CUSTOMER NUMBER:	38327

ATTORNEY DOCKET NUMBER: LEEL-0101

THE COMMISSIONER OF PATENTS AND TRADEMARKS
WASHINGTON, D.C. 20231

Sir:

Transmitted herewith for filing is the Utility patent application of:

INVENTOR:	**(1) Xinru SU (2) Baozhang LI (3) Yisong SU and (4) Zhiwen XIAO**
For:	**CATHODE, ELECTROCHEMICAL DEVICE AND ELECTRONIC DEVICE COMPRISING SAME**

Enclosed are:

- ☒ Specification with claims and abstract
- ☒ Executed Declarations
- ☒ Priority claim based on China Patent Application No. 201811308841.3 filed November 5, 2018.
- ☒ 4 sheets of ☒ formal ☐ informal drawings
- ☒ Assignment to NINGDE AMPEREX TECHNOLOGY LIMITED
- ☒ Power of Attorney
- ☒ Assignee Statement under 37 CFR §3.73(c)
- ☒ Preliminary Amendment
- ☒ The filing fee is calculated as shown below:

FOR	NUMBER FILED		NUMBER EXTRA	RATE	CALCULATIONS
TOTAL CLAIMS	20	-20	0	x$100=	$0.00
INDEPENDENT CLAIMS	3	-3	0	x$460 =	0
MULTIPLE DEPENDENT CLAIM(S) (if applicable)				+$820 =	0
APPLICATION SIZE (42 PAGES)	SETS OF 50 SHEETS IN EXCESS OF 100 SHEETS=			x$400 =	
			BASIC FILING FEE		$300.00
			SEARCH FEE		$660.00
			EXAMINATION FEE		$760.00
			TOTAL OF ABOVE		$1,720.00
REDUCTION FOR FILING BY SMALL ENTITY (Note 37 C.F.R. §§ 1.9, 1.27, 1.28).					0
				TOTAL	**$1,720.00**

☒ Payment of **$1,720.00** to cover the filing fee is being paid through credit card payment procedure.

☐ Applicant(s) qualifies for small entity status.

☒ The Commissioner is hereby authorized to charge any additional fees associated with this communication, including patent application filing fees and processing fees under 37 C.F.R.§ 1.16 and 1.17, or credit any overpayment to **Deposit Account Number 60-0155**

Respectfully submitted,

/juan.carlos.a.marquez/

Juan Carlos A. Marquez
Registration Number 34,072

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Customer No. 38327
March 11, 2019

Zhuhai CosMX Battery Co. EX1002
Zhuhai CosMX Battery Co. v. Ningde Amperex Tech. Ltd.

PTO/AIA/14 (11-15)
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Application Data Sheet 37 CFR 1.76	Attorney Docket Number	LEEL-0101
	Application Number	
Title of Invention	CATHODE, ELECTROCHEMICAL DEVICE AND ELECTRONIC DEVICE COMPRISING SAME	

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
	Xinru		SU	

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

City	Ningde City, Fujian Province	Country of Residence [i]	CN

Mailing Address of Inventor:

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

Inventor 2 Remove

Legal Name

Prefix	Given Name	Middle Name	Family Name	Suffix
	Baozhang		LI	

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

City	Ningde City, Fujian Province	Country of Residence [i]	CN

Mailing Address of Inventor:

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

Inventor 3 Remove

Legal Name

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Prefix	Given Name	Middle Name	Family Name	Suffix
	Yisong		SU	

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

City	Ningde City, Fujian Province	Country of Residence [i]	CN

Mailing Address of Inventor:

Address 1	No. 1, Xingang Road, Zhangwan Town
Address 2	Jiaocheng District

City	Ningde City, Fujian Province	State/Province	
Postal Code	352100	**Country** [i]	CN

Inventor 4 Remove

Legal Name

Prefix	Given Name	Middle Name	Family Name	Suffix
	Zhiwen		XIAO	

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

City	Ningde City, Fujian Province	Country of Residence [i]	CN

Mailing Address of Inventor:

Address 1	No. 1, Xingang Road, Zhangwan Town
Address 2	Jiaocheng District

City	Ningde City, Fujian Province	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	38327		
Email Address	mail@marqueziplaw.com	Add Email	Remove Email
Email Address	juancarlos@marqueziplaw.com	Add Email	Remove Email

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Application Information:

Title of the Invention	CATHODE, ELECTROCHEMICAL DEVICE AND ELECTRONIC DEVICE COMPRISING SAME		
Attorney Docket Number	LEEL-0101	**Small Entity Status Claimed**	☐
Application Type	Nonprovisional		
Subject Matter	Utility		
Total Number of Drawing Sheets (if any)	4	**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	38327		

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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)
201811308841.3	CN	2018-11-05	B711

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	LEEL-0101
	Application Number	
Title of Invention	CATHODE, ELECTROCHEMICAL DEVICE AND ELECTRONIC DEVICE COMPRISING SAME	

Authorization or Opt-Out of Authorization to Permit Access:

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

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

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

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

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

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

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

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

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

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

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

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Application Data Sheet 37 CFR 1.76	Attorney Docket Number	LEEL-0101
	Application Number	
Title of Invention	CATHODE, ELECTROCHEMICAL DEVICE AND ELECTRONIC DEVICE COMPRISING SAME	

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		
Address 2	Jiaocheng District		
City	Ningde City, Fujian Province	**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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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	/juan.carlos.a.marquez/			Date (YYYY-MM-DD)	2019-03-11
First Name	Juan Carlos	Last Name	Marquez	Registration Number	34072

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	LEEL-0101
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Title of Invention	CATHODE, ELECTROCHEMICAL DEVICE AND ELECTRONIC DEVICE COMPRISING SAME	

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.**

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

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

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

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

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

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

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

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

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

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

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

CATHODE, ELECTROCHEMICAL DEVICE AND ELECTRONIC DEVICE COMPRISING SAME

CROSS REFERENCE TO RELATED APPLICATIONS

The present application claims the benefit of priority from the China Patent Application No. 201811308841.3, filed on 5 November 2018, the disclosure of which is hereby incorporated by reference in its entirety.

BACKGROUND

1. Field of the Invention

Embodiments of the present application relate to the field of electrochemical devices, and more particularly, to a cathode and a lithium-ion battery.

2. Description of the Related Art

Electrochemical devices (for example, lithium-ion batteries) have entered our daily lives with advances in technology and environmental protection. With the large-scale popularization of lithium-ion batteries, safety problems caused by an external force puncturing lithium-ion batteries occasionally occur on the user side, and their safety performance has received more and more attention. In particular, the numerous incidents of battery fermentation in some mobile phones resulting in explosions has caused users, resellers and lithium-ion battery manufacturers to put forward new requirements for the safety performance of lithium-ion batteries.

At present, the methods for improving the safety of lithium-ion batteries comes at the expense of the energy density of lithium-ion batteries. Therefore, it is imperative to provide a technical means capable of significantly improving the safety performance of lithium-ion batteries while realizing higher energy density in them.

SUMMARY

The embodiments of the present application are directed to a cathode. A region covered by an active material layer on the cathode current collector of the cathode adopts an active material layer in a two-layer structure, and a region not covered by the active material layer is provided with an insulating layer. By adjusting the gap between the active material layer and the insulating layer, the overlapping problem that may occur when the active material layer and the insulating layer are disposed can be effectively alleviated, and a failure caused by an internal short circuit generated when the electrochemical device is pierced by an external force is avoided, thereby effectively improving the safety performance of the electrochemical device in a penetration test.

Some embodiments of the present application provide a cathode, including a cathode current collector, a first cathode active material layer, a second cathode active material layer and an insulating layer, where the first cathode active material layer includes a first cathode active material, and the second cathode active material layer includes a second cathode active material. The cathode current collector has a first surface, where the first cathode active material layer is disposed between the cathode current collector and the second cathode active material layer and covers a first portion of the first surface of the cathode current collector, and the insulating layer covers a second portion of the first surface of the cathode current collector that is different from the first portion.

According to some embodiments of the present application, a first distance exists between the insulating layer and the first cathode active material layer in a longitudinal direction of the cathode current collector, a second distance exists between the insulating layer and the second cathode active material layer in the longitudinal direction of the cathode current collector; and the first distance and the second distance are respectively greater than or equal to 0 and the second distance is less than or equal to the first distance.

According to some embodiments of the present application, the second cathode active material layer completely covers the surface of the first cathode active material layer.

According to some embodiments of the present application, the first distance is from about 0 mm to about 83 mm.

According to some embodiments of the present application, the thickness of the first cathode active material layer is from about 0.1 μm to about 20 μm.

According to some embodiments of the present application, the thickness of the insulating layer is greater than the thickness of the first cathode active material layer.

According to some embodiments of the present application, the first cathode active material and the second cathode active material are each independently selected from the group consisting of lithium cobaltate, lithium iron phosphate, lithium manganese iron phosphate, sodium iron phosphate, lithium vanadium phosphate, sodium vanadium phosphate, oxy-lithium-vanadium phosphate, oxy-sodium-vanadium phosphate, lithium vanadate, lithium manganate, lithium nickelate, lithium nickel cobalt manganese oxide, lithium-rich manganese-based material, lithium nickel cobalt aluminum oxide, lithium titanate and combinations thereof.

According to some embodiments of the present application, the first cathode active material layer and the second cathode active material layer respectively further include a binder and a conductive agent, wherein the binder is selected from the group consisting of polyvinylidene fluoride, a vinylidene fluoride-hexafluoropropylene copolymer, polyamide, polyacrylonitrile, polyacrylate ester, polyacrylic acid, polyacrylate salt, sodium carboxymethyl cellulose, polyvinylpyrrolidone, polyvinyl ether, polymethyl methacrylate, polytetrafluoroethylene, polyhexafluoropropylene, styrene butadiene rubber and combinations thereof, and

the conductive agent is selected from the group consisting of carbon nanotubes, conductive carbon black, acetylene black, graphene, Ketjen black, carbon fibers and combinations thereof.

According to some embodiments of the present application, the insulating layer includes at least one of inorganic particles and a polymer, where the inorganic particles are selected from the group consisting of aluminum oxide, silicon dioxide, magnesium oxide, titanium oxide, hafnium oxide, tin oxide, cerium dioxide, nickel oxide, zinc oxide, calcium oxide, zirconium dioxide, yttrium oxide, silicon carbide, boehmite, aluminum hydroxide, magnesium hydroxide, calcium hydroxide, barium sulfate and combinations thereof, and the polymer is selected from the group consisting of a homopolymer of vinylidene fluoride, a copolymer of vinylidene fluoride, a copolymer of hexafluoropropylene, polystyrene, polyphenylacetylene, sodium poly(vinyl acid), potassium poly(vinyl acid), polymethyl methacrylate, polyethylene, polypropylene, polytetrafluoroethylene and combinations thereof.

Some embodiments of the present application provide an electrochemical device, including a anode, a separator and a cathode, where the cathode includes a cathode current collector, having a first surface; a first cathode active material layer, including a first cathode active material; a second cathode active material layer, including a second cathode active material; and an insulating layer, where the first cathode active material layer is disposed between the cathode current collector and the second cathode active material layer and covers a first portion of the first surface of the cathode current collector, and the insulating layer covers a second portion of the first surface of the cathode current collector that is different from the first portion; and the separator is disposed between the anode and the cathode, and the anode, the separator, and the cathode are wound to form an electrode assembly.

According to some embodiments of the present application, a first distance exists between the insulating layer and the first cathode active material layer in

the longitudinal direction of the cathode current collector, a second distance exists between the insulating layer and the second cathode active material layer in the longitudinal direction of the cathode current collector; and the first distance and the second distance are respectively greater than or equal to 0 and the second distance is less than or equal to the first distance.

According to some embodiments of the present application, the first distance and the second distance are disposed at a corner of the electrode assembly.

According to some embodiments of the present application, the thickness D of the electrode assembly is from about 1.5 mm to about 50 mm.

According to some embodiments of the present application, the first distance between the insulating layer and the first cathode active material layer in the longitudinal direction of the cathode current collector satisfies the following formula:

$$0 \leq \text{the first distance} \leq \frac{\pi}{2}D + 4\text{mm}.$$

According to some embodiments of the present application, the second distance between the insulating layer and the second cathode active material layer in the longitudinal direction of the cathode current collector satisfies the following formula:

$$0 \leq \text{the second distance} \leq \frac{\pi}{2}D + 4\text{mm}.$$

Some embodiments of the present application provide an electronic device, including the electrochemical device in the above embodiments.

BRIEF DESCRIPTION OF THE DRAWINGS

The drawings that are necessary to describe the embodiments of the present application or the prior art will be briefly described below to facilitate the

descriptions of the embodiments of the present application. Obviously, the drawings of the following descriptions are only partial embodiments of the present application. For those skilled in the art, the drawings of other embodiments can still be obtained according to the structures illustrated in the drawings without the need for creative labor.

Fig. 1 is a schematic structural view of a cathode in which an active material layer and an insulating layer overlap according to some embodiments of the present application.

Fig. 2 is a schematic structural view of a cathode according to some embodiments of the present application.

Fig. 3 is a schematic structural view of a cathode in which an end of a second cathode active material layer is shorter than an end of a first cathode active material layer according to some embodiments of the present application.

Fig. 4A is a schematic structural diagram of an electrode assembly in which the first distance and the second distance are in the minimum range thereof according to some embodiments of the present application.

Fig. 4B is a schematic structural diagram of an electrode assembly in which the first distance and the second distance are in the maximum range thereof according to some embodiments of the present application.

DETAILED DESCRIPTION

Embodiments of this application are described below in detail. Throughout the entire specification of this application, same or similar components or components having same or similar functions are represented by using similar reference numerals. The embodiments related to the accompanying drawings that are described herein are illustrative and schematic, and are used to provide basic understanding for this application. The embodiments of this application should not be construed as limitations to this application.

In this specification, unless otherwise particularly indicated or limited, relativistic wordings such as "central", "longitudinal", "lateral", "front", "back", "right", "left", "inner", "outer", "relatively low", "relatively high", "horizontal", "vertical", "higher than", "lower than", "above", "below", "top", "bottom", and derived wordings thereof (such as "horizontally", "downward", and "upward") should be construed as referenced directions described in discussion or shown in the accompanying drawings. These relativistic wordings are merely for ease of description, and require constructing or operating this application in a particular direction.

In addition, amounts, ratios, and other numerical values are sometimes presented herein in a range format. It should be understood that such range formats are for convenience and brevity, and should be interpreted with flexibility, and include not only those numerical values that are specifically designated as range limitations, but also include all individual numerical values or sub-ranges that are within the range, as each value and sub-range is specified explicitly.

Further, for convenience of description, "first", "second", "third" and the like may be used herein to distinguish different components of one drawing or series of drawings. Unless otherwise specified or limited, "first", "second", "third" and the like are not intended to describe the corresponding components.

As used herein, the term "about" is used for describing and explaining a small variation. When being used in combination with an event or a case, the terms can refer to an example in which the event or case exactly occurs, or an example in which the event or case similarly occurs. For example, when being used in combination with a value, the terms may refer to a variation range being less than or equal to ±10% of the value, for example, less than or equal to ±5%, less than or equal to ±4%, less than or equal to ±3%, less than or equal to ±2%, less than or equal to ±1%, less than or equal to ±0.5%, less than or equal to ±0.1%, or less than or equal to ±0.05%. In addition, amounts, ratios, and other

numerical values are sometimes presented herein in a range format. It should be understood that such range formats are for convenience and brevity, and should be interpreted with flexibility, and include not only those numerical values that are specifically designated as range limitations, but also include all individual numerical values or sub-ranges that are within the range, as each value and sub-range is specified explicitly.

The embodiments of the present application provide a cathode. An active material layer in a region covered by a cathode active material layer is in a two-layer structure, and a region not covered by the cathode active material layer is provided with an insulating layer. By adjusting the gap between the active material layer and the insulating layer, the problem of damage to the cathode due to the overlapping of the active material layer and the insulating layer is alleviated, so that the contact resistance between the cathode current collector and the anode active material layer can be effectively enhanced when the cathode is damaged by an external force, thereby enhancing the safety performance of the lithium-ion battery in the corresponding test (i.e., nail penetration test).

Lithium-ion batteries usually have four types of short-circuit events during the nail penetration test where the layers are comprised: a cathode active material layer-anode active material layer, a cathode active material layer-anode current collector, a cathode current collector-anode current collector, and a cathode current collector-anode active material layer. Among the four short-circuit events, the cathode current collector-anode active material layer short-circuit event is the most dangerous because the amount of energy released during this type of short-circuit event is greatest.

In an electrochemical device (e.g., a lithium-ion battery), the lithium-ion battery includes a cathode, a anode, a separator, an electrolytic solution and the like. The cathode includes a cathode current collector, a cathode active material layer and the like, where the cathode current collector includes a region not

covered by the active material layer (also referred to as an uncovered foil region) in addition to the region covered by the active material layer. For example, when the electrode assembly of the lithium-ion battery is a wound electrode assembly, its uncovered foil region includes an outer layer region of the electrode assembly and an inner layer tab welding region of the electrode assembly.

In the region covered by the cathode active material layer, the cathode current collector may be protected by coating a cathode active material layer in a two-layer structure. However, during the nail penetration test, the cathode current collector of the uncovered foil region will come directly into contact with the nail, and the nail will electrically connect to the anode active material layer inside the electrode assembly to create a cathode current collector-anode active material layer or a cathode current collector-nail-anode active material layer short-circuit event. Therefore, by providing an insulating layer on the uncovered foil region, the uncovered foil region of the cathode current collector in the cathode can be effectively protected, thereby avoiding a cathode current collector-anode active material layer or a cathode current collector-nail-anode active material layer short-circuit event, where the higher the coverage of the insulating layer on the uncovered foil region of the cathode current collector, the more obvious the effect of avoiding a short circuit. However, since the thickness of the insulating layer is greater than the thickness of the first cathode active material layer on the bottom layer of the active material layer, when the second cathode active material layer is coated on the first cathode active material layer, the second cathode active material layer easily overlaps with the insulating layer due to fluctuations in processing tolerance, and the insulating layer covers above or below the second cathode active material layer.

Fig. 1 is a schematic structural view of a cathode in which an active material layer and an insulating layer overlap according to some embodiments of the present application. As shown in Fig. 1, the cathode 10 includes a cathode current collector 11, a first cathode active material layer 12, a second cathode active material layer 13 and an insulating layer 14. The first cathode active

material layer 12 is disposed between the cathode current collector 11 and the second cathode active material layer 13 and covers a first portion on one surface of the cathode current collector 11, the insulating layer is disposed on a second portion on the surface not covered by the first cathode active material layer 12 in a longitudinal direction of the cathode current collector 11, where no gap exists between the insulating layer and the first cathode active material layer 12 in the longitudinal direction of the cathode current collector 11, and the insulating layer and the second cathode active material layer overlap in the longitudinal direction of the cathode current collector 11. The above technical solution can significantly improve the nail penetration test performance of the lithium-ion battery. However, since the thickness of the overlapping portion of the second cathode active material layer 13 and the insulating layer 14 is excessively large, the second cathode active material in the second cathode active material layer 13 may exceed the limit of its compaction density in the subsequent cold pressing step, so that the particles of the second cathode active material in the second cathode active material layer 13 are ruptured. The rupture of the second cathode active material may affect the intercalation and de-intercalation of lithium ions, resulting in undesirable phenomena such as low battery capacity of the electrode assembly and the like.

Some embodiments of the present application provide a cathode, which avoids the problem of overlapping caused by the poor design of the above cathode by setting the gap size between the cathode active material layer and the insulating layer.

Fig. 2 is a schematic structural view of a cathode according to some embodiments of the present application.

