SCOTT J
Serial No.: 16/013,887	Group Art Unit: 1729
Filing Date: June 20, 2018	Confirmation No.: 3106
For: SEPARATOR AND ENERGY STORAGE DEVICE	Customer No.: 155692

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16. (Withdrawn) The method according to claim 15, wherein the polyethylene is at least one selected from the group consisting of high density polyethylene, low density polyethylene, and ultrahigh molecular weight polyethylene.

17. (Withdrawn) The method according to claim 13, wherein the second solvent is one or more independently selected from the group consisting of N-methylpyrrolidone, dimethylacetamide and dimethylformamide, and the third solvent is one or more selected from the group consisting of deionized water, ethanol, propanol, acetone, dimethyl carbonate and diethyl carbonate.

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Respectfully submitted

Taylor English Duma LLP

Date: January 16, 2021

By: /zhaoyang li/
Zhaoyang Li, Ph.D.
Reg. No. 46,872
Attorney for Applicants

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Fax: (415) 851-8868
zli@taylorenglish.com
Customer No.: 155692

Bibliographic Data

Application No: 16/013,887

Foreign Priority claimed: (•) Yes ( ) No

35 USC 119 (a-d) conditions met: [✓] Yes [ ] No [ ] Met After Allowance

Verified and Acknowledged: /OSEI K AMPONSAH/ Examiner's Signature [ ] Initials

Title: SEPARATOR AND ENERGY STORAGE DEVICE

FILING or 371(c) DATE	CLASS	GROUP ART UNIT	ATTORNEY DOCKET NO.
06/20/2018	429	1729	76604-1012
RULE			

APPLICANTS

Ningde Amperex Technology Limited, Ningde, CHINA

INVENTORS

Jianjian Yi, Ningde, CHINA

Xinzhi Zhang, Ningde, CHINA

Zengbin Wei, Ningde, CHINA

Xinghua Tao, Ningde, CHINA

CONTINUING DATA

FOREIGN APPLICATIONS

CHINA CN201810321779.5 04/11/2018

IF REQUIRED, FOREIGN LICENSE GRANTED**

07/09/2018

STATE OR COUNTRY

CHINA

ADDRESS

Taylor English Duma LLP - Remote
1600 Parkwood Circle, Suite 200
Atlanta, GA 30339
UNITED STATES

FILING FEE RECEIVED

$1,720

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)

155692 7590 12/18/2020
Taylor English Duma LLP - Remote
1600 Parkwood Circle, Suite 200
Atlanta, GA 30339

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.
16/013,887	06/20/2018	Jianjian Yi	76604-1012	3106

TITLE OF INVENTION: SEPARATOR AND ENERGY STORAGE DEVICE

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	03/18/2021

EXAMINER	ART UNIT	CLASS-SUBCLASS
CHMIELECKI, SCOTT J	1729	429-144000

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/SB/122) attached.

☐ "Fee Address" indication (or "Fee Address" Indication form PTO/SB/47; Rev 03-09 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 Taylor English Duma 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	(B) RESIDENCE: (CITY and STATE OR COUNTRY)
Ningde Amperex Technology Limited	Ningde, China

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. 50-5154

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 /zhaoyang li/ Date 2021-02-22

Typed or printed name Zhaoyang Li Registration No. 46,872

PTOL-85 Part B (08-18) Approved for use through 01/31/2020 OMB 0651-0033 U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE

CosMX Exhibit 1002, Page 328 of 334

Electronic Patent Application Fee Transmittal	
Application Number:	16013887
Filing Date:	20-Jun-2018
Title of Invention:	SEPARATOR AND ENERGY STORAGE DEVICE
First Named Inventor/Applicant Name:	Jianjian Yi
Filer:	Zhaoyang Li/Pamela Harrison
Attorney Docket Number:	76604-1012
Filed as Large Entity	
Filing Fees for Utility under 35 USC 111(a)	