As shown in Fig. 2, the cathode 10 includes a cathode current collector 11, a first cathode active material layer 12, a second cathode active material layer 13 and an insulating layer 14. In particular, by adjusting the positions of the first cathode active material layer 12, the second cathode active material layer 13

and the insulating layer 14 in the longitudinal direction of the cathode current collector, a first distance 15 and a second distance 16 respectively exist between the first cathode active material layer 12 and the insulating layer 14 and between the second cathode active material layer 13 and the insulating layer 14, where the first cathode active material layer 12 is disposed between the cathode current collector 11 and the second cathode active material layer 13 and covers a first portion on one surface of the cathode current collector 11, and the insulating layer is disposed on a second portion of the surface not covered by the first cathode active material layer 12 in the longitudinal direction of the cathode current collector 11. A first distance 15 exists between the insulating layer 14 and the first cathode active material layer 12 in the longitudinal direction of the cathode current collector 11, a second distance 16 exists between the insulating layer 14 and the second cathode active material layer 13 in the longitudinal direction of the cathode current collector 11, and the first distance and the second distance are respectively greater than or equal to 0 and the second distance is less than or equal to the first distance. The arrangement of the first distance 15 and the second distance 16 effectively avoids the overlapping of the first cathode active material layer 12, the second cathode active material layer 13 and the insulating layer 14, thereby enhancing the reliability of the cathode in the preparation process, and lowering the possibility of a rupture of the second cathode active material in the second cathode active material layer 13 during the cold pressing technique.

In some embodiments of the present application, an end of the second cathode active material layer 13 in the longitudinal direction of the cathode current collector is longer than or equal to an end of the first cathode active material layer 12 in the longitudinal direction of the cathode current collector, so that the second cathode active material layer 13 completely covers the surface of the first cathode active material layer 12.

Fig. 3 is a schematic structural view of a cathode in which an end of a second cathode active material layer 13 is shorter than an end of a first cathode

active material layer 12 according to some embodiments of the present application. As shown in Fig. 3, the end of the second cathode active material layer 13 in the longitudinal direction of the cathode current collector is shorter than the end of the first cathode active material layer 12 in the longitudinal direction of the cathode current collector, so that the tail end of the first cathode active material layer 12 in the longitudinal direction of the cathode current collector has an exposed portion not covered by the second cathode active material layer 13. The above technical solution can significantly enhance the nail penetration test performance of the lithium-ion battery. However, the exposed portion of the first cathode active material layer 12 causes the de-intercalation of lithium ions from the first cathode active material layer during charging, the de-intercalated lithium ions may form lithium metal particles on the anode current collector opposite the exposed portion, and the lithium metal particles increasingly intensify as the number of cycles of lithium-ion battery increases, thereby causing lithium metal particle pits to appear on the electrode assembly and lower storage capacity of the lithium-ion battery.

In some embodiments of the present application, the first distance is from about 0 mm to about 83 mm, which ensures the reliability of the cathode in the preparation process and does not lower the safety performance of the cathode in the nail penetration test. In some embodiments of the present application, the first distance is from about 6 mm to about 83 mm.

In some embodiments of the present application, the second distance is from about 0 mm to about 83 mm, which ensures the reliability of the cathode in the preparation process and does not lower the safety performance of the cathode in the nail penetration test. In some embodiments of the present application, the second distance is from about 6 mm to about 83 mm.

In some embodiments of the present application, the particle size of the cathode active material may be measured by a Malvern particle size tester: the cathode active material is dispersed in a dispersing agent (ethanol or acetone, or

other surfactants), and after 30 mins of ultrasound, the sample is added to a Malvern particle size tester to start the test. In the volume-based particle size distribution of the first cathode active material, the particle diameter cumulated to 50% by volume of the small particle diameter (Dv50), i.e., the average particle diameter, in a range of from about 0.2 μm to about 15 μm, and in the volume-based particle size distribution of the first cathode active material, the particle diameter cumulated to 90% by volume of the small particle diameter (Dv90) in a range of less than or equal to about 40 μm. The first cathode active material having a smaller Dv90 enables higher coverage and adhesion to the cathode current collector 11, where the coverage is the total coated area of the region to be coated minus the exposed area of the layer to be coated exposed through the pores in the coating layer as a percentage of the total coated area. In some embodiments of the present application, the average particle diameter (Dv50) of the second cathode active material: the average particle diameter (Dv50) of the first cathode active material is from about 1:1 to about 40:1. The smaller the particles of the first cathode active material, the smaller the thickness of the first cathode active material layer can be made.

In some embodiments of the present application, the thickness of the first cathode active material layer 12 is from about 0.1 μm to about 20 μm. In some embodiments of the present application, the thickness of the first cathode active material layer 12 is from about 0.5 μm to about 15 μm. In some embodiments of the present application, the thickness of the first cathode active material layer 12 is from about 2 μm to about 8 μm. In particular, the thickness of the first cathode active material layer 12 is not less than the particle size Dv90 of the first cathode active material, thereby ensuring the coverage of the first cathode active material layer 12.

In some embodiments of the present application, the thickness of the first cathode active material layer 12 is less than or equal to the thickness of the insulating layer 14. In some embodiments of the present application, the thickness of the insulating layer 14 is greater than about 0.1 μm to achieve a

certain insulating effect. In some embodiments of the present application, the thickness of the insulating layer 14 is from about 8 μm to about 30 μm.

According to some embodiments of the present application, the insulating layer includes at least one of inorganic particles and a polymer, a suitable dispersing agent may also be added, and the dispersing agent includes, but is not limited to, ethanol or acetone, or other surfactants. The inorganic particles are selected from the group consisting of aluminum oxide, silicon dioxide, magnesium oxide, titanium oxide, hafnium oxide, tin oxide, cerium dioxide, nickel oxide, zinc oxide, calcium oxide, zirconium dioxide, yttrium oxide, silicon carbide, boehmite, aluminum hydroxide, magnesium hydroxide, calcium hydroxide, barium sulfate and combinations thereof; and the polymer is selected from the group consisting of a homopolymer of vinylidene fluoride, a copolymer of vinylidene fluoride, a copolymer of hexafluoropropylene, polystyrene, polyphenylacetylene, sodium poly(vinyl acid), potassium poly(vinyl acid), polymethyl methacrylate, polyethylene, polypropylene, polytetrafluoroethylene and combinations thereof.

According to some embodiments of the present application, the first cathode active material and the second cathode active material are each independently selected from the group consisting of lithium cobaltate, lithium iron phosphate, lithium manganese iron phosphate, sodium iron phosphate, lithium vanadium phosphate, sodium vanadium phosphate, oxy-lithium-vanadium phosphate, oxy-sodium-vanadium phosphate, lithium vanadate, lithium manganate, lithium nickelate, lithium nickel cobalt manganese oxide, lithium-rich manganese-based material, lithium nickel cobalt aluminum oxide, lithium titanate and combinations thereof.

In some embodiments of the present application, the first cathode active material layer 12 and the second cathode active material layer 13 further include a binder, and the binder includes, but is not limited to, one or a combination of polyvinylidene fluoride, a vinylidene fluoride-hexafluoropropylene copolymer,

polyamide, polyacrylonitrile, polyacrylate ester, polyacrylic acid, polyacrylate salt, sodium carboxymethyl cellulose, polyvinylpyrrolidone, polyvinyl ether, polymethyl methacrylate, polytetrafluoroethylene, polyhexafluoropropylene and styrene butadiene rubber. On the one hand, the binder allows a better adhesion between the active material layer to the cathode current collector, and on the other hand, as the content of the binder increases, the compaction density of the first cathode active material layer 12 lowers. The content of the binder of the first cathode active material layer 12 is from about 1.5 wt% to about 6 wt% based on the total weight of the first cathode active material layer 12, and the content of the binder of the second cathode active material layer 13 is from about 0.5 wt% to about 4 wt% based on the total weight of the second cathode active material layer 13.

In some embodiments of the present application, the first cathode active material layer 12 and the second cathode active material layer 13 may further contain a certain amount of conductive agent. The conductive agent includes, but is not limited to, one or a combination of carbon nanotubes, conductive carbon black, acetylene black, graphene, Ketjen black and carbon fibers. The content of the conductive agent of the first cathode active material layer is from about 0.5 wt% to about 5 wt% based on the total weight of the first cathode active material layer, and the content of the conductive agent of the second cathode active material layer is from about 0.5 wt% to about 5 wt% based on the total weight of the second cathode active material layer.

Further, the first cathode active material layer 12 or the second cathode active material layer 13 may be subjected to some other treatments, or the cathode current collector 11 may be subjected to some treatments, such as roughness treatment, heat treatment, etc. The principle or effect may be to enhance adhesion to the cathode current collector. Although not described in detail in the present application, it is included within the scope of the present application.

In some embodiments of the present application, the first distance and the second distance are disposed at a corner of a side edge of the electrode assembly. In the use of a lithium-ion battery having a wound electrode assembly, the probability of an external force impact (such as nail penetration) on the corner of the side edge of the electrode assembly is much less than the probability on the upper and lower outer layers of the electrode assembly, so that disposing the first distance and the second distance at the corner of the side edge of the electrode assembly can effectively ensure the reliability of the preparation technique and maintain the safety performance of the electrode assembly.

Fig. 4A and Fig. 4B are respectively a schematic structural diagram of an electrode assembly in which the first distance and the second distance are the minimum range and maximum range thereof according to some embodiments of the present application. As shown in Fig. 4A, according to the electrode assembly of the lithium-ion battery provided by some embodiments of the present application, the electrode assembly of the lithium-ion battery is in a wound structure, including the cathode, a anode and a separator 41 of the embodiments of the present application, where the anode includes a anode active material layer 42 and an anode current collector 43, and the cathode includes a cathode current collector 11, a first cathode active material layer 12, a second cathode active material layer 13 and an insulating layer 14. The separator is disposed between the anode and the cathode, where a first distance exists between the insulating layer and the first cathode active material layer in the longitudinal direction of the cathode current collector, a second distance exists between the insulating layer and the second cathode active material layer in the longitudinal direction of the cathode current collector, and the first distance and the second distance are respectively equal to 0 (i.e., the minimum value).

As shown in FIG. 4B, in some embodiments of the present application, the first distance having a maximum range 44 is disposed at the corner of the side edge of the electrode assembly, where if the maximum range of the first distance

is too large, the excessive exposure of the cathode current collector 11 may be caused, and the first distance may further be beyond the corner of the side edge of the electrode assembly so as to expose the cathode current collector 11 at the upper and lower outer layers of the electrode assembly, so that the protection on the cathode current collector 11 by the insulating layer 14 is lowered, thereby reducing the safety performance and the nail penetration test pass rate of the electrode assembly. In some embodiments of the present application, the maximum range 44 of the first distance and the second distance are correspondingly adjusted according to the thickness D of the electrode assembly, thereby ensuring that the maximum range of the first distance and the second distance at the corner of the side edge of the electrode assembly cannot be beyond the corner of the side edge of the electrode assembly.

The thickness D of the electrode assembly is a distance from the junction between the tail end of the cathode active material layer and the uncovered foil region of the cathode current collector to the outermost uncovered foil region on the opposite side of the electrode assembly.

In some embodiments of the present application, the thickness D of the electrode assembly is from about 1.5 mm to about 50 mm.

In some embodiments of the present application, the first distance 15 between the insulating layer and the first cathode active material layer in the longitudinal direction of the current collector satisfies the following formula:

$$0 \leq \text{the first distance} \leq \frac{\pi}{2}D + 4\text{mm}.$$

In some embodiments of the present application, the second distance 16 between the insulating layer and the second cathode active material layer in the longitudinal direction of the current collector satisfies the following formula:

$$0 \leq \text{the second distance} \leq \frac{\pi}{2}D + 4\text{mm}.$$

It should be clearly understood by those skilled in the art that 4 mm in the above formula is an allowable error range (i.e., a processing tolerance) of the error generated when the electrode assembly is processed, and the numerical range of the processing tolerance can be adjusted according to the actual operation process without being limited thereto.

The cathode current collector of the cathode in some embodiments of the present application may be aluminum foil or nickel foil, and the anode current collector of the anode may be copper foil or nickel foil. However, other cathode current collectors and anode current collectors commonly used in the art may be used.

The conductive agent and the binder of the anode active material layer in some embodiments of the present application are similar to the conductive agent and the binder of the cathode active material layer described above, and will not be described herein. The anode active material layer includes a anode active material including, but not limited to, selected from the group consisting of carbon materials, metal compounds, oxides, sulfides, nitrides of lithium such as LiN_3, lithium metal, metal elements and semimetal elements that form alloys with lithium, polymer materials, and combinations thereof.

In the above anode active materials, examples of the carbon material may include low graphitized carbon, easily graphitizable carbon, artificial graphite, natural graphite, mesophase carbon microspheres, soft carbon, hard carbon, pyrolytic carbon, coke, glassy carbon, organic polymer compound sintered body, carbon fibers and activated carbon, where the coke may include pitch coke, needle coke and petroleum coke. The organic polymer compound sintered body refers to a material obtained by calcining a polymer material such as a phenol plastic or a furan resin at a suitable temperature to carbonize it, and some of these materials are classified into low graphitized carbon or easily graphitizable carbon. Examples of the polymer material may include polyacetylene and polypyrrole.

Further, in the above anode active material, a material whose charging and discharging voltages are close to the charging and discharging voltages of lithium metal is selected. This is because the lower the charging and discharging voltages of the anode active material are, the higher the energy density of the lithium-ion battery is achieved, where the anode active material may be a carbon material because their crystal structures have little change during charging and discharging, and therefore, better cycle performance and greater charging and discharging capacities can be obtained. In particular, graphite may be selected because it can provide a large electrochemical equivalent and a high energy density.

Further, the anode active material may include elemental lithium metal, a metal element and a semimetal element capable of forming an alloy together with lithium (Li), an alloy and a compound including such element, etc. In particular, they are used together with carbon materials to obtain good cycle performance and high energy density. In addition to the alloys including two or more metal elements, the alloys used herein also include alloys containing one or more metal elements and one or more semimetal elements. The alloy may be in the form of a solid solution, a eutectic crystal (eutectic mixture), an intermetallic compound, and a mixture thereof.

Examples of the metal elements and the semimetal 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 alloys and compounds may include a material having a chemical formula: $Ma_sMb_tLi_u$ and a material having a chemical formula: $Ma_pMc_qMd_r$. In these chemical formulae, Ma represents at least one of metal elements and semimetal elements capable of forming an alloy together with lithium; Mb represents at least one of metal elements and semimetal elements other than lithium and Ma; Mc represents at least one of the non-metal elements; Md represents at least one of metal elements and semimetal

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 $r\geq 0$.

Further, an inorganic compound not including lithium (Li), such as MnO_2, V_2O_5, V_6O_{13}, NiS and MoS, may be used in the anode active material layer.

The separator in some embodiments of the present application includes, but is not limited to, at least one selected from the group consisting of polyethylene, polypropylene, polyethylene terephthalate, polyimide and aramid. For example, the polyethylene includes at least one component selected from the group consisting of high-density polyethylene, low-density polyethylene and ultra-high molecular weight polyethylene. In particular, polyethylene and polypropylene, which have a good effect on preventing short circuits, can improve the stability of the battery in a shutdown event.

The surface of the separator may further include a porous layer, where the porous layer is disposed on at least one surface of the separator, and the porous layer includes inorganic particles and a binder, wherein the inorganic particles are selected from one or more of a combination of aluminum oxide (Al_2O_3), silicon oxide (SiO_2), magnesium oxide (MgO), titanium oxide (TiO_2), hafnium oxide (HfO_2), tin oxide (SnO_2), cerium dioxide (CeO_2), nickel oxide (NiO), zinc oxide (ZnO), calcium oxide (CaO), zirconium dioxide (ZrO_2), yttrium oxide (Y_2O_3), silicon carbide (SiC), boehmite, aluminum hydroxide, magnesium hydroxide, calcium hydroxide and barium sulfate. The binder is selected from one or more of a combination of polyvinylidene fluoride, a vinylidene fluoride-hexafluoropropylene copolymer, polyamide, polyacrylonitrile, polyacrylate ester, polyacrylic acid, polyacrylate salt, sodium carboxymethyl cellulose, polyvinylpyrrolidone, polyvinyl ether, polymethyl methacrylate, polytetrafluoroethylene and polyhexafluoropropylene.

The porous layer can improve the heat resistance, oxidation resistance and electrolytic solution wettability of the separator, and enhance the binding property between the separator and the cathode or anode.

The lithium-ion battery of the present application further includes an electrolyte, the electrolyte may be one or more of a gel electrolyte, a solid electrolyte and an electrolytic solution, and the electrolytic solution includes a lithium salt and a non-aqueous solvent.

In some embodiments of the present application, 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 difluoroborate. For example, the lithium salt is $LiPF_6$ because it can provide a high ionic conductivity and improve the cycle performance.

The non-aqueous solvent may be a carbonate compound, a carboxylate compound, an ether compound, other organic solvents, or a combination thereof.

The carbonate compound may be a chain carbonate compound, a cyclic carbonate compound, a fluorocarbonate compound, or a combination thereof.

Examples of the chain carbonate compound are diethyl carbonate (DEC), dimethyl carbonate (DMC), dipropyl carbonate (DPC), methylpropyl carbonate (MPC), ethylpropyl carbonate (EPC), methylethyl carbonate (MEC) and combinations thereof. Examples of the cyclic carbonate compound are ethylene carbonate (EC), propylene carbonate (PC), butylene carbonate (BC), vinyl ethylene carbonate (VEC), propyl propionate (PP) and combinations thereof. Examples of the fluorocarbonate compound are 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-methylethylene carbonate, 1-fluoro-1-methylethylene carbonate, 1,2-difluoro-1-methylethylene carbonate, 1,1,2-trifluoro-2-methylethylene carbonate, trifluoromethylethylene carbonate and combinations thereof.

Examples of the carboxylate compound are methyl acetate, ethyl acetate, n-propyl acetate, t-butyl acetate, methyl propionate, ethyl propionate, propyl

propionate, γ-butyrolactone, decalactone, valerolactone, mevalonolactone, caprolactone, methyl formate and combinations thereof.

Examples of the ether compound are dibutyl ether, tetraethylene glycol dimethyl ether, diglyme, 1,2-dimethoxyethane, 1,2-diethoxyethane, ethoxy methoxyethane, 2-methyltetrahydrofuran, tetrahydrofuran and combinations thereof.

Examples of other organic solvents are 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 and combinations thereof.

In some embodiments of the present application, the cathode, the separator and the anode are sequentially wound or stacked into an electrode assembly, and then loaded into, for example, an aluminum plastic film, the electrolytic solution is injected, and formation and packaging are performed to prepare the lithium-ion battery. Subsequently, the prepared lithium-ion battery is subjected to a performance test, capacity test and nail penetration test.

Those skilled in the art will appreciate that while the above is illustrated with a lithium-ion battery, the electrochemical device of the present application further includes any other suitable electrochemical device. Such an electrochemical device includes any device that generates an electrochemical reaction without departing from the disclosure of the present application, and its specific examples include all kinds of primary batteries, secondary batteries, fuel cells, solar cells, or capacitors. In particular, the electrochemical device is a lithium secondary battery, including a lithium metal secondary battery, a lithium-ion secondary battery, a lithium polymer secondary battery or a lithium-ion polymer secondary battery.

The use of the electrochemical device of the present application is not particularly limited and can be used for any use known in the art. In one

embodiment, the electrochemical device of the present application may be used for, but not limited to, a notebook computer, a pen input computer, a mobile computer, an e-book player, a portable phone, a portable fax machine, a portable copy machine, a portable printer, stereo headphones, a video recorder, a liquid crystal display television, a portable cleaner, a portable CD player, a mini disk, a transceiver, an electronic notebook, a calculator, a memory card, a portable recorder, a radio, a backup power supply, a motor, a car, a motorcycle, a power bicycle, a bicycle, a lighting fixture, a toy, a game console, a clock, an electric tool, a flash light, a camera, a large household battery, a lithium-ion capacitor and the like.

Some specific embodiments and comparative embodiments are listed below and battery capacity tests and battery nailing tests are separately performed to better illustrate the present application. Those skilled in the art will appreciate that the preparation methods described in the present application are merely exemplary embodiments, and that any other suitable preparation method is within the scope of the present application.

Embodiment 1

Using aluminum foil as a cathode current collector, a layer of small-particle lithium iron phosphate slurry, including the first cathode active material (where the lithium iron phosphate had a particle size of Dv50: 3 μm and Dv90: 10 μm), was uniformly coated on the surface of the aluminum foil. The lithium iron phosphate slurry, composed of 95.8 wt% of lithium iron phosphate ($LiFePO_4$), 2.8 wt% of polyvinylidene fluoride (PVDF) and 1.4 wt% of conductive carbon black, was dried at 85°C to form a first cathode active material layer; a layer of aluminum oxide slurry was coated at a position 3 mm away from the first cathode active material layer in the longitudinal direction of the cathode current collector (i.e., the first distance was 3 mm), and the aluminum oxide slurry, composed of 98 wt% of aluminum oxide (Al_2O_3) and 2 wt% of polyvinylidene fluoride (PVDF) was dried at 85°C to form an insulating layer having a

thickness of 15 μm; then a layer of lithium cobaltate slurry (slurry of a second cathode active material layer) was coated on the dried first cathode active material layer, and the lithium cobaltate slurry, composed of 97.8 wt% of lithium cobaltate (LCO) (where the lithium cobaltate had a particle size of Dv50: 13 μm and Dv90: 38 μm), 0.8 wt% of polyvinylidene fluoride (PVDF) and 1.4 wt% of conductive carbon black, was dried at 85°C to form the second cathode active material layer, the distance of the tail end of the second cathode active material layer in the longitudinal direction of the cathode current collector beyond the first cathode active material layer being 3 mm and not covering the insulating layer (i.e., the second distance was 0 mm); and then the first cathode active material layer and the second cathode active material layer were cold-pressed, where the cold pressing pressure was 60T and the cold pressing speed was 40 m/min, and after cutting and slitting, the first cathode active material layer and the second cathode active material layer were dried at 85°C under vacuum for 4 hours to obtain a cathode, where the thickness of the first cathode active material layer was 8 μm and the thickness of the second cathode active material layer was 50 μm.

Using copper foil as an anode current collector, a layer of graphite slurry, composed of 97.7 wt% of artificial graphite, 1.3 wt% of sodium carboxymethyl cellulose (CMC) and 1.0 wt% of styrene butadiene rubber (SBR), was uniformly coated on the surface of the copper foil, dried at 85°C, and subjected to cold pressing, cutting and slitting to obtain a anode.

A solution prepared from a lithium salt $LiPF_6$ and a non-aqueous organic solvent (ethylene carbonate (EC):diethyl carbonate (DEC):propylene carbonate (PC):propyl propionate (PP):vinylene carbonate (VC)=20:30:20:28:2, mass ratio) in a mass ratio of 8:92 was used as an electrolytic solution of the lithium-ion battery.

The cathode and the anode were wound, and separated by a polyethylene separator, so as to prepare a wound electrode assembly, where the first distance

and the second distance were disposed at the corner of the side edge of the electrode assembly, and the thickness D of the electrode assembly was 3.2 mm. After the electrode assembly was subjected to top side sealing, code spraying, vacuum drying, electrolytic solution injection and high-temperature standing, formation and capacity grading were performed to obtain the finished lithium-ion battery.

Embodiment 2

The preparation method was the same as that of Embodiment 1, except that a layer of aluminum oxide slurry was coated at a position 5 mm away from the first cathode active material layer in the longitudinal direction of the cathode current collector (i.e., the first distance was 5 mm, and the second distance was 2 mm) in Embodiment 2.

Embodiment 3

The preparation method was the same as that of Embodiment 1, except that a layer of aluminum oxide slurry was coated at a position 9 mm away from the first cathode active material layer in the longitudinal direction of the cathode current collector (i.e., the first distance was 9 mm) and the tail end of the second cathode active material layer in the longitudinal direction of the cathode current collector was beyond the tail end of the first cathode active material layer by 5 mm (i.e., the second distance was 4 mm) in Embodiment 3.

Embodiment 4

The preparation method was the same as that of Embodiment 1, except that the thickness of the insulating layer was 10 μm in Embodiment 4.

Embodiment 5

The preparation method was the same as that of Embodiment 1, except that the thickness of the insulating layer was 20 μm in Embodiment 5.

Embodiment 6

The preparation method was the same as that of Embodiment 1, except that the thickness of the insulating layer was 5 μm in Embodiment 6.

Embodiment 7

The preparation method was the same as that of Embodiment 1, except that the thickness of the insulating layer was 1 μm in Embodiment 7.

Embodiment 8

The preparation method was the same as that of Embodiment 2, except that the thickness D of the electrode assembly was 2.8 mm in Embodiment 8.

Embodiment 9

The preparation method was the same as that of Embodiment 2, except that the thickness D of the electrode assembly was 3.6 mm in Embodiment 9.

Embodiment 10

The preparation method was the same as that of Embodiment 2, except that the thickness D of the electrode assembly was 4.8 mm in Embodiment 10.

Embodiment 11

The preparation method was the same as that of Embodiment 1, except that a layer of aluminum oxide slurry was coated at a position 20 mm away from the first cathode active material layer in the longitudinal direction of the cathode current collector (i.e., the first distance was 20 mm) and the tail end of the second cathode active material layer in the longitudinal direction of the cathode current collector was beyond the tail end of the first cathode active material layer by 2 mm (i.e., the second distance was 18 mm) in Embodiment 11.

Embodiment 12

The preparation method was the same as that of Embodiment 1, except that the tail end of the second cathode active material layer in the longitudinal direction of the cathode current collector was shorter than the tail end of the first cathode active material layer by 7 mm (i.e., the second distance was 10 mm) in Embodiment 12.

Embodiment 13

The preparation method was the same as that of Embodiment 1, except that a layer of aluminum oxide slurry was coated at a position 0 mm away from the first cathode active material layer in the longitudinal direction of the cathode current collector and the second cathode active material layer covered a portion of the insulating layer (i.e., the second distance was -3 mm) in Embodiment 13.

Comparative Embodiment 1

Using aluminum foil as a cathode current collector, a layer of small-particle lithium iron phosphate slurry, including the first cathode active material (where the lithium iron phosphate had a particle size of Dv50: 3 μm and Dv90: 10 μm), was uniformly coated on the surface of the aluminum foil. The lithium iron phosphate slurry, composed of 95.8 wt% of lithium iron phosphate ($LiFePO_4$), 2.8 wt% of polyvinylidene fluoride (PVDF) and 1.4 wt% of conductive carbon black, was dried at 85°C to form a first cathode active material layer; a layer of lithium cobaltate slurry (slurry of a second cathode active material layer) was coated on the dried first cathode active material layer, and the lithium cobaltate slurry, composed of 97.8 wt% of lithium cobaltate (LCO) (where the lithium cobaltate had a particle size of Dv50: 13 μm and Dv90: 38 μm), 0.8 wt% of polyvinylidene fluoride (PVDF) and 1.4 wt% of conductive carbon black, was dried at 85°C to form the second cathode active material layer, the distance of the tail end of the second cathode active material layer in the longitudinal direction of the cathode current collector beyond the first cathode active material layer being 3 mm; and then the first cathode active material layer and the second cathode active material layer were cold-pressed, where the cold

pressing pressure was 60T and the cold pressing speed was 40 m/min, and after cutting and slitting, the first cathode active material layer and the second cathode active material layer were dried at 85°C under vacuum for 4 hours to obtain a cathode, where the thickness of the first cathode active material layer was 8 μm and the thickness of the second cathode active material layer was 50 μm.

Using copper foil as an anode current collector, a layer of graphite slurry, composed of 97.7 wt% of artificial graphite, 1.3 wt% of sodium carboxymethyl cellulose (CMC) and 1.0 wt% of styrene butadiene rubber (SBR), was uniformly coated on the surface of the copper foil, dried at 85°C, subjected to cold pressing, cutting and slitting, and dried under vacuum at 85°C for 4 hours to obtain a anode.

A solution prepared from a lithium salt $LiPF_6$ and a non-aqueous organic solvent (ethylene carbonate (EC):diethyl carbonate (DEC):propylene carbonate (PC):propyl propionate (PP):vinylene carbonate (VC)=20:30:20:28:2, mass ratio) in a mass ratio of 8:92 was used as an electrolytic solution of the lithium-ion battery.

The cathode and the anode were wound, and separated by a polyethylene separator, so as to prepare a wound electrode assembly, where the thickness D of the electrode assembly was 3.2 mm. After the electrode assembly was subjected to top side sealing, code spraying, vacuum drying, electrolytic solution injection and high-temperature standing, formation and capacity grading were performed to obtain the finished lithium-ion battery.

After the finished lithium-ion batteries of the above embodiments and comparative embodiments were completed, the capacity, thickness, width and length of the finished products were recorded to determine the volumetric energy density of the lithium-ion battery. The battery capacity test and the battery nail penetration test were subsequently carried out on the finished lithium-ion batteries of the above embodiments and comparative embodiment.

Battery capacity test:

The electrochemical device (lithium-ion battery) to be tested was allowed to stand in a 25 ±3°C environment for 30 minutes, charged at a constant current of 0.5 C to a voltage of 4.4 V (rated voltage), and then charged at a constant voltage until the charge and discharge rate reached 0.05 C, and then the electrochemical device to be tested was allowed to stand for 30 minutes. The lithium-ion battery to be tested was discharged to 3.0 V at a rate of 0.2 C, and allowed to stand for 30 minutes. Finally, the discharge capacity was taken as the actual battery capacity of the battery.

Lithium-ion battery energy density = discharge capacity/ (length*width*thickness of lithium-ion battery).

Battery nail penetration test:

10 electrochemical devices (lithium-ion batteries) to be tested were taken and charged at a constant current of 0.5 C at room temperature to a voltage of 4.4 V, and further charged to a current of 0.05 C at a constant voltage of 4.4 V to a fully charged state of 4.4 V. After that, the lithium-ion battery was subjected to nail penetration under room temperature conditions, where a nail with a diameter of 2.5 mm (steel nail, made of carbon steel, and having a taper of 16.5 mm and a total length of 100 mm) was used for nail penetration at a nail penetration speed of 30 mm/s, and the nail penetration depth was determined by the taper of the steel nail through the lithium-ion battery. Whether the lithium-ion battery produced smoke, fire or explosion was observed. If no smoke, fire or explosion was produced, it was considered that the lithium-ion battery passed the nail penetration test.

The experimental parameters and measurement results of the embodiments and a comparative embodiment are shown in Table 1 below.

Table 1

Group	Positional Relationship between First cathode active material Layer and Second cathode active material Layer	Thickness of Electrode Assembly (mm)	First Distance (mm)	Second Distance (mm)	Thickness of First cathode active material Layer (um)	Thickness of Insulating Layer (um)	Nail Penetration Pass Rate	Energy Density of Lithium-ion Battery (Wh/L)	Whether to Precipitate Lithium
Embodiment 1	Upper Layer Beyond Lower Layer	3.2	3	0	8	15	10/10	680	No
Embodiment 2	Upper Layer Beyond Lower Layer	3.2	5	2	8	15	10/10	680	No
Embodiment 3	Upper Layer Beyond Lower Layer	3.2	9	4	8	15	10/10	680	No
Embodiment 4	Upper Layer Beyond Lower Layer	3.2	3	0	8	10	8/10	682	No
Embodiment 5	Upper Layer Beyond Lower Layer	3.2	3	0	8	20	10/10	678	No
Embodiment 6	Upper Layer Beyond Lower Layer	3.2	3	0	8	5	7/10	683	No
Embodiment 7	Upper Layer Beyond Lower Layer	3.2	3	0	8	1	6/10	684	No
Embodiment 8	Upper Layer Beyond Lower Layer	2.8	5	2	8	15	10/10	680	No
Embodiment 9	Upper Layer Beyond Lower Layer	3.6	5	2	8	15	10/10	680	No
Embodiment 10	Upper Layer Beyond Lower Layer	4.8	5	2	8	15	10/10	680	No
Embodiment 11	Upper Layer Beyond Lower Layer	3.2	20	18	8	15	5/10	680	No
Embodiment 12	Lower Layer Beyond Upper Layer	3.2	3	10	8	15	8/10	678	Yes
Embodiment 13	Upper Layer Beyond Lower Layer	3.2	0	-3	8	15	8/10	678	Yes
Comparative Embodiment 1	Upper Layer Beyond Lower Layer	3.2	-	-	8	0	2/10	685	No

By comparing Comparative Embodiment 1 and Embodiments 1 to 13, it can be seen that by using the cathode active material layer in a two-layer structure in the region covered by the cathode active material layer and using the insulating layer in the uncovered foil region, the nail penetration test pass rate of the lithium-ion battery can be greatly improved, and the energy density is almost not affected.

By comparing Embodiment 12 and Embodiment 1, it can be seen that when the tail end of the second cathode active material layer in the longitudinal direction of the cathode current collector is shorter than the tail end of the first cathode active material layer, a lithium precipitation phenomenon occurs.

It can be seen from Embodiment 13 and Embodiments 1, 2, 3 and 11 that the covering of the second cathode active material layer and the insulating layer causes the lithium precipitation phenomenon.

It can be seen from Embodiments 1 and 4 to 7 that as the thickness of the insulating layer decreases, the energy density of the lithium-ion battery is slightly increased; however, if the thickness of the insulating layer is too low, the nail penetration pass rate of the lithium-ion battery is lowered.

It can be seen from Embodiments 2 and 8 to 10 that for a lithium-ion battery including electrode assemblies having different thicknesses, the reasonable disposing of the first distance and the second distance significantly enhances the safety performance of the lithium-ion battery without significantly lowering the energy density of the lithium-ion battery and generating the side effect of lithium precipitation.

The above description summarizes the features of several embodiments, which will enable a person of ordinary skill in the art to understand the various aspects of the present application. A person of ordinary skill in the art can readily use this application as a basis for designing or modifying other compositions to achieve the same objectives and/or the same advantages as the

embodiments herein. It is also to be understood by a person of ordinary skill in the art that these equal examples do not depart from the spirit and scope of the present application, and it is possible to make various changes, substitutions and modifications to the present application without departing from the spirit and scope of the present application. Although the methods disclosed herein have been described with reference to the specific operations that are carried out in a specific order, it should be understood that these operations can be combined, subdivided, or reordered to form an equivalent method without departing from the teachings of the present application. Therefore, the order and grouping of operations are not a limitation to the present application unless specifically indicated herein.

What is claimed is:

1. A cathode, comprising:

a cathode current collector, having a first surface;

a first cathode active material layer, comprising a first cathode active material;

a second cathode active material layer, comprising a second cathode active material; and

an insulating layer, wherein

the first cathode active material layer is disposed between the cathode current collector and the second cathode active material layer and covers a first portion of the first surface of the cathode current collector, and the insulating layer covers a second portion of the first surface of the cathode current collector that is different from the first portion.

2. The cathode according to claim 1, wherein a first distance exists between the insulating layer and the first cathode active material layer in a longitudinal direction of the cathode current collector, a second distance exists between the insulating layer and the second cathode active material layer in the longitudinal direction of the cathode current collector; and the first distance and the second distance are respectively greater than or equal to 0 and the second distance is less than or equal to the first distance.

3. The cathode according to claim 1, wherein the second cathode active material layer completely covers the surface of the first cathode active material layer.

4. The cathode according to claim 2, wherein the first distance is from about 0 mm to about 83 mm.

5. The cathode according to claim 1, wherein the thickness of the first cathode active material layer is from about 0.1 μm to about 20 μm.

6. The cathode according to claim 1, wherein the thickness of the insulating layer is greater than the thickness of the first cathode active material layer.

7. The cathode according to claim 1, wherein the first cathode active material and the second cathode active material are each independently selected from the group consisting of lithium cobaltate, lithium iron phosphate, lithium manganese iron phosphate, sodium iron phosphate, lithium vanadium phosphate, sodium vanadium phosphate, oxy-lithium-vanadium phosphate, oxy-sodium-vanadium phosphate, lithium vanadate, lithium manganate, lithium nickelate, lithium nickel cobalt manganese oxide, lithium-rich manganese-based material, lithium nickel cobalt aluminum oxide, lithium titanate and combinations thereof.

8. The cathode according to claim 1, wherein the first cathode active material layer and the second cathode active material layer each further comprise a binder and a conductive agent, wherein the binder is selected from the group consisting of polyvinylidene fluoride, a vinylidene fluoride-hexafluoropropylene copolymer, polyamide, polyacrylonitrile, polyacrylate ester, polyacrylic acid, polyacrylate salt, sodium carboxymethyl cellulose, polyvinylpyrrolidone, polyvinyl ether, polymethyl methacrylate, polytetrafluoroethylene, polyhexafluoropropylene, styrene butadiene rubber and combinations thereof; and

the conductive agent is selected from the group consisting of carbon nanotubes, conductive carbon black, acetylene black, graphene, Ketjen black, carbon fibers and combinations thereof.

9. The cathode according to claim 1, wherein the insulating layer comprises at least one of inorganic particles and a polymer, wherein the inorganic particles are selected from the group consisting of aluminum oxide, silicon dioxide, magnesium oxide, titanium oxide, hafnium oxide, tin oxide, cerium dioxide, nickel oxide, zinc oxide, calcium oxide, zirconium dioxide,

yttrium oxide, silicon carbide, boehmite, aluminum hydroxide, magnesium hydroxide, calcium hydroxide, barium sulfate and combinations thereof; and

the polymer is selected from the group consisting of a homopolymer of vinylidene fluoride, a copolymer of vinylidene fluoride, a copolymer of hexafluoropropylene, polystyrene, polyphenylacetylene, sodium poly(vinyl acid), potassium poly(vinyl acid), polymethyl methacrylate, polyethylene, polypropylene, polytetrafluoroethylene and combinations thereof.

10. An electrochemical device, comprising an anode, a separator and a cathode, wherein the cathode comprises a cathode current collector, having a first surface; a first cathode active material layer, comprising a first cathode active material; a second cathode active material layer, comprising a second cathode active material; and an insulating layer, wherein the first cathode active material layer is disposed between the cathode current collector and the second cathode active material layer and covers a first portion of the first surface of the cathode current collector, and the insulating layer covers a second portion of the first surface of the cathode current collector that is different from the first portion; and

the separator is disposed between the anode and the cathode, and the anode, the separator, and the cathode are wound to form an electrode assembly.

11. The electrochemical device according to claim 10, wherein a first distance exists between the insulating layer and the first cathode active material layer in a longitudinal direction of the cathode current collector, a second distance exists between the insulating layer and the second cathode active material layer in the longitudinal direction of the cathode current collector; and the first distance and the second distance are respectively greater than or equal to 0 and the second distance is less than or equal to the first distance.

12. The electrochemical device according to claim 11, wherein the first distance and the second distance are disposed at a corner of the electrode

assembly.

13. The electrochemical device according to claim 10, wherein the thickness D of the electrode assembly is from about 1.5 mm to about 50 mm.

14. The electrochemical device according to claim 11, wherein the first distance between the insulating layer and the first cathode active material layer in the longitudinal direction of the cathode current collector satisfies the following formula:

$$0 \leq \text{the first distance} \leq \frac{\pi}{2}D + 4\text{mm}.$$

15. The electrochemical device according to claim 11, wherein the second distance between the insulating layer and the second cathode active material layer in the longitudinal direction of the cathode current collector satisfies the following formula:

$$0 \leq \text{the second distance} \leq \frac{\pi}{2}D + 4\text{mm}.$$

16. An electronic device, comprising an electrochemical device, wherein the electrochemical device comprises an anode, a separator and a cathode, wherein the cathode comprises a cathode current collector, having a first surface; a first cathode active material layer, comprising a first cathode active material; a second cathode active material layer, comprising a second cathode active material; and an insulating layer, wherein the first cathode active material layer is disposed between the cathode current collector and the second cathode active material layer and covers a first portion of the first surface of the cathode current collector, and the insulating layer covers a second portion of the first surface of the cathode current collector that is different from the first portion; and

the separator is disposed between the anode and the cathode, and the anode, the separator, and the cathode are wound to form an electrode assembly.