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:	41988147
Application Number:	16013887
International Application Number:	
Confirmation Number:	3106
Title of Invention:	SEPARATOR AND ENERGY STORAGE DEVICE
First Named Inventor/Applicant Name:	Jianjian Yi
Customer Number:	155692
Filer:	Zhaoyang Li/Pamela Harrison
Filer Authorized By:	Zhaoyang Li
Attorney Docket Number:	76604-1012
Receipt Date:	23-FEB-2021
Filing Date:	20-JUN-2018
Time Stamp:	11:13:23
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	yes
Payment Type	CARD
Payment was successfully received in RAM	$1200
RAM confirmation Number	E20212MB13544937
Deposit Account	505154
Authorized User	Pamela Harrison
The Director of the USPTO is hereby authorized to charge indicated fees and credit any overpayment as follows: 37 CFR 1.16 (National application filing, search, and examination fees) 37 CFR 1.17 (Patent application and reexamination processing fees)	

37 CFR 1.19 (Document supply fees)

37 CFR 1.20 (Post Issuance fees)

37 CFR 1.21 (Miscellaneous fees and charges)

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)	01975258.PDF	898907 13178851b32bf28698c1727e3a4a3b68004da936	no	1
Warnings:					
Information:					
2	Fee Worksheet (SB06)	fee-info.pdf	30208 e940374caba276d75ef733bb88a4c6a6015f5261	no	2
Warnings:					
Information:					
		Total Files Size (in bytes):	929115		

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.

UNITED STATES PATENT AND TRADEMARK OFFICE

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

APPLICATION NO.	ISSUE DATE	PATENT NO.	ATTORNEY DOCKET NO.	CONFIRMATION NO.
16/013,887	03/30/2021	10964987	76604-1012	3106

155692 7590 03/10/2021

Taylor English Duma LLP - Remote
1600 Parkwood Circle, Suite 200
Atlanta, GA 30339

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 79 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 Data Management (ODM) at (571)-272-4200.

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

Ningde Amperex Technology Limited, Ningde, CHINA;
Jianjian Yi, Ningde, CHINA;
Xinzhi Zhang, Ningde, CHINA;
Zengbin Wei, Ningde, CHINA;
Xinghua Tao, Ningde, CHINA;

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)

AO 120 (Rev. 08/10)

TO:	**Mail Stop 8 Director of the U.S. Patent and Trademark Office P.O. Box 1450 Alexandria, VA 22313-1450**	**REPORT ON THE FILING OR DETERMINATION OF AN ACTION REGARDING A PATENT OR TRADEMARK**

In Compliance with 35 U.S.C. § 290 and/or 15 U.S.C. § 1116 you are hereby advised that a court action has been filed in the U.S. District Court Eastern District of Texas on the following

☐ Trademarks or ☑ Patents. (☐ the patent action involves 35 U.S.C. § 292.):

DOCKET NO.	DATE FILED	U.S. DISTRICT COURT
2:22-cv-232	6/24/2022	Eastern District of Texas

PLAINTIFF	DEFENDANT
Ningde Amperex Technology Limited	Zhuhai CosMX Battery Co., Ltd.

	PATENT OR TRADEMARK NO.	DATE OF PATENT OR TRADEMARK	HOLDER OF PATENT OR TRADEMARK
1	10,971,706	4/6/2021	Ningde Amperex Technology Limited
2	11,329,352	5/10/2022	Ningde Amperex Technology Limited
3			
4			
5			

In the above—entitled case, the following patent(s)/ trademark(s) have been included:

DATE INCLUDED	INCLUDED BY ☑ Amendment ☐ Answer ☐ Cross Bill ☐ Other Pleading	
8/4/2022		
PATENT OR TRADEMARK NO.	DATE OF PATENT OR TRADEMARK	HOLDER OF PATENT OR TRADEMARK
1 10,833,363	11/10/2020	Ningde Amperex Technology Limited
2 10,964,987	3/30/2021	Ningde Amperex Technology Limited
3		
4		
5		

In the above—entitled case, the following decision has been rendered or judgement issued:

DECISION/JUDGEMENT

CLERK	(BY) DEPUTY CLERK	DATE

Copy 1—Upon initiation of action, mail this copy to Director Copy 3—Upon termination of action, mail this copy to Director
Copy 2—Upon filing document adding patent(s), mail this copy to Director Copy 4—Case file copy