17. The electronic device according to claim 16, wherein a first distance exists between the insulating layer and the first cathode active material layer in a longitudinal direction of the cathode current collector, a second distance exists between the insulating layer and the second cathode active material layer in the longitudinal direction of the cathode current collector; and the first distance and the second distance are respectively greater than or equal to 0 and the second distance is less than or equal to the first distance.

18. The electronic device according to claim 17, wherein the first distance and the second distance are disposed at a corner of the electrode assembly.

19. The electronic device according to claim 16, wherein the thickness D of the electrode assembly is from about 1.5 mm to about 50 mm.

20. The e electronic device according to claim 17, wherein the first distance between the insulating layer and the first cathode active material layer in the longitudinal direction of the cathode current collector satisfies the following formula:

$$0 \leq \text{the first distance} \leq \frac{\pi}{2}\mathrm{D} + 4\mathrm{mm}; \text{ and}$$

the second distance between the insulating layer and the second cathode active material layer in the longitudinal direction of the cathode current collector satisfies the following formula:

$$0 \leq \text{ the second distance } \leq \frac{\pi}{2}\mathrm{D} + 4\mathrm{mm}.$$

ABSTRACT OF THE DISCLOSURE

The present application relates to a cathode, an electrochemical device and an electronic device including the same. The cathode includes: a cathode current collector, a first cathode active material layer, a second cathode active material layer and an insulating layer; where the first cathode active material layer covers a first portion of a first surface of the cathode current collector, and the insulating layer covers a second portion of the first surface of the cathode current collector that is different from the first portion, where a first distance exists between the insulating layer and the first cathode active material layer in a longitudinal direction of the cathode current collector. By providing a gap between the active material layer in a two-layer structure and the insulating layer in the cathode, the potential problem of the overlapping of the active material layer in a two-layer structure and the insulating layer on the cathode is alleviated, thereby ensuring that the electrochemical device cannot catch fire and lead to failure in the event of being punctured, and further ensuring the mechanical safety performance of the electrochemical device.

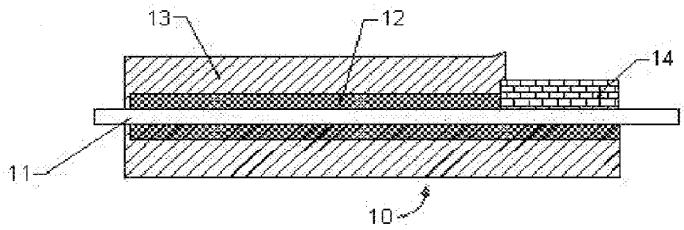

FIG. 1

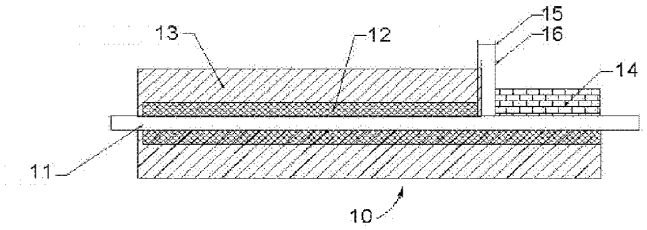

FIG. 2

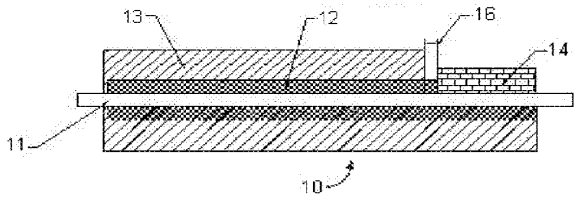

FIG. 3

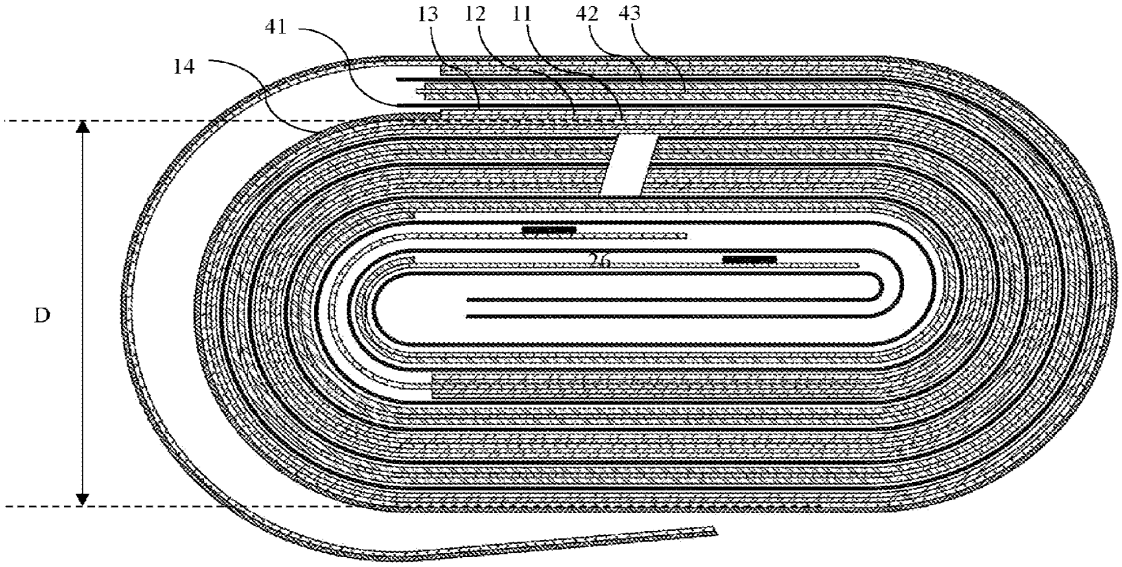

FIG. 4A

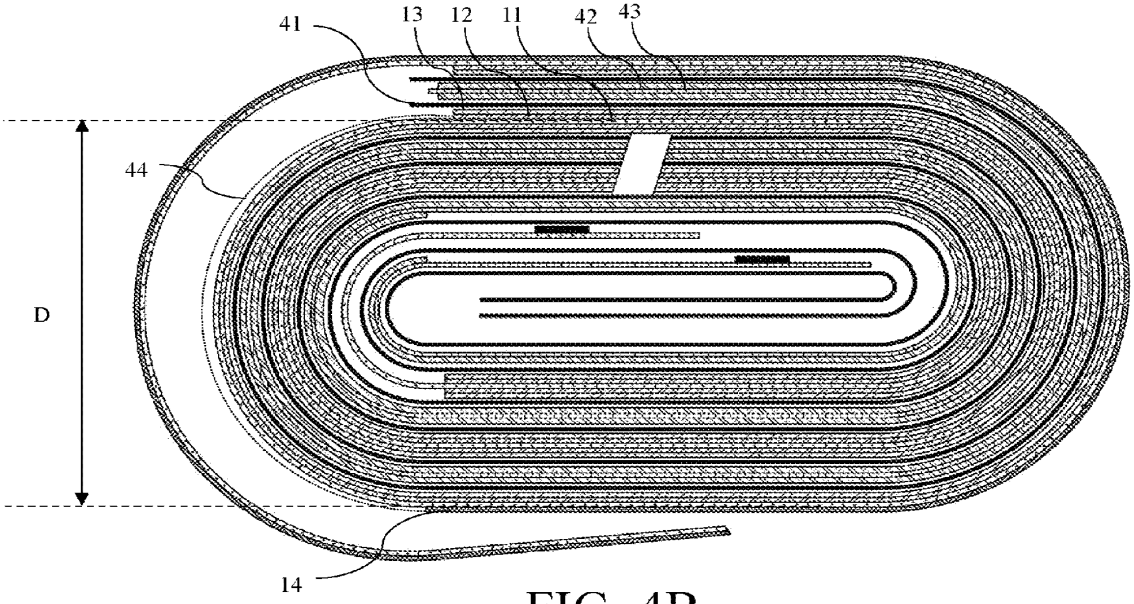

FIG. 4B

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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	CATHODE, ELECTROCHEMICAL DEVICE AND ELECTRONIC DEVICE COMPRISING SAME

As the below named inventor, I hereby declare that:

This declaration is directed to:

- [X] 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: XinRu SU Date (Optional) : _____

Signature: XinRu SU

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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	CATHODE, ELECTROCHEMICAL DEVICE AND ELECTRONIC DEVICE COMPRISING SAME

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.

WARNING:

Petitioner/applicant is cautioned to avoid submitting personal information in documents filed in a patent application that may contribute to identity theft. Personal information such as social security numbers, bank account numbers, or credit card numbers (other than a check or credit card authorization form PTO-2038 submitted for payment purposes) is never required by the USPTO to support a petition or an application. If this type of personal information is included in documents submitted to the USPTO, petitioners/applicants should consider redacting such personal information from the documents before submitting them to the USPTO. Petitioner/applicant is advised that the record of a patent application is available to the public after publication of the application (unless a non-publication request in compliance with 37 CFR 1.213(a) is made in the application) or issuance of a patent. Furthermore, the record from an abandoned application may also be available to the public if the application is referenced in a published application or an issued patent (see 37 CFR 1.14). Checks and credit card authorization forms PTO-2038 submitted for payment purposes are not retained in the application file and therefore are not publicly available.

LEGAL NAME OF INVENTOR

Inventor: Baozhang Li Date (Optional): _____

Signature: Baozhang Li

Note: An application data sheet (PTO/SB/14 or equivalent), including naming the entire inventive entity, must accompany this form or must have been previously filed. Use an additional PTO/AIA/01 form for each additional inventor.

This collection of information is required by 35 U.S.C. 115 and 37 CFR 1.63. 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 1 minute 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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DECLARATION (37 CFR 1.63) FOR UTILITY OR DESIGN APPLICATION USING AN APPLICATION DATA SHEET (37 CFR 1.76)

Title of Invention	CATHODE, ELECTROCHEMICAL DEVICE AND ELECTRONIC DEVICE COMPRISING SAME

As the below named inventor, I hereby declare that:

This declaration is directed to:

- [X] 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.

WARNING:

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LEGAL NAME OF INVENTOR

Inventor: Yisong Su Date (Optional): _____

Signature: _____

Note: An application data sheet (PTO/SB/14 or equivalent), including naming the entire inventive entity, must accompany this form or must have been previously filed. Use an additional PTO/AIA/01 form for each additional inventor.

This collection of information is required by 35 U.S.C. 115 and 37 CFR 1.63. 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 1 minute 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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PTO/AIA/01 (06-12)
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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	CATHODE, ELECTROCHEMICAL DEVICE AND ELECTRONIC DEVICE COMPRISING SAME

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.

WARNING:

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LEGAL NAME OF INVENTOR

Inventor: ZhiWen Xiao Date (Optional) : _____

Signature: ZhiWen XIAO

Note: An application data sheet (PTO/SB/14 or equivalent), including naming the entire inventive entity, must accompany this form or must have been previously filed. Use an additional PTO/AIA/01 form for each additional inventor.

This collection of information is required by 35 U.S.C. 115 and 37 CFR 1.63. 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 1 minute 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.

Electronic Patent Application Fee Transmittal

Application Number:	
Filing Date:	
Title of Invention:	CATHODE, ELECTROCHEMICAL DEVICE AND ELECTRONIC DEVICE COMPRISING SAME
First Named Inventor/Applicant Name:	Xinru SU
Filer:	Juan Carlos A. Marquez/Lily Niu
Attorney Docket Number:	LEEL-0101

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:	35387620
Application Number:	16298738
International Application Number:	
Confirmation Number:	3478
Title of Invention:	CATHODE, ELECTROCHEMICAL DEVICE AND ELECTRONIC DEVICE COMPRISING SAME
First Named Inventor/Applicant Name:	Xinru SU
Customer Number:	38327
Filer:	Juan Carlos A. Marquez/Lily Niu
Filer Authorized By:	Juan Carlos A. Marquez
Attorney Docket Number:	LEEL-0101
Receipt Date:	11-MAR-2019
Filing Date:	
Time Stamp:	17:49:58
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	yes
Payment Type	EFT
Payment was successfully received in RAM	$1720
RAM confirmation Number	031219INTEFSW17513800
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	Transmittal of New Application	LEEL-101-Application_transmittal.pdf	223626 5a4d6b8cff9e915edc22ad81b4253afd12a50f62	no	1
Warnings:					
Information:					
2	Application Data Sheet	LEEL-101-ADS.pdf	1823371 b3cec8d6f6167da4724ad38cd2ac8f0b5922af97	no	9
Warnings:					
Information:					
3	Specification	LEEL-101-Specification.pdf	266075 1040364795b538cb6fe17158b36d6ce3e75ed55e	no	32
Warnings:					
Information:					
4	Claims	LEEL-101-Claims.pdf	159620 418a74b7fcf03791d4561ceefd8775253ff795d4	no	5
Warnings:					
Information:					
5	Abstract	LEEL-101-Abstract.pdf	60025 793f4e726076a325ef122ea19dd6574b15259189	no	1
Warnings:					
Information:					
6	Drawings-only black and white line drawings	LEEL-101-Drawings.pdf	1328586 a9615550fed629259d8be92bbd2b8b391f2f22e8	no	4
Warnings:					
Information:					

7	Oath or Declaration filed	LEEL-101-Declaraations.pdf	2349918 13eb7628587fa8f8ea725fa1e46a62c495a840a7	no	4
Warnings:					
Information:					
8	Fee Worksheet (SB06)	fee-info.pdf	34602 13e4103d693bdd980c34baa72f946e0db8ba57ff	no	2
Warnings:					
Information:					
		Total Files Size (in bytes):	6245823		

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.

Customized 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 Customer Number **38327** 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 Customer Number **38327**:
OR

☐

Firm or Individual Name			
Address			
City		State	Zip
Country			
Telephone		Email	

PLEASE FILL IN ALL BOXES AND SPACES BELOW THAT APPLY TO SIGNER.

I am the Applicant (if the Applicant is a juristic entity, list the Applicant name hereinbelow):
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., see 37 CFR 1.46(b)(2))

SIGNATURE of Applicant for Patent

Signature	Cheng Chi Lin	Date	2018,8,31
Name	Cheng Chi Lin	Telephone	
Title & Applicant Name	IP manager	/ NINGDE AMPEREX TECHNOLOGY LIMITED	

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 35 U.S.C. 115 and 37 CFR 1.63. 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 1 minute 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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STATEMENT UNDER 37 CFR 3.73(c)

Applicant/Patent Owner: NINGDE AMPEREX TECHNOLOGY LIMITED

Application No./Patent No.: 16/298,738 Filed/Issue Date: March 11, 2019

Titled: CATHODE ELECTROCHEMICAL DEVICE AND ELECTRONIC DEVICE COMPRISING THE SAME

NINGDE AMPEREX TECHNOLOGY LIMITED, a company

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

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

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

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

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

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

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

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

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

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

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

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

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

1. From: _____ 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**.

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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.

/juan.carlos.a.marquez/	March 11, 2019
Signature	Date
Juan Carlos A. Marquez	34,072
Printed or Typed Name	Title or Registration Number

[Page 2 of 2]

Privacy Act Statement

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

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

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

ASSIGNMENT

WHEREAS, I, Xinru SU of Fujian Province, China ("Assignor"), is the inventor of an invention entitled " CATHODE, ELECTROCHEMICAL DEVICE AND ELECTRONIC DEVICE COMPRISING SAME " that is the subject matter of: (check all that apply)

[X] a U.S. application for Letters Patent which claims the priority of the Chinese Patent Application No. 201811308841.3 filed on 2018/11/05;

[ ] an application made under the Patent Cooperation Treaty which is identifiable at WIPO by Application No. PCT/_____ filed on _____

[ ] an application for Letters Patent which is identifiable in the Patent Office of the U.S. by Application No. _____ filed on _____;

WHEREAS, Ningde Amperex Technology Limited, a corporation organized and existing under the laws of China ("Assignee"), and having offices at, No.1 XinGang Road, ZhangWan Town, JiaoCheng District, Ningde City, Fujian Province, PRC 352100 is desirous of acquiring the entire right, title and interest in and to the invention, the applications, and any and all Letters Patent or similar foreign or domestic legal protection

[x] in the United States
[ ] in all other countries or jurisdictions;

"NOW THEREFORE, for good and valuable consideration, the receipt and adequacy of which is hereby acknowledged,

a) we agree to transfer, and
b) we do hereby transfer,

to Assignee, its successors and assigns, effective as of _____ *nunc pro tunc*, our entire right, title and interest in the above named countries and jurisdictions in and to the following including the right to sue for past infringement: the invention, the above-identified applications, all applications from which any of the above-identified applications claim priority, corresponding U.S. and non-U.S. applications, any continuation, division, renewal, or substitute for the applications, all Letters Patent, any reissue, re-examination, or similar legal protection issuing related to the Letters Patent, and all rights and benefits under any applicable treaty or convention, and I/we authorize the Director of the United States Patent and Trademark Office or foreign equivalent to issue the Letters Patent or similar legal protection to the Assignee."

We authorize the U.S. Attorneys handling this matter in the U.S. and the Assignee, its successors and assigns, to insert in this instrument the filing date(s) and application numbers when ascertained. We further authorize the Assignee, its successors and assigns, or anyone it may properly designate, to apply for Letters Patent or similar legal protection, in its own name if desired, in the above named countries and jurisdictions and appoint Assignee the common representative in the above-identified international application and any international application for the invention.

We represent to the Assignee, its successors and assigns, that we shall not execute any writing or do any act whatsoever conflicting with this Assignment. We, our executors or administrators, will at any time upon request, without additional consideration, but at the expense of the Assignee, its successors and assigns, execute and deliver to Assignee or its legal representatives such additional writings and do such additional acts as the Assignee, its successors and assigns, may deem desirable to perfect its enjoyment of this grant,

and render all assistance in making application for and obtaining, maintaining, and enforcing the Letters Patent or similar legal protection on the invention in any and all countries and jurisdictions, including without limitation providing testimony in any related interference, litigation or proceeding. To the extent that we, our executors or administrators are unable or unavailable to execute and deliver to Assignee or its legal representatives such additional writings and do such additional acts as Assignee, its successors and assigns may deem desirable to perfect its enjoyment of this grant, and render all assistance in making application for and obtaining, maintaining, and enforcing the Letters Patent or similar legal protection on the invention in any and all countries and jurisdictions, we, our executors or administrators hereby authorize Assignee, its successors and assigns to act on our behalf.

If any provision(s) of this Assignment are held unenforceable or in conflict with the law of any jurisdiction, the validity of the remaining provisions will not be affected by such holding and the part held unenforceable in or in conflict with the law of one jurisdiction will remain in effect for other jurisdictions until held unenforceable or in conflict with the law of that jurisdiction.

Xinru SU

Xinru SU

(Inventor / Assignor)

2019/3/5

Date

ASSIGNMENT

WHEREAS, I, Baozhang LI of Fujian Province, China ("Assignor"), is the inventor of an invention entitled " CATHODE, ELECTROCHEMICAL DEVICE AND ELECTRONIC DEVICE COMPRISING SAME " that is the subject matter of: (check all that apply)

[X] a U.S. application for Letters Patent which claims the priority of the Chinese Patent Application No. 201811308841.3 filed on 2018/11/05;

[ ] an application made under the Patent Cooperation Treaty which is identifiable at WIPO by Application No. PCT/_____ filed on _____

[ ] an application for Letters Patent which is identifiable in the Patent Office of the U.S. by Application No. _____ filed on _____;

WHEREAS, Ningde Amperex Technology Limited, a corporation organized and existing under the laws of China ("Assignee"), and having offices at, No.1 XinGang Road, ZhangWan Town, JiaoCheng District, Ningde City, Fujian Province, PRC 352100 is desirous of acquiring the entire right, title and interest in and to the invention, the applications, and any and all Letters Patent or similar foreign or domestic legal protection

[x] in the United States
[ ] in all other countries or jurisdictions;

"NOW THEREFORE, for good and valuable consideration, the receipt and adequacy of which is hereby acknowledged,

a) we agree to transfer, and
b) we do hereby transfer,

to Assignee, its successors and assigns, effective as of _____ *nunc pro tunc*, our entire right, title and interest in the above named countries and jurisdictions in and to the following including the right to sue for past infringement: the invention, the above-identified applications, all applications from which any of the above-identified applications claim priority, corresponding U.S. and non-U.S. applications, any continuation, division, renewal, or substitute for the applications, all Letters Patent, any reissue, re-examination, or similar legal protection issuing related to the Letters Patent, and all rights and benefits under any applicable treaty or convention, and I/we authorize the Director of the United States Patent and Trademark Office or foreign equivalent to issue the Letters Patent or similar legal protection to the Assignee."

We authorize the U.S. Attorneys handling this matter in the U.S. and the Assignee, its successors and assigns, to insert in this instrument the filing date(s) and application numbers when ascertained. We further authorize the Assignee, its successors and assigns, or anyone it may properly designate, to apply for Letters Patent or similar legal protection, in its own name if desired, in the above named countries and jurisdictions and appoint Assignee the common representative in the above-identified international application and any international application for the invention.

We represent to the Assignee, its successors and assigns, that we shall not execute any writing or do any act whatsoever conflicting with this Assignment. We, our executors or administrators, will at any time upon request, without additional consideration, but at the expense of the Assignee, its successors and assigns, execute and deliver to Assignee or its legal representatives such additional writings and do such additional acts as the Assignee, its successors and assigns, may deem desirable to perfect its enjoyment of this grant,

and render all assistance in making application for and obtaining, maintaining, and enforcing the Letters Patent or similar legal protection on the invention in any and all countries and jurisdictions, including without limitation providing testimony in any related interference, litigation or proceeding. To the extent that we, our executors or administrators are unable or unavailable to execute and deliver to Assignee or its legal representatives such additional writings and do such additional acts as Assignee, its successors and assigns may deem desirable to perfect its enjoyment of this grant, and render all assistance in making application for and obtaining, maintaining, and enforcing the Letters Patent or similar legal protection on the invention in any and all countries and jurisdictions, we, our executors or administrators hereby authorize Assignee, its successors and assigns to act on our behalf.

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Baozhang LI

Baozhang Li

(Inventor / Assignor)

2019/3/5

Date

ASSIGNMENT

WHEREAS, I, Yisong SU of Fujian Province, China ("Assignor"), is the inventor of an invention entitled " CATHODE, ELECTROCHEMICAL DEVICE AND ELECTRONIC DEVICE COMPRISING SAME " that is the subject matter of: (check all that apply)

[X] a U.S. application for Letters Patent which claims the priority of the Chinese Patent Application No. 201811308841.3 filed on 2018/11/05;

[ ] an application made under the Patent Cooperation Treaty which is identifiable at WIPO by Application No. PCT/_____ filed on _____

[ ] an application for Letters Patent which is identifiable in the Patent Office of the U.S. by Application No. _____ filed on _____;

WHEREAS, Ningde Amperex Technology Limited, a corporation organized and existing under the laws of China ("Assignee"), and having offices at, No.1 XinGang Road, ZhangWan Town, JiaoCheng District, Ningde City, Fujian Province, PRC 352100 is desirous of acquiring the entire right, title and interest in and to the invention, the applications, and any and all Letters Patent or similar foreign or domestic legal protection

[x] in the United States
[ ] in all other countries or jurisdictions;

"NOW THEREFORE, for good and valuable consideration, the receipt and adequacy of which is hereby acknowledged,

a) we agree to transfer, and
b) we do hereby transfer,

to Assignee, its successors and assigns, effective as of _____ *nunc pro tunc*, our entire right, title and interest in the above named countries and jurisdictions in and to the following including the right to sue for past infringement: the invention, the above-identified applications, all applications from which any of the above-identified applications claim priority, corresponding U.S. and non-U.S. applications, any continuation, division, renewal, or substitute for the applications, all Letters Patent, any reissue, re-examination, or similar legal protection issuing related to the Letters Patent, and all rights and benefits under any applicable treaty or convention, and I/we authorize the Director of the United States Patent and Trademark Office or foreign equivalent to issue the Letters Patent or similar legal protection to the Assignee."

We authorize the U.S. Attorneys handling this matter in the U.S. and the Assignee, its successors and assigns, to insert in this instrument the filing date(s) and application numbers when ascertained. We further authorize the Assignee, its successors and assigns, or anyone it may properly designate, to apply for Letters Patent or similar legal protection, in its own name if desired, in the above named countries and jurisdictions and appoint Assignee the common representative in the above-identified international application and any international application for the invention.

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and render all assistance in making application for and obtaining, maintaining, and enforcing the Letters Patent or similar legal protection on the invention in any and all countries and jurisdictions, including without limitation providing testimony in any related interference, litigation or proceeding. To the extent that we, our executors or administrators are unable or unavailable to execute and deliver to Assignee or its legal representatives such additional writings and do such additional acts as Assignee, its successors and assigns may deem desirable to perfect its enjoyment of this grant, and render all assistance in making application for and obtaining, maintaining, and enforcing the Letters Patent or similar legal protection on the invention in any and all countries and jurisdictions, we, our executors or administrators hereby authorize Assignee, its successors and assigns to act on our behalf.

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Su Yisong
(Inventor / Assignor)

2019/3/5

Date

ASSIGNMENT

WHEREAS, I, Zhiwen XIAO of Fujian Province, China ("Assignor"), is the inventor of an invention entitled " CATHODE, ELECTROCHEMICAL DEVICE AND ELECTRONIC DEVICE COMPRISING SAME " that is the subject matter of: (check all that apply)

[X] a U.S. application for Letters Patent which claims the priority of the Chinese Patent Application No. 201811309841.3 filed on 2018/11/05.

[ ] an application made under the Patent Cooperation Treaty which is identifiable at WIPO by Application No. PCT/_____ filed on _____

[ ] an application for Letters Patent which is identifiable in the Patent Office of the U.S. by Application No. _____ filed on _____;

WHEREAS, Ningde Amperex Technology Limited, a corporation organized and existing under the laws of China ("Assignee"), and having offices at, No.1 XinGang Road, ZhangWan Town, JiaoCheng District, Ningde City, Fujian Province, PRC 352100 is desirous of acquiring the entire right, title and interest in and to the invention, the applications, and any and all Letters Patent or similar foreign or domestic legal protection

[x] in the United States
[ ] in all other countries or jurisdictions;

"NOW THEREFORE, for good and valuable consideration, the receipt and adequacy of which is hereby acknowledged,

a) we agree to transfer, and
b) we do hereby transfer,

to Assignee, its successors and assigns, effective as of _____ *nunc pro tunc*, our entire right, title and interest in the above named countries and jurisdictions in and to the following including the right to sue for past infringement: the invention, the above-identified applications, all applications from which any of the above-identified applications claim priority, corresponding U.S. and non-U.S. applications, any continuation, division, renewal, or substitute for the applications, all Letters Patent, any reissue, re-examination, or similar legal protection issuing related to the Letters Patent, and all rights and benefits under any applicable treaty or convention, and I/we authorize the Director of the United States Patent and Trademark Office or foreign equivalent to issue the Letters Patent or similar legal protection to the Assignee."

We authorize the U.S. Attorneys handling this matter in the U.S. and the Assignee, its successors and assigns, to insert in this instrument the filing date(s) and application numbers when ascertained. We further authorize the Assignee, its successors and assigns, or anyone it may properly designate, to apply for Letters Patent or similar legal protection, in its own name if desired, in the above named countries and jurisdictions and appoint Assignee the common representative in the above-identified international application and any international application for the invention.

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and render all assistance in making application for and obtaining, maintaining, and enforcing the Letters Patent or similar legal protection on the invention in any and all countries and jurisdictions, including without limitation providing testimony in any related interference, litigation or proceeding. To the extent that we, our executors or administrators are unable or unavailable to execute and deliver to Assignee or its legal representatives such additional writings and do such additional acts as Assignee, its successors and assigns may deem desirable to perfect its enjoyment of this grant, and render all assistance in making application for and obtaining, maintaining, and enforcing the Letters Patent or similar legal protection on the invention in any and all countries and jurisdictions, we, our executors or administrators hereby authorize Assignee, its successors and assigns to act on our behalf.

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ZhiWen XIAO

ZhiWen Xiao

(Inventor/ Assignor)

2019/3/5

Date

Electronic Acknowledgement Receipt	
EFS ID:	35387766
Application Number:	16298738
International Application Number:	
Confirmation Number:	3478
Title of Invention:	CATHODE, ELECTROCHEMICAL DEVICE AND ELECTRONIC DEVICE COMPRISING SAME
First Named Inventor/Applicant Name:	Xinru SU
Correspondence Address:	Juan Carlos A. Marquez Marquez Intellectual Property Law Office PLLC 1629 K Street, NW Suite 300 Washington DC 20006 US 202-349-1690 USPTO@dockettrak.com
Filer:	Juan Carlos A. Marquez/Lily Niu
Filer Authorized By:	Juan Carlos A. Marquez
Attorney Docket Number:	LEEL-0101
Receipt Date:	11-MAR-2019
Filing Date:	
Time Stamp:	17:57:51
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	Transmittal Letter	LEEL-101-POA_transmittal.pdf	162382 f49b8d9a7e12f1e3aba9baf7d8a7604bc912893d	no	1
Warnings:					
Information:					
2	Power of Attorney	LEEL-101-POA.pdf	48819 99caa366fb685ed4d31ae908fd4227496ef7d6bf	no	1
Warnings:					
Information:					
3	Assignee showing of ownership per 37 CFR 3.73	LEEL-101-Assignee_statement.pdf	118083 9e4958ac8b13ce5bb43c1f10b5a28ae8d8c2da9f	no	3
Warnings:					
Information:					
4	Assignee showing of ownership per 37 CFR 3.73	LEEL-101-Assignments.pdf	3965256 62c127615cdf59b995f928f58d583ae33573169f	no	10
Warnings:					
Information:					
		Total Files Size (in bytes):	4294540		

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.

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

PTO/AIA/82A (07-13)
Approved for use through 11/30/2014. OMB 0651-0051
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE
Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it displays a valid OMB control number.

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	16/298,738
Filing Date	March 11, 2019
First Named Inventor	Xinru SU
Title	CATHODE, ELECTROCHEMICAL DEVICE AND ELECTRONIC DEVICE COMPRISING THE SAME
Art Unit	
Examiner Name	
Attorney Docket Number	LEEL-0101

SIGNATURE of Applicant or Patent Practitioner

Signature	/juan.carlos.a.marquez/	Date (Optional)	March 11, 2019
Name	Juan Carlos A. Marquez	Registration Number	34,072
Title (if Applicant is a juristic entity)	Attorney of Record		
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.

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.

PATENT APPLICATION FEE DETERMINATION RECORD

Substitute for Form PTO-875

Application or Docket Number: 16/298,738

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))	20 minus 20 =	*			OR	x 100 =	0.00
INDEPENDENT CLAIMS (37 CFR 1.16(h))	3 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

AMENDMENT A

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

AMENDMENT B

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

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

UNITED STATES PATENT AND TRADEMARK OFFICE

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

APPLICATION NUMBER	FILING or 371(c) DATE	GRP ART UNIT	FIL FEE REC'D	ATTY.DOCKET.NO	TOT CLAIMS	IND CLAIMS
16/298,738	03/11/2019	1726	1720	LEEL-0101	20	3

CONFIRMATION NO. 3478

FILING RECEIPT

38327
Juan Carlos A. Marquez
Marquez Intellectual Property Law Office PLLC
1629 K Street, NW
Suite 300
Washington, DC 20006

Date Mailed: 03/28/2019

Receipt is acknowledged of this non-provisional patent application. The application will be taken up for examination in due course. Applicant will be notified as to the results of the examination. Any correspondence concerning the application must include the following identification information: the U.S. APPLICATION NUMBER, FILING DATE, NAME OF APPLICANT, and TITLE OF INVENTION. Fees transmitted by check or draft are subject to collection. Please verify the accuracy of the data presented on this receipt. **If an error is noted on this Filing Receipt, please submit a written request for a Filing Receipt Correction. Please provide a copy of this Filing Receipt with the changes noted thereon. If you received a "Notice to File Missing Parts" for this application, please submit any corrections to this Filing Receipt with your reply to the Notice. When the USPTO processes the reply to the Notice, the USPTO will generate another Filing Receipt incorporating the requested corrections**

Inventor(s)

Xinru SU, Ningde City, CHINA;
Baozhang LI, Ningde City, CHINA;
Yisong SU, Ningde City, CHINA;
Zhiwen XIAO, Ningde City, CHINA;

Applicant(s)

NINGDE AMPEREX TECHNOLOGY LIMITED, Ningde City, CHINA;

Assignment For Published Patent Application

NINGDE AMPEREX TECHNOLOGY LIMITED

Power of Attorney: The patent practitioners associated with Customer Number 38327

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 201811308841.3 11/05/2018 Access Code Provided

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: 03/26/2019
The country code and number of your priority application, to be used for filing abroad under the Paris Convention, is **US 16/298,738**
Projected Publication Date: 05/07/2020
Non-Publication Request: No
Early Publication Request: No
Title

CATHODE, ELECTROCHEMICAL DEVICE AND ELECTRONIC DEVICE COMPRISING SAME

Preliminary Class

429

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

PROTECTING YOUR INVENTION OUTSIDE THE UNITED STATES

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

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

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

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

For information on preventing theft of your intellectual property (patents, trademarks and copyrights), you may wish to consult the U.S. Government website, http://www.stopfakes.gov. Part of a Department of Commerce initiative, this website includes self-help "toolkits" giving innovators guidance on how to protect intellectual property in specific

countries such as China, Korea and Mexico. For questions regarding patent enforcement issues, applicants may call the U.S. Government hotline at 1-866-999-HALT (1-866-999-4258).

LICENSE FOR FOREIGN FILING UNDER

Title 35, United States Code, Section 184

Title 37, Code of Federal Regulations, 5.11 & 5.15

GRANTED

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

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

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NOT GRANTED

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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：201811308841.3

申　请　类　型：发明专利

发明 创造 名称：正极极片、电化学装置及包含其的电子装置

申　　请　　日：2018 年 11 月 05 日

申　　请　　人：宁德新能源科技有限公司

发明人或设计人：苏辛如、李保章、苏义松、肖质文

局长

申长雨

2018 年 11 月 15 日

2018113088413

权　利　要　求　书

1．一种正极极片，包括：

正极集流体，具有第一表面；

第一正极活性物质层，包括第一正极活性物质；

第二正极活性物质层，包括第二正极活性物质；以及

绝缘层；

其中所述第一正极活性物质层设置于所述正极集流体和所述第二正极活性物质层之间且覆盖所述正极集流体的第一表面的第一部分，所述绝缘层覆盖所述正极集流体的第一表面的不同于所述第一部分的第二部分。

2．根据权利要求1所述的正极极片，其中所述绝缘层与所述第一正极活性物质层在所述正极集流体长度方向上存在第一距离，所述绝缘层与所述第二正极活性物质层在所述正极集流体长度方向上存在第二距离，所述第一距离及所述第二距离大于或等于0且所述第二距离小于或等于所述第一距离。

3．根据权利要求1所述的正极极片，其中所述第二正极活性物质层完全覆盖所述第一正极活性物质层的表面。

4．根据权利要求2所述的正极极片，其中所述第一距离为0 mm～83 mm。

5．根据权利要求1所述的正极极片，其中所述第一正极活性物质层的厚度为0.1 μm～20 μm。

6．根据权利要求1所述的正极极片，其中所述绝缘层的厚度大于所述第一正极活性物质层的厚度。

7．根据权利要求1所述的正极极片，其中所述第一正极活性物质和所述第二正极活性物质各自独立地选自由钴酸锂、磷酸铁锂、磷酸锰铁锂、磷酸铁

钠、磷酸钒锂、磷酸钒钠、磷酸钒氧锂、磷酸钒氧钠、钒酸锂、锰酸锂、镍酸锂、镍钴锰酸锂、富锂锰基材料、镍钴铝酸锂、钛酸锂及其组合所组成的群组。

8．根据权利要求 1 所述的正极极片，其中所述第一正极活性物质层和所述第二正极活性物质层均还包括粘结剂及导电剂，所述粘结剂选自由聚偏氟乙烯、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、聚六氟丙烯、丁苯橡胶及其组合所组成的群组，及

所述导电剂选自由碳纳米管、导电炭黑、乙炔黑、石墨烯、科琴黑和碳纤维及其组合所组成的群组。

9．根据权利要求 1 所述的正极极片，其中所述绝缘层包括无机粒子与聚合物中的至少一种，其中所述无机粒子选自由氧化铝、二氧化硅、氧化镁、氧化钛、二氧化铪、氧化锡、二氧化铈、氧化镍、氧化锌、氧化钙、二氧化锆、氧化钇、碳化硅、勃姆石、氢氧化铝、氢氧化镁、氢氧化钙、硫酸钡及其组合所组成的群组，

所述聚合物选自由偏氟乙烯的均聚物、偏氟乙烯的共聚物、六氟丙烯的共聚物、聚苯乙烯、聚苯乙炔、聚乙烯酸钠、聚乙烯酸钾、聚甲基丙烯酸甲酯、聚乙烯、聚丙烯、聚四氟乙烯及其组合所组成的群组。

10．一种电化学装置，包括负极极片、隔离膜及正极极片，其中所述正极极片包括正极集流体，其具有第一表面；第一正极活性物质层，其包括第一正极活性物质；第二正极活性物质层，其包括第二正极活性物质；以及绝缘层，其中所述第一正极活性物质层设置于所述正极集流体和所述第二正极活性物质层之间且覆盖所述正极集流体的第一表面的第一部分，所述绝缘层覆盖所述正极集流体的第一表面的不同于所述第一部分的第二部分；

以及所述隔离膜间隔于所述负极极片与所述正极极片之间，且所述负极极片、所述隔离膜及所述正极极片卷绕形成电极组件。

11．根据权利要求 10 所述的电化学装置，其中所述绝缘层与所述第一正极活性物质层在所述正极集流体长度方向上存在第一距离，所述绝缘层与所述第二正极活性物质层在所述正极集流体长度方向上存在第二距离，所述第一距离及所述第二距离大于或等于 0 且所述第二距离小于或等于所述第一距离。

12．根据权利要求 11 所述的电化学装置，其中所述第一距离及所述第二距离设置在所述电极组件的拐角处。

13．根据权利要求 10 所述的电化学装置，其中所述电极组件的厚度 D 为 1.5mm~50mm。

14．根据权利要求 11 所述的电化学装置，其中所述绝缘层与所述第一正极活性物质层在所述正极集流体长度方向上的第一距离满足以下公式:

$$0 \leq \text{第一距离} \leq \frac{\pi}{2}D + 4mm$$

15．根据权利要求 11 所述的电化学装置，其中所述绝缘层与所述第二正极活性物质层在所述正极集流体长度方向上的第二距离满足以下公式:

$$0 \leq \text{第二距离} \leq \frac{\pi}{2}D + 4mm$$

16．一种电子装置，其包含根据权利要求 10-15 中任一权利要求所述的电化学装置。

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说　　明　　书

正极极片、电化学装置及包含其的电子装置

技术领域

本申请的实施例涉及电化学装置技术领域，更具体地，涉及正极极片和锂离子电池。

背景技术

电化学装置（例如，锂离子电池）已伴随着科技的进步及环保要求的提高进入了我们日常的生活。随着锂离子电池的大量普及，在用户端偶尔会出现因外力刺破锂离子电池导致的安全问题，其安全性能越来越受到人们的重视，尤其是一些手机爆炸事件的持续发酵，使得包括使用者、售后端及锂离子电池生产厂商都对锂离子电池的安全性能提出了新的要求。

目前改善锂离子电池安全的方法都是以牺牲锂离子电池的能量密度为代价，因此，急需提供一种在较高能量密度的条件下，能够显著提高锂离子电池安全性能的技术手段。

发明内容

本申请的实施例的目的之一在于提供一种正极极片，其正极极片在正极集流体上的活性物质层覆盖的区域采用双层结构的活性物质层并在无活性物质层覆盖的区域设置一层绝缘层，通过调整在活性物质层与绝缘层间的间隙大小可以有效的改善活性物质层及绝缘层设置时所可能产生的重叠问题，避免电化学装置受外力刺穿时所产生的内短路从而造成的失效，进而有效提升电化学装置在穿刺测试中的安全性能表现。

本申请的一些实施例提供了一种正极极片，其包括正极集流体、第一正极活性物质层、第二正极活性物质层及绝缘层。其中，所述第一正极活性物质层，包括第一正极活性物质，且第二正极活性物质层，包括第二正极活性物质。所述正极集流体具有第一表面，其中所述第一正极活性物质

层设置于所述正极集流体和所述第二正极活性物质层之间且覆盖所述正极集流体的第一表面的第一部分，所述绝缘层覆盖所述正极集流体的第一表面的不同于所述第一部分的第二部分。

根据本申请的一些实施例，所述绝缘层与所述第一正极活性物质层在所述正极集流体长度方向上存在第一距离，所述绝缘层与所述第二正极活性物质层在所述正极集流体长度方向上存在第二距离，所述第一距离及所述第二距离大于或等于0且所述第二距离小于或等于所述第一距离。

根据本申请的一些实施例，所述第二正极活性物质层完全覆盖所述第一正极活性物质层的表面。

根据本申请的一些实施例，所述第一距离为约0 mm～约83 mm。

根据本申请的一些实施例，所述第一正极活性物质层的厚度为约0.1 μm～约20 μm。

根据本申请的一些实施例，所述绝缘层的厚度大于所述第一正极活性物质层的厚度。

根据本申请的一些实施例，所述第一正极活性物质和所述第二正极活性物质各自独立地选自由钴酸锂、磷酸铁锂、磷酸锰铁锂、磷酸铁钠、磷酸钒锂、磷酸钒钠、磷酸钒氧锂、磷酸钒氧钠、钒酸锂、锰酸锂、镍酸锂、镍钴锰酸锂、富锂锰基材料、镍钴铝酸锂、钛酸锂及其组合所组成的群组。

根据本申请的一些实施例，所述第一正极活性物质层和所述第二正极活性物质层均还粘结剂及导电剂，所述粘结剂选自由聚偏氟乙烯、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、聚六氟丙烯、丁苯橡胶及其组合所组成的群组，及

所述导电剂选自由碳纳米管、导电炭黑、乙炔黑、石墨烯、科琴黑和碳纤维及其组合所组成的群组。

根据本申请的一些实施例，所述绝缘层包括无机粒子与聚合物中的至少一种，其中所述无机粒子选自由氧化铝、二氧化硅、氧化镁、氧化钛、二氧化铪、氧化锡、二氧化铈、氧化镍、氧化锌、氧化钙、二氧化锆、氧化钇、碳化硅、勃姆石、氢氧化铝、氢氧化镁、氢氧化钙、硫酸钡及其组

合所组成的群组，所述聚合物选自由偏氟乙烯的均聚物、偏氟乙烯的共聚物、六氟丙烯的共聚物、聚苯乙烯、聚苯乙炔、聚乙烯酸钠、聚乙烯酸钾、聚甲基丙烯酸甲酯、聚乙烯、聚丙烯、聚四氟乙烯及其组合所组成的群组。

本申请的一些实施例提供了一种电化学装置，包括负极极片、隔离膜及正极极片，其中所述正极极片包括正极集流体，其具有第一表面；第一正极活性物质层，其包括第一正极活性物质；第二正极活性物质层，其包括第二正极活性物质；以及绝缘层，其中所述第一正极活性物质层设置于所述正极集流体和所述第二正极活性物质层之间且覆盖所述正极集流体的第一表面的第一部分，所述绝缘层覆盖所述正极集流体的第一表面的不同于所述第一部分的第二部分；以及所述隔离膜间隔于所述负极极片与所述正极极片之间，且所述负极极片、所述隔离膜及所述正极极片卷绕形成电极组件。

根据本申请的一些实施例，所述绝缘层与所述第一正极活性物质层在所述正极集流体长度方向上存在第一距离，所述绝缘层与所述第二正极活性物质层在所述正极集流体长度方向上存在第二距离，所述第一距离及所述第二距离大于或等于0且所述第二距离小于或等于所述第一距离。

根据本申请的一些实施例，所述第一距离及所述第二距离设置在所述电极组件的拐角处。

根据本申请的一些实施例，所述电极组件的厚度D为约1.5mm~约50mm。

根据本申请的一些实施例，所述绝缘层与所述第一正极活性物质层在所述正极集流体长度方向上的第一距离满足以下公式：

$0 \leq \text{第一距离} \leq \frac{\pi}{2} + 4\text{mm}$。

根据本申请的一些实施例，所述绝缘层与所述第二正极活性物质层在所述正极集流体长度方向上的第二距离满足以下公式：

$0 \leq \text{第二距离} \leq \frac{\pi}{2}D + 4\text{mm}$。

本申请的一些实施例提供了一种电子装置，其包含上述实施例所述的电化学装置。

附图说明

在下文中将简要地说明为了描述本申请实施例或现有技术所必要的附

图以便于描述本申请的实施例。显而易见地，下文描述中的附图仅只是本申请中的部分实施例。对本领域技术人员而言，在不需要创造性劳动的前提下，依然可以根据这些附图中所例示的结构来获得其他实施例的附图。

图 1 是根据本申请一些实施例的活性物质层与绝缘层重叠的正极极片的结构示意图。

图 2 是根据本申请一些实施例的正极极片的结构示意图。

图 3 是根据本申请一些实施例的第二正极活性物质层的端部短于第一正极活性物质层的端部的正极极片的结构示意图。

图 4A 是根据本申请一些实施例中所述第一距离与所述第二距离为其最小范围的电极组件的结构示意图。

图 4B 是根据本申请一些实施例中所述第一距离与所述第二距离为其最大范围的电极组件的结构示意图。

具体实施方式

本申请的实施例将会被详细的描述在下文中。在本申请说明书全文中，将相同或相似的组件以及具有相同或相似的功能的组件通过类似附图标记来表示。在此所描述的有关附图的实施例为说明性质的、图解性质的且用于提供对本申请的基本理解。本申请的实施例不应该被解释为对本申请的限制。

在本说明书中，除非经特别指定或限定之外，相对性的用词例如：“中央的”、“纵向的”、“侧向的”、“前方的”、“后方的”、“右方的”、“左方的”、“内部的”、“外部的”、“较低的”、“较高的”、“水平的”、“垂直的”、“高于”、“低于”、“上方的”、“下方的”、“顶部的”、“底部的”以及其衍生性的用词（例如“水平地”、“向下地”、“向上地”等等）应该解释成引用在讨论中所描述或在附图中所描示的方向。这些相对性的用词仅用于描述上的方便，且并不要求将本申请以特定的方向建构或操作。

另外，有时在本文中以范围格式呈现量、比率和其它数值。应理解，此类范围格式是用于便利及简洁起见，且应灵活地理解，不仅包含明确地

指定为范围限制的数值，而且包含涵盖于所述该范围内的所有个别数值或子范围，如同明确地指定每一数值及子范围一般。

再者，为便于描述，“第一”、“第二”、“第三”等等可在本文中用于区分一个图或一系列图的不同组件。除非经特别指定或限定之外，“第一”、“第二”、“第三”等等不意欲描述对应组件。

如本文中所使用，术语“约”用以描述及说明小的变化。当与事件或情形结合使用时，所述术语可指代其中事件或情形精确发生的例子以及其中事件或情形极近似地发生的例子。举例来说，当结合数值使用时，术语可指代小于或等于所述数值的±10%的变化范围，例如小于或等于±5%、小于或等于±4%、小于或等于±3%、小于或等于±2%、小于或等于±1%、小于或等于±0.5%、小于或等于±0.1%、或小于或等于±0.05%。另外，有时在本文中以范围格式呈现量、比率和其它数值。应理解，此类范围格式是用于便利及简洁起见，且应灵活地理解，不仅包含明确地指定为范围限制的数值，而且包含涵盖于所述范围内的所有个别数值或子范围，如同明确地指定每一数值及子范围一般。

本申请的实施例通过提供一种正极极片，其在有正极活性物质层覆盖的区域中的活性物质层采用双层结构，在无正极活性物质层覆盖的区域设置了一层绝缘层，并通过调整设置在活性物质层与绝缘层之间的间隙大小，改善由于活性物质层与绝缘层的重叠设置所导致的正极极片的破损问题，使其在受到外力产生破损时能够有效的提高正极集流体与负极活性物质层之间的接触电阻，从而提升了锂离子电池在相应测试（即穿钉（nail）测试）中的安全性能表现。

锂离子电池在穿钉测试过程中通常会发生四种短路模式：正极活性物质层-负极活性物质层，正极活性物质层-负极集流体，正极集流体-负极集流体，正极集流体-负极活性物质层。在这四种短路模式中，正极集流体-负极活性物质层的短路模式是四种短路模式中最为危险的，因为这种短路模式发生时的短路功率非常大。

在电化学装置（如锂离子电池）中，锂离子电池包括正极极片、负极极片、隔离膜以及电解液等。正极极片包括正极集流体、正极活性物质层

等。其中，正极集流体上除了活性物质层覆盖的区域外，还包括没有活性物质层覆盖的区域（也称作空箔区域）。举例来说，当锂离子电池的电极组件为卷绕式电极组件时，其空箔区域包括电极组件的外层区域以及电极组件的内层极耳焊接区域。

在正极活性物质层覆盖区域中，可以通过涂布双层结构的正极活性物质层，实现对正极集流体的保护。但是在穿钉测试的过程中，空箔区域的正极集流体也会直接和钉子接触，而钉子会和电极组件内部的负极活性物质层导通，从而形成正极集流体-负极活性物质层或正极集流体-钉子-负极活性物质层的短路模式。因此，通过在空箔区上设置一层绝缘层可以有效的保护正极极片中的正极集流体的空箔区域，进而避免出现正极集流体-负极活性物质层或正极集流体-钉子-负极活性物质层的短路模式，其中绝缘层对正极集流体的空箔区域的覆盖度越高，避免短路的作用越明显。但是由于绝缘层的厚度大于活性物质层底层的第一正极活性物质层的厚度，当在第一正极活性物质层上涂布第二正极活性物质层时会由于加工公差的波动，使得第二正极活性物质层容易与绝缘层发生重叠，并导致绝缘层覆盖在第二正极活性物质层的上方或下方

图 1 是根据本申请一些实施例的活性物质层与绝缘层重叠的正极极片的结构示意图。如图 1 所示，正极极片 10 包含正极集流体 11、第一正极活性物质层 12、第二正极活性物质层 13 及绝缘层 14。所述第一正极活性物质层 12 设置于所述正极集流体 11 和所述第二正极活性物质层 13 之间并覆盖在所述正极集流体 11 的一个表面上的第一部分，所述绝缘层设置在该表面上沿着所述正极集流体 11 的长度方向上没有被所述第一正极活性物质层 12 覆盖的第二部分，其中所述绝缘层与所述第一正极活性物质层 12 在所述正极集流体 11 的长度方向上不存在任何的间隙，且所述绝缘层与所述第二正极活性物质层在所述正极集流体 11 的长度方向上发生重叠，以上技术方案可以显著提高锂离子电池的穿钉测试表现。但是，由于所述第二正极活性物质层 13 与所述绝缘层 14 的重叠部分的厚度偏大，在后续的冷压步骤时，会导致所述第二正极活性物质层 13 中的第二正极活性物质超过其压实密度的极限，使得所述第二正极活性物质层 13 中的所述第二正极活

性物质的颗粒破裂。而所述第二正极活性物质的破裂会影响其锂离子的嵌入及脱出，导致电极组件会出现电池容量偏低等不良现象。

本申请的一些实施例提供了一种正极极片，所述正极极片通过设置位于正极活性物质层与绝缘层之间的间隙大小以避免上述正极极片设计不良所导致的重叠问题。

图 2 是根据本申请一些实施例的正极极片的结构示意图。

如图 2 所示，正极极片 10 包含正极集流体 11、第一正极活性物质层 12、第二正极活性物质层 13 及绝缘层 14。特别的，所述正极极片通过调整所述第一正极活性物质层 12、所述第二正极活性物质层 13 以及所述绝缘层 14 在所述正极集流体长度方向上的设置位置，使第一正极活性物质层 12 及所述第二正极活性物质层 13 与所述绝缘层 14 的中间分别存在第一距离 15 与第二距离 16。其中，所述第一正极活性物质层 12 设置于所述正极集流体 11 和所述第二正极活性物质层 13 之间并覆盖在所述正极集流体 11 的一个表面上的第一部分，所述绝缘层设置在该表面上沿着所述正极集流体 11 的长度方向上没有被所述第一正极活性物质层 12 覆盖的第二部分；所述绝缘层 14 与所述第一正极活性物质层 12 在所述正极集流体 11 长度方向上存在第一距离 15，所述绝缘层 14 与所述第二正极活性物质层 13 在所述正极集流体 11 长度方向上存在第二距离 16，所述第一距离及所述第二距离大于或等于 0 且所述第二距离小于或等于所述第一距离。上述所述第一距离 15 与所述第二距离 16 的设置有效的避免了所述第一正极活性物质层 12 及所述第二正极活性物质层 13 与所述绝缘层 14 的重叠，从而提高所述正极极片在制备过程中的可靠性，并降低所述第二正极活性物质层 13 中的第二正极活性物质在冷压工艺中可能的破裂问题。

在本申请的一些实施例中，所述第二正极活性物质层 13 在所述正极集流体长度方向上的端部长于或等于所述第一正极活性物质层 12 在所述正极集流体长度方向上的端部，使得所述第二正极活性物质层 13 完全覆盖所述第一正极活性物质层 12 的表面。

图 3 是根据本申请一些实施例的第二正极活性物质层 13 的端部短于第一正极活性物质层 12 的端部的正极极片的结构示意图。如图 3 所示，所述

第二正极活性物质层 13 在所述正极集流体长度方向上的端部短于所述第一正极活性物质层 12 在所述正极集流体长度方向上的端部，使得所述第一正极活性物质层 12 在所述正极集流体长度方向上的尾端出现未受所述第二正极活性物质层 13 覆盖的暴露部分。以上技术方案可以显著提高锂离子电池的穿钉测试表现。但是，所述第一正极活性物质层 12 的暴露部分在充电过程中会导致锂离子从第一正极活性物质层中脱出，脱出的锂离子会在与所述暴露部分相对的负极集流体上形成锂金属颗粒，并随着锂离子电池循环次数的增多不断加剧，从而导致电极组件外观出现锂金属颗粒麻点，并降低锂离子电池的容量。

在本申请的一些实施例中，所述第一距离为约 0mm～约 83mm，其确保正极极片在制备过程中的可靠性，且不会降低所述正极极片在穿钉测试中的安全性能表现。在本申请的一些实施例中，所述第一距离为约 6mm～约 83mm。

在本申请的一些实施例中，所述第二距离为约 0mm～约 83mm，其确保正极极片在制备过程中的可靠性，且不会降低所述正极极片在穿钉测试中的安全性能表现。在本申请的一些实施例中，所述第二距离为约 6mm～约 83mm。

在本申请的一些实施例中，对于正极活性物质颗粒度的测量，可以通过马尔文粒度测试仪进行测量：将正极活性物质分散在分散剂中（乙醇或丙酮，或其他的表面活性剂中），超声 30min 后，将样品加入到马尔文粒度测试仪内，开始测试。所述第一正极活性物质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（Dv50），即平均粒径，的范围为约 0.2μm~约 15μm，同时所述第一正极活性物质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（Dv90）的范围为小于或等于约 40 μm。当所述第一正极活性物质具有较小的 Dv90，能够对所述正极集流体 11 实现较高的覆盖度和粘结作用，其中所述覆盖度为待涂覆区域的总涂覆面积减去通过涂覆层中的孔隙暴露的待涂覆层的暴露面积与所述总涂覆面积的百分比。在本申请的一些实施例中，所述第二正极活性物质的平均粒径（Dv50）：所述第一正极活性物质平均粒径（Dv50）为约 1：1~

约 40：1。所述第一正极活性物质的颗粒越小，所述第一正极活性物质层的厚度可以做得越薄。

在本请一些实施例中，所述第一正极活性物质层 12 的厚度为约 0.1μm~约 20μm。在本申请一些实施例中，所述第一正极活性物质层 12 的厚度为约 0.5μm~约 15μm。在本申请一些实施例中，所述第一正极活性物质层 12 的厚度为约 2μm~约 8μm。特别的，所述第一正极活性物质层 12 的厚度不小于所述第一正极活性物质的颗粒度 Dv90，这是为了保证所述第一正极活性物质层 12 的覆盖度。

在本申请的一些实施例中，所述第一正极活性物质层 12 的厚度小于或等于所述绝缘层 14 的厚度。在本申请的一些实施例中，所述绝缘层 14 的厚度大于约 0.1μm，以达到一定的绝缘效果。在本申请的一些实施例中，所述绝缘层 14 的厚度为约 8μm～约 30μm，。

根据本申请的一些实施例，所述绝缘层包括无机粒子与聚合物中的至少一种，也可以加入适当的分散剂，所述分散剂包括，但不限于，乙醇或丙酮，或其他的表面活性剂。所述无机粒子选自由氧化铝、二氧化硅、氧化镁、氧化钛、二氧化铪、氧化锡、二氧化铈、氧化镍、氧化锌、氧化钙、二氧化锆、氧化钇、碳化硅、勃姆石、氢氧化铝、氢氧化镁、氢氧化钙、硫酸钡及其组合所组成的群组；所述聚合物选自由偏氟乙烯的均聚物、偏氟乙烯的共聚物、六氟丙烯的共聚物、聚苯乙烯、聚苯乙炔、聚乙烯酸钠、聚乙烯酸钾、聚甲基丙烯酸甲酯、聚乙烯、聚丙烯、聚四氟乙烯及其组合所组成的群组。

根据本申请的一些实施例，所述第一正极活性物质和所述第二正极活性物质各自独立地选自由钴酸锂、磷酸铁锂、磷酸锰铁锂、磷酸铁钠、磷酸钒锂、磷酸钒钠、磷酸钒氧锂、磷酸钒氧钠、钒酸锂、锰酸锂、镍酸锂、镍钴锰酸锂、富锂锰基材料、镍钴铝酸锂、钛酸锂及其组合所组成的群组。

在本申请一些实施例中，所述第一正极活性物质层 12 和所述第二正极活性物质层 13 还包括粘结剂，所述粘结剂包括但不限于聚偏氟乙烯、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、聚六氟丙烯和丁苯橡胶中的一种及其组合。粘结剂一方面使得活性物质层与正极集流体可以有更好的粘结，另一方面粘结剂含量增加，所述第一正极活性物质层 12 的压实密度更低，所述第一正极活性物质层 12 的粘结剂的含量以所述第一正极活性物质层 12 的总重量计为约 1.5 重量%~约 6 重量%，所述第二正极活性物质层 13 的粘结剂的含量以所述第二正极活性物质层 13 的总重量计为约 0.5 重量%~约 4 重量%。

在本申请一些实施例中，所述第一正极活性物质层 12 和所述第二正极活性物质层 13 中还可以含有一定量的导电剂。所述导电剂包括，但不限于，碳纳米管、导电炭黑、乙炔黑、石墨烯、科琴黑和碳纤维中的一种及其组合。所述第一正极活性物质层的所述导电剂的含量以所述第一正极活性物质层的总重量计为约 0.5 重量%~约 5 重量%，所述第二正极活性物质层的所述导电剂的含量以所述第二正极活性物质层的总重量计为约 0.5 重量%~约 5 重量%。

此外，可以对所述第一正极活性物质层 12 或所述第二正极活性物质层 13 进行一些其他处理，或者对所述正极集流体 11 进行一些处理，如粗糙度处理、热处理等，其作用原理或者作用效果可以是增强对正极集流体的粘结，虽然本申请中未涉详细描述，但其包括在本申请的范围内。

在本申请的一些实施例中，所述第一距离及所述第二距离设置在所述电极组件的侧边的拐角处。由于在具有卷绕式电极组件的锂离子电池使用过程中，所述电极组件的侧边的拐角处受到的外力冲击（如钉子穿透）的概率远小于从所述电极组件的上下外层的概率，将所述第一距离及所述第二距离设置在所述电极组件的侧边的拐角处可以有效的兼顾制备工艺的可靠性且维持所述电极组件的安全性能。

图 4A 和 4B 分别是根据本申请一些实施例中所述第一距离与所述第二距离为最小范围及最大范围的电极组件的结构示意图。如图 4A 所示，本申请的一些实施例提供的锂离子电池的电极组件，所述锂离子电池的电极组件为卷绕式结构，其包括本申请实施例的正极极片、负极极片及隔离膜 41，其中所述负极极片包括负极活性物质层 42 以及负极集流体 43，所述正极极片包括正极集流体 11、第一正极活性物质层 12、第二正极活性物质层

13 以及绝缘层 14。所述隔离膜间隔于所述负极极片与所述正极极片之间，其中所述绝缘层与所述第一正极活性物质层在所述正极集流体长度方向上存在第一距离，所述绝缘层与所述第二正极活性物质层在所述正极集流体长度方向上存在第二距离，所述第一距离与所述第二距离等于 0（即最小值）。

如图 4B 所示，在本申请的一些实施例中，所述电极组件的侧边的拐角处设置了具有最大范围 44 的所述第一距离，其中所述第一距离的最大范围如果过大则会导致暴露过多的所述正极集流体 11，甚至会进一步使所述第一距离超出所述电极组件的侧边的拐角处，进而暴露在所述电极组件上下外层处的所述正极集流体 11，使得所述绝缘层 14 对所述正极集流体 11 的保护下降，进一步降低所述电极组件的安全性能及穿钉测试通过率。本申请的一些实施例根据所述电极组件的厚度 D 来相应的调整所述第一距离与所述第二距离的最大范围 44，以确保设置在所述电极组件的侧边的拐角处的所述第一距离与所述第二距离的最大范围不会超出所述电极组件的侧边的拐角处。

所述电极组件的厚度 D 为所述正极活性物质层末端与所述正极集流体空箔区的交界处到所述电极组件相对侧上最外层的空箔区之间的距离。

在本申请的一些实施例中，所述电极组件的厚度 D 为约 1.5mm～约 50mm。

在本申请的一些实施例中，所述绝缘层与所述第一正极活性物质层在所述集流体长度方向上的所述第一距离 15 满足以下公式：

$0 \leq$ 第一距离 $\leq \frac{\pi}{2}D + 4mm$。

在本申请的一些实施例中，所述绝缘层与所述第二正极活性物质层在所述集流体长度方向上的所述第二距离 16 满足以下公式：

$0 \leq$ 第二距离 $\leq \frac{\pi}{2}D + 4mm$。

本领域技术人员应可清楚的理解上述公式中的 4mm 为对所述电极组件进行加工时所产生的误差的允许的误差范围，即加工公差，所述加工公差的数值范围可以根据实际操作过程需要进行调整，而不受其限制。

本申请一些实施例中的正极极片的正极集流体可以为铝箔或镍箔，负

极极片的负极集流体可为铜箔或镍箔，然而，可以采用本领域常用的其他正极集流体及负极集流体。

本申请一些实施例中的负极活性物质层的导电剂和粘结剂与上面描述的正极活性物质层的导电剂和粘结剂类似，在此不再赘述。所述负极活性物质层包含负极活性物质，其包括，但不限于，选自由碳材料、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元素和半金属元素、聚合物材料及其组合所组成的群组。

在上述负极活性物质中，所述碳材料的实例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。聚合物材料的实例可以包括聚乙炔和聚吡咯。

在上述负极活性物质中，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。这是因为负极活性物质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，负极活性物质可以选择碳材料，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，所述负极活性物质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。特别地，将它们和碳材料一起使用，因为在这种情况中，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。

上述金属元素和半金属元素的实例可以包括锡（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实例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，可以在所述负极活性物质层中使用不包括锂（Li）的无机化合物，例如 MnO_2、V_2O_5、V_6O_{13}、NiS 和 MoS。

本申请一些实施例中的隔离膜包括，但不限于，选自聚乙烯、聚丙烯、聚对苯二甲酸乙二醇酯、聚酰亚胺和芳纶中的至少一种。举例来说，聚乙烯包括选自高密度聚乙烯、低密度聚乙烯和超高分子量聚乙烯中的至少一种组分。尤其是聚乙烯和聚丙烯，它们对防止短路具有良好的作用，并可以通过关断效应改善电池的稳定性。

所述隔离膜的表面还可包括多孔层，所述多孔层设置在所述隔离膜的至少一个表面上，所述多孔层包括无机颗粒和粘结剂，所述无机颗粒选自氧化铝（Al_2O_3）、氧化硅（SiO_2）、氧化镁（MgO）、氧化钛（TiO_2）、二氧化铪（HfO_2）、氧化锡（SnO_2）、二氧化铈（CeO_2）、氧化镍（NiO）、氧化锌（ZnO）、氧化钙（CaO）、氧化锆（ZrO_2）、氧化钇（Y_2O_3）、碳化硅（SiC）、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的组合。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的组合。

所述多孔层可以提升所述隔离膜的耐热性能、抗氧化性能和电解液浸润性能，增强所述隔离膜与正极极片或负极极片之间的粘接性。

本申请的锂离子电池还包括电解质，所述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。

在本申请一些实施例中，所述锂盐选自 $LiPF_6$、$LiBF_4$、$LiAsF_6$、$LiClO_4$、$LiB(C_6H_5)_4$、$LiCH_3SO_3$、$LiCF_3SO_3$、$LiN(SO_2CF_3)_2$、$LiC(SO_2CF_3)_3$、$LiSiF_6$、LiBOB 和二氟硼酸锂中的一种或多种。举例来说，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。

所述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。

上述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。

上述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）、碳酸亚丙酯（PC）、碳酸亚丁酯（BC）、碳酸乙烯基亚乙酯（VEC）、丙酸丙酯（PP）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。

上述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、丙酸丙酯、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。

上述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。

上述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。

在本申请一些实施例中，将上述正极极片、隔离膜、负极极片按顺序卷绕或堆叠成电极组件，之后装入例如铝塑膜中，注入电解液，化成、封装，即制成锂离子电池。随后，对制备的锂离子电池进行性能测试、电池

容量测试以及电池穿钉测试。

本领域的技术人员将理解，虽然上面以锂离子电池进行了举例说明，本申请的电化学装置进一步包含其他任何合适的电化学装置。在不背离本申请公开的内容的基础上，这样的电化学装置包括发生电化学反应的任何装置，它的具体实例包括所有种类的一次电池、二次电池、燃料电池、太阳能电池或电容。特别地，所述电化学装置是锂二次电池，包括锂金属二次电池、锂离子二次电池、锂聚合物二次电池或锂离子聚合物二次电池。

本申请电化学装置的用途没有特别限定，其可用于现有技术中已知的任何用途。在一个实施例中，本申请的电化学装置可用于，但不限于，笔记本电脑、笔输入型计算机、移动电脑、电子书播放器、便携式电话、便携式传真机、便携式复印机、便携式打印机、头戴式立体声耳机、录像机、液晶电视、手提式清洁器、便携CD机、迷你光盘、收发机、电子记事本、计算器、存储卡、便携式录音机、收音机、备用电源、电机、汽车、摩托车、助力自行车、自行车、照明器具、玩具、游戏机、钟表、电动工具、闪光灯、照相机、家庭用大型蓄电池和锂离子电容器等。

下面列举了一些具体实施例和对比例并分别对其进行了电池容量测试以及电池穿钉测试以更好地对本申请进行说明。本领域的技术人员将理解，本申请中描述的制备方法仅是示范实施例，其他任何合适的制备方法均在本申请的范围内。

实施例1

采用铝箔作为正极集流体，在铝箔表面均匀的涂布一层小颗粒磷酸铁锂浆料，包括第一正极活性物质（其中磷酸铁锂的颗粒度为Dv50：3μm，Dv90：10μm）。磷酸铁锂浆料的组成为95.8wt%磷酸铁锂（$LiFePO_4$）、2.8wt%聚偏氟乙烯（PVDF）和1.4wt%导电炭黑，在85℃下烘干，形成第一正极活性物质层；随后在沿正极集流体长度方向上与所述第一正极活性物质层距离3mm的位置涂布一层氧化铝浆料（即第一距离为3mm），氧化铝浆料的组成为98wt%氧化铝（Al_2O_3）和2wt%聚偏氟乙烯（PVDF），85℃下烘干，形成厚度为15μm的绝缘层；随后在烘干后的第一正极活性

物质层上继续涂布一层钴酸锂浆料（第二正极活性物质层的浆料），钴酸锂浆料组成为97.8wt%钴酸锂(LCO)(其中钴酸锂的颗粒度为Dv50:13μm，Dv90：38 μm）、0.8wt%聚偏氟乙烯（PVDF）和1.4wt%导电炭黑，在85℃下烘干，形成第二正极活性物质层，所述第二正极活性物质层在所述正极集流体长度方向上的末端超出所述第一正极活性物质层的末端的距离为3mm，且没有覆盖到所述绝缘层（即第二距离为0mm）；随后对第一正极活性物质层及第二正极活性物质层进行冷压，其中冷压压力为 60T，冷压速度40m/min，裁片、分切后，在85℃的真空条件下干燥4小时，制备得到正极极片。其中所述第一正极活性物质层厚度为8μm且所述第二正极活性物质层厚度为50μm。

采用铜箔作为负极集流体，在铜箔表面均匀的涂布一层石墨浆料，浆料组成为97.7wt%人造石墨、1.3wt%羧甲基纤维素钠（CMC）以及1.0wt%丁苯橡胶（SBR）的组合，在85℃下烘干，并随后进行冷压、裁片、分切，制备得到负极极片。

将锂盐$LiPF_6$与非水有机溶剂(碳酸乙烯酯(EC):碳酸二乙酯(DEC):碳酸亚丙酯（PC）：丙酸丙酯（PP）：碳酸亚乙烯酯（VC）=20:30:20:28:2，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。

将正极极片和负极极片进行卷绕，正极极片和负极极片之间以聚乙烯隔离膜进行分隔，从而制备得到卷绕型电极组件，其中所述第一距离与所述第二距离设置在所述电极组件的侧边的拐角处，所述电极组件的厚度 D为3.2 mm。所述电极组件经顶侧封、喷码、真空干燥、注入电解液、高温静置后进行化成及容量，即可得到成品锂离子电池。

实施例2

与实施例1的制备方法相同，不同的地方是实施例2中在沿正极集流体长度方向上与所述第一正极活性物质层距离 5mm 的位置涂布一层氧化铝浆料（即第一距离为5mm，且第二距离为2mm）。

实施例3

与实施例 1 的制备方法相同，不同的地方是实施例 3 中在沿正极集流体长度方向上与所述第一正极活性物质层距离 9mm 的位置涂布一层氧化铝浆料（即第一距离为 9mm），且所述第二正极活性物质层在所述正极集流体长度方向上的末端超出所述第一正极活性物质层的末端 5mm（即第二距离为 4mm）。

实施例 4

与实施例 1 的制备方法相同，不同的地方是实施例 4 中的绝缘层的厚度为 10μm。

实施例 5

与实施例 1 的制备方法相同，不同的地方是实施例 5 中的绝缘层的厚度为 20μm。

实施例 6

与实施例 1 的制备方法相同，不同的地方是实施例 6 中的绝缘层的厚度为 5μm。

实施例 7

与实施例 1 的制备方法相同，不同的地方是实施例 7 中的绝缘层的厚度为 1μm。

实施例 8

与实施例 2 的制备方法相同，不同的地方是实施例 8 中的电极组件的厚度 D 为 2.8mm。

实施例 9

与实施例 2 的制备方法相同，不同的地方是实施例 9 中的电极组件的厚度 D 为 3.6mm。

实施例 10

与实施例 2 的制备方法相同，不同的地方是实施例 10 中的电极组件的厚度 D 为 4.8mm。

实施例 11

与实施例 1 的制备方法相同，不同的地方是实施例 11 中在沿正极集流体长度方向上与所述第一正极活性物质层距离 20mm 的位置涂布一层氧化铝浆料（即第一距离为 20mm），且所述第二正极活性物质层在所述正极集流体长度方向上的末端超出所述第一正极活性物质层的末端 2mm（即第二距离为 18mm）。

实施例 12

与实施例 1 的制备方法相同，不同的地方是实施例 12 中的所述第二正极活性物质层在所述正极集流体长度方向上的末端短于所述第一正极活性物质层的末端的距离为 7mm（即第二距离为 10mm）。

实施例 13

与实施例 1 的制备方法相同，不同的地方是实施例 13 中在沿正极集流体长度方向上与所述第一正极活性物质层距离 0mm 的位置涂布一层氧化铝浆料，且所述第二正极活性物质层覆盖部分所述绝缘层（即第二距离为 -3mm）。

对比例 1

采用铝箔作为正极集流体，在铝箔表面均匀的涂布一层小颗粒磷酸铁锂浆料，包括第一正极活性物质（其中磷酸铁锂的颗粒度为 Dv50：3μm，Dv90：10μm）。磷酸铁锂浆料的组成为 95.8wt% 磷酸铁锂（$LiFePO_4$）、2.8wt%聚偏氟乙烯（PVDF）和 1.4wt%导电炭黑，在 85℃下烘干，形成第一正极活性物质层；随后在烘干后的第一正极活性物质层上继续涂布一层

钴酸锂浆料（第二正极活性物质层的浆料），钴酸锂浆料组成为 97.8wt%钴酸锂（LCO）（其中钴酸锂的颗粒度为 Dv50：13μm，Dv90：38μm）、0.8wt%聚偏氟乙烯（PVDF）和 1.4wt%导电炭黑，在 85℃下烘干，形成第二正极活性物质层，所述第二正极活性物质层在所述正极集流体长度方向上的末端超出所述第一正极活性物质层的末端的距离为 3mm；随后对第一正极活性物质层及第二正极活性物质层进行冷压，其中冷压压力为 60T，冷压速度 40m/min，裁片、分切后，在 85℃的真空条件下干燥 4 小时，制备得到正极极片。其中所述第一正极活性物质层厚度为 8μm 且所述第二正极活性物质层厚度为 50μm。

采用铜箔作为负极集流体，在铜箔表面均匀的涂布一层石墨浆料，浆料组成为 97.7wt%人造石墨、1.3wt%羧甲基纤维素钠（CMC）以及 1.0wt%丁苯橡胶（SBR），85℃下烘干，并随后进行冷压、裁片、分切，在 85℃的真空条件下干燥 4h，制备得到负极极片。

将锂盐 $LiPF_6$与非水有机溶剂（碳酸乙烯酯（EC）：碳酸二乙酯（DEC）：碳酸亚丙酯（PC）：丙酸丙酯（PP）：碳酸亚乙烯酯（VC）=20:30:20:28:2，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。

将正极极片和负极极片进行卷绕，正极极片和负极极片之间以聚乙烯隔离膜进行分隔，从而制备得到卷绕型电极组件，其中所述电极组件的厚度 D 为 3.2 mm。所述电极组件经顶侧封、喷码、真空干燥、注入电解液、高温静置后进行化成及容量，即可得到成品锂离子电池。

上述实施例及对比例的锂离子电池成品完成后，纪录其成品的容量、厚度、宽度、长度以确定电池的体积能量密度。随后对上述实施例及对比例的锂离子电池成品进行电池容量测试及电池穿钉测试。

电池容量测试：

将待测的电化学装置（锂离子电池）在 25±3℃环境中静置 30 分钟，以 0.5C 倍率恒流充电至电压至 4.4V（额定电压），随后以恒压充电直到充放电倍率达到 0.05C 时停止充电，并将待测的电化学装置放置 30 分钟。之后再以 0.2C 倍率将电池放电至 3.0V，并将待测的锂离子电池放置 30 分钟。

最后取放电容量作为电池的实际电池容量。

锂离子电池能量密度=放电容量/（锂离子电池的长度*宽度*厚度）。

电池穿钉测试：

取 10 枚待测的电化学装置（锂离子电池）在常温下以 0.5C 倍率恒定电流充电至电压 4.4V，进一步在 4.4V 恒定电压下充电至电流 0.05C，使其处于 4.4V 满充状态。之后在常温条件下对锂离子电池进行穿钉，采用直径为 2.5mm 钉子（钢钉，材质为碳钢，锥度为 16.5mm，钢钉总长为 100mm），以 30mm/s 的穿钉速度穿钉，穿钉深度以钢钉锥度穿过锂离子电池为准，观察锂离子电池是否产烟、起火或爆炸。若没有则认为锂离子电池通过穿钉测试。

各个实施例以及对比例的实验参数和测量结果如下表 1 所示。

表 1

组别	第一正极活性物质层与第二正极活性物质层的位置关系	电极组件厚度(mm)	第一距离(mm)	第二距离(mm)	第一正极活性物质层厚度(um)	绝缘层厚度(um)	穿钉通过率	锂离子电池能量密度(Wh/L)	是否析锂
实施例 1	上层超出下层	3.2	3	0	8	15	10/10	680	否
实施例 2	上层超出下层	3.2	5	2	8	15	10/10	680	否
实施例 3	上层超出下层	3.2	9	4	8	15	10/10	680	否
实施例 4	上层超出下层	3.2	3	0	8	10	8/10	682	否
实施例 5	上层超出下层	3.2	3	0	8	20	10/10	678	否
实施例 6	上层超出下层	3.2	3	0	8	5	7/10	683	否
实施例 7	上层超出下层	3.2	3	0	8	1	6/10	684	否
实施例 8	上层超出下层	2.8	5	2	8	15	10/10	680	否
实施例 9	上层超出下层	3.6	5	2	8	15	10/10	680	否
实施例 10	上层超出下层	4.8	5	2	8	15	10/10	680	否
实施例 11	上层超出下层	3.2	20	18	8	15	5/10	680	否
实施例 12	下层超出上层	3.2	3	10	8	15	8/10	678	是
实施例 13	上层超出下层	3.2	0	-3	8	15	8/10	678	是
对比例 1	上层超出下层	3.2	-	-	8	0	2/10	685	否

通过比较对比例 1 和实施例 1-13 可知，通过结合在正极活性物质层覆盖区域中采用双层结构的正极活性物质层以及在空箔区域中采用绝缘层，锂离子电池的穿钉测试通过率会有巨大程度的改善，并且对其能量密度基

本没有多大影响。

通过比较实施例 12 及实施例 1 可知，当第二正极活性物质层在正极集流体长度方向上的末端短于所述第一正极活性物质层的末端时，会产生析锂现象。

从实施例 13 和实施例 1、2、3 和 11 可知，当所述第二正极活性物质层与所述绝缘层覆盖时，会导致析锂现象。

从实施例 1 和 4-7 可知，随着绝缘层厚度的减少，锂离子电池的能量密度会小幅提升；但是，绝缘层厚度过低也会导致锂离子电池的穿钉通过率下降。

从实施例 2 和 8-10 可知，对于包括不同厚度的电极组件的锂离子电池，通过第一距离和第二距离的合理设置，能够在不显著降低锂离子电池的能量密度，不产生析锂等副作用的情况下，显著提高锂离子电池的安全性能。

上文说明摘要整理出数个实施例的特征，这使得所属技术领域中具有通常知识者能够更加理解本申请的多种方面。所属技术领域中具有通常知识者可轻易地使用本申请作为基础，以设计或修改其他组合物，以便实现与此处申请的实施例相同的目的及/或达到相同的优点。所属技术领域中具有通常知识者亦可理解，这些均等的实例并未悖离本申请的精神与范畴，且其可对本申请进行各种改变、替换与修改，而不会悖离本申请的精神与范畴。虽然本文中所揭示的方法已参考以具体次序执行的具体操作加以描述，但应理解，可在不脱离本申请的教示的情况下组合、细分或重新排序这些操作以形成等效方法。因此，除非本文中特别指示，否则操作的次序及分组不是对本申请的限制。

2018113088413

说 明 书 附 图

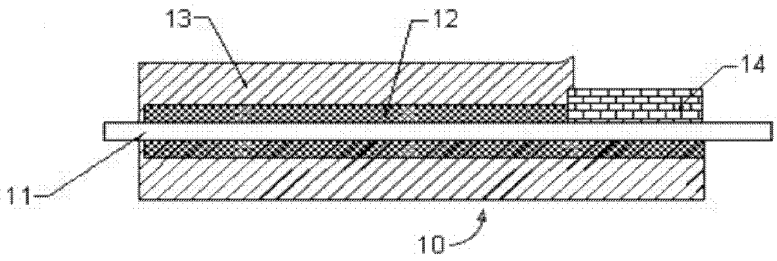

图 1

2018113088413

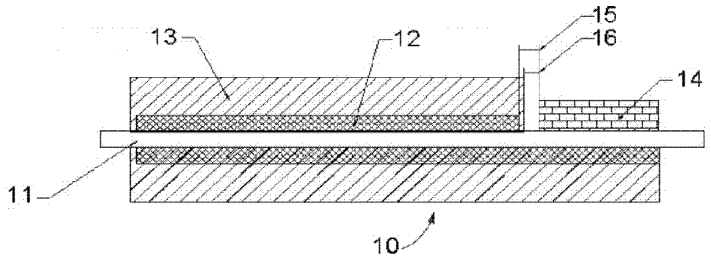

图 2

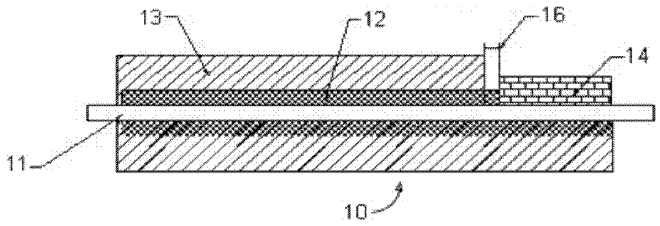

图 3

2018113088413

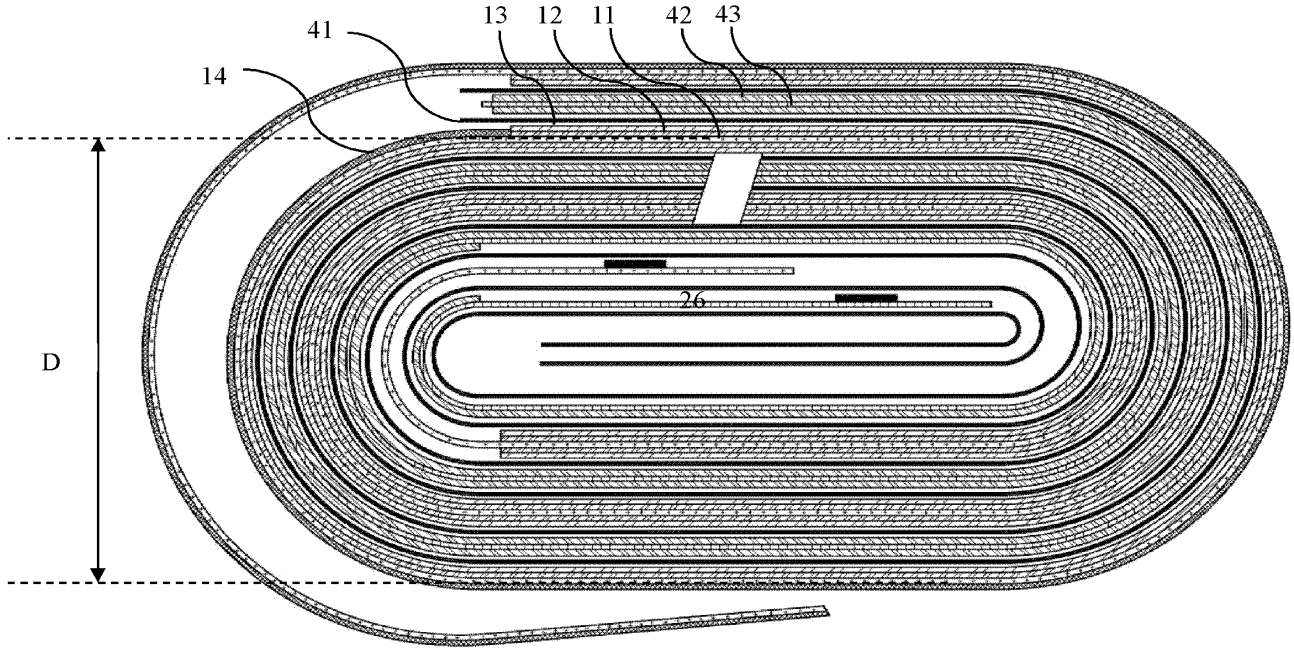

图 4A

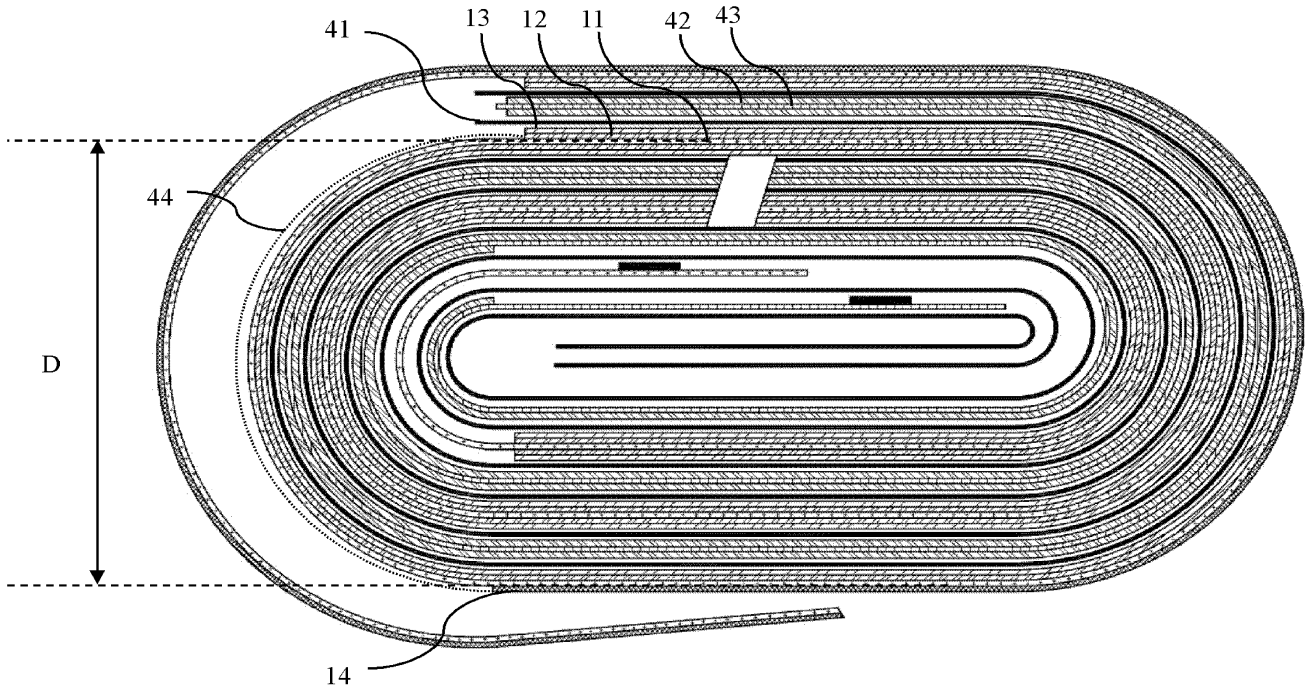

图 4B

UNITED STATES PATENT AND TRADEMARK OFFICE

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APPLICATION NUMBER	FILING OR 371(C) DATE	FIRST NAMED APPLICANT	ATTY. DOCKET NO./TITLE
16/298,738	03/11/2019	Xinru SU	LEEL-0101

CONFIRMATION NO. 3478

38327
Juan Carlos A. Marquez
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PUBLICATION NOTICE

Title:CATHODE, ELECTROCHEMICAL DEVICE AND ELECTRONIC DEVICE COMPRISING SAME

Publication No.US-2020-0144605-A1
Publication Date:05/07/2020

NOTICE OF PUBLICATION OF APPLICATION

The above-identified application will be electronically published as a patent application publication pursuant to 37 CFR 1.211, et seq. The patent application publication number and publication date are set forth above.

The publication may be accessed through the USPTO's publically available Searchable Databases via the Internet at www.uspto.gov. The direct link to access the publication is currently http://www.uspto.gov/patft/.

The publication process established by the Office does not provide for mailing a copy of the publication to applicant. A copy of the publication may be obtained from the Office upon payment of the appropriate fee set forth in 37 CFR 1.19(a)(1). Orders for copies of patent application publications are handled by the USPTO's Public Records Division. The Public Records Division can be reached by telephone at (571) 272-3150 or (800) 972-6382, by facsimile at (571) 273-3250, by mail addressed to the United States Patent and Trademark Office, Public Records Division, Alexandria, VA 22313-1450 or via the Internet.

In addition, information on the status of the application, including the mailing date of Office actions and the dates of receipt of correspondence filed in the Office, may also be accessed via the Internet through the Patent Electronic Business Center at www.uspto.gov using the public side of the Patent Application Information and Retrieval (PAIR) system. The direct link to access this status information is currently https://portal.uspto.gov/pair/PublicPair. Prior to publication, such status information is confidential and may only be obtained by applicant using the private side of PAIR.

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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
16/298,738	03/11/2019	Xinru SU	LEEL-0101	3478

38327 7590 06/09/2020

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EXAMINER	
LYNCH, VICTORIA HOM	

ART UNIT	PAPER NUMBER
1724	

NOTIFICATION DATE	DELIVERY MODE
06/09/2020	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):

USPTO@dockettrak.com
lniu@marqueziplaw.com
mail@marqueziplaw.com

Office Action Summary	Application No. 16/298,738	Applicant(s) SU et al.	
	Examiner VICTORIA H LYNCH	Art Unit 1724	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 3/11/19.

☐ 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) 1-20 is/are pending in the application.

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

6) ☐ Claim(s) _____ is/are allowed.

7) ☑ Claim(s) 1-5,7-13 and 15-19 is/are rejected.

8) ☑ Claim(s) 6,14 and 20 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 3/11/19 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

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

Claim Objections

2. Claim 20 is objected to because of the following informalities: the limitation "The **e** electronic device" in line 1 appears to include a drafting error. Appropriate correction is required.

Claim Rejections - 35 USC § 112

3. 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.

4. Claims 3, 5, and 6 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.

5. Claim 3 recites the limitation "**the** surface of the first cathode active " in line 2. There is insufficient antecedent basis for this limitation in the claim. For the purpose of this Office Action, the limitation has been interpreted as "**a** surface of the first cathode active ".

6. Claim 5 recites the limitation "**the** thickness" in line 1. There is insufficient antecedent basis for this limitation in the claim. For the purpose of this Office Action, the limitation has been interpreted as "**a** thickness".

7. Claim 6 recites the limitation "**the** thickness" in lines 1 and 2. There is insufficient antecedent basis for this limitation in the claim. For the purpose of this Office Action, the limitation has been interpreted as "**a** thickness".

8. Claim 13 is 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.

9. Claim 13 recites the limitation "**the** thickness" in lines 1-2. There is insufficient antecedent basis for this limitation in the claim. For the purpose of this Office Action, the limitation has been interpreted as "**a** thickness".

10. Claim 19 is 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.

11. Claim 19 recites the limitation "**the** thickness" in line 1. There is insufficient antecedent basis for this limitation in the claim. For the purpose of this Office Action, the limitation has been interpreted as "**a** thickness".

Claim Rejections - 35 USC § 102

12. 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.

13. The following is a quotation of the appropriate paragraphs of 35 U.S.C. 102 that form the basis for the rejections under this section made in this Office action:

> A person shall be entitled to a patent unless –
>
> (a)(1) the claimed invention was patented, described in a printed publication, or in public use, on sale or otherwise available to the public before the effective filing date of the claimed invention.

14. Claim(s) 1-4, 7 and 8 is/are rejected under 35 U.S.C. 102(a)(1) as being anticipated by Tanaka et al. (US 2016/0294015).

Regarding claim 1, Tanaka discloses a cathode (positive electrode 1, Fig. 10, [0027]), comprising: a cathode current collector (positive electrode current collector 3, Fig. 10, [0074]), having a first surface (see Fig. A as annotated Fig. 10);

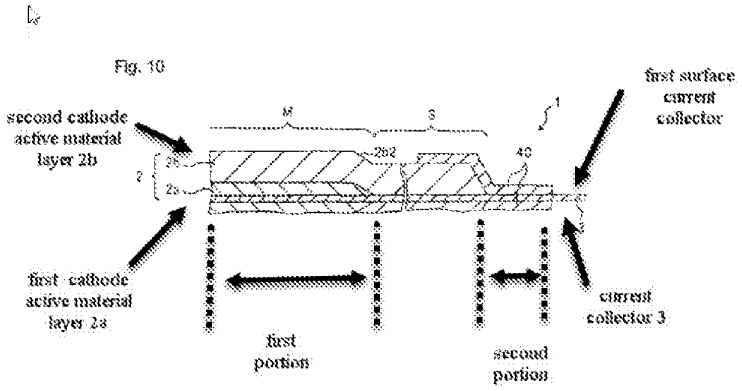

Fig. A

a first cathode active material layer (first active material layer 2a, Fig. 10, [0071]), comprising a first cathode active material(positive electrode active material [0040]); a second cathode active material layer (second active material layer 2b, Fig. 10, [0071]), comprising a second cathode active material(positive electrode active material [0040]); and an insulating layer (insulating member 40, Fig. 10, [0074]), wherein the first cathode active material layer is disposed between the cathode current collector and the second cathode active material layer and covers a first portion of the first surface of the cathode current collector (Fig. A), and the insulating layer

covers a second portion of the first surface of the cathode current collector that is different from the first portion (Fig. A).

Regarding claim 2, Tanaka discloses all of the claim limitations as set forth above. Tanaka further discloses a first distance exists between the insulating layer and the first cathode active material layer in a longitudinal direction of the cathode current collector (see Fig. B as annotated Fig. 10),

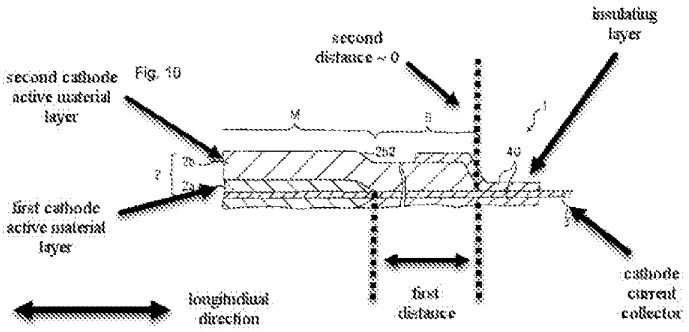

Fig. B

a second distance exists between the insulating layer and the second cathode active material layer in the longitudinal direction of the cathode current collector(Fig. B); and the first distance and the second distance are respectively greater than or equal to 0 (Fig. B)and the second distance is less than or equal to the first distance(Fig. B).

Regarding claim 3, Tanaka discloses all of the claim limitations as set forth above. Tanaka further discloses the second cathode active material layer completely covers a surface of the first cathode active material layer(Fig. B).

Regarding claim 4, Tanaka discloses all of the claim limitations as set forth above. Tanaka further discloses the first distance is from 0.5 to 5 mm (single-layer part S in Fig. 10, [0066]) which is within the claim limitation of about 0 mm to about 83 mm. According to the MPEP, “"[W]hen, as by a recitation of ranges or otherwise, a claim covers several compositions,

the claim is 'anticipated' if *one* of them is in the prior art." *Titanium Metals Corp. v. Banner,* 778 F.2d 775, 227 USPQ 773 (Fed. Cir. 1985) See MPEP 2131.03.

Regarding claim 7, Tanaka discloses all of the claim limitations as set forth above. Tanaka further discloses the first cathode active material and the second cathode active material are each independently selected from the group consisting of lithium cobaltate ([0040]), lithium vanadium phosphate($LiMPO_4$ [0040]), lithium manganate([0040]), lithium nickelate ([0040]), lithium nickel cobalt manganese oxide([0040]), lithium-rich manganese-based material([0040]), lithium nickel cobalt aluminum oxide([0040]), and combinations thereof ([0040]).

Regarding claim 8, Tanaka discloses all of the claim limitations as set forth above. Tanaka further discloses the first cathode active material layer and the second cathode active material layer each further comprise a binder (binding agent [0042]) and a conductive agent(conductive assistant [0042]), wherein the binder is selected from the group consisting of polyvinylidene fluoride ([0042]), polytetrafluoroethylene ([0042]), and combinations thereof; and the conductive agent is selected from the group consisting of conductive carbon black ([0042]), carbon fibers ([0042]) and combinations thereof([0042]).

Claim Rejections - 35 USC § 103

15. 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.

The factual inquiries set forth in *Graham v. John Deere Co.*, 383 U.S. 1, 148 USPQ 459 (1966), that are applied for establishing a background for determining obviousness under 35 U.S.C. 103 are summarized as follows:

1. Determining the scope and contents of the prior art.

2. Ascertaining the differences between the prior art and the claims at issue.

3. Resolving the level of ordinary skill in the pertinent art.

4. Considering objective evidence present in the application indicating obviousness or nonobviousness.

16. This application currently names joint inventors. In considering patentability of the claims the examiner presumes that the subject matter of the various claims was commonly owned as of the effective filing date of the claimed invention(s) absent any evidence to the contrary. Applicant is advised of the obligation under 37 CFR 1.56 to point out the inventor and effective filing dates of each claim that was not commonly owned as of the effective filing date of the later invention in order for the examiner to consider the applicability of 35 U.S.C. 102(b)(2)(C) for any potential 35 U.S.C. 102(a)(2) prior art against the later invention.

17. Claim 5 is/are rejected under 35 U.S.C. 103 as being unpatentable over Tanaka et al. (US 2016/0294015) as applied to claim 1 above.

Regarding claim 5, Tanaka discloses all of the claim limitations as set forth above. Tanaka further discloses a thickness of the active material layer is preferably about 5 to 200 μm ([0064]) which overlaps the claim limitation of the thickness of the first cathode active material layer is from about 0.1 μm to about 20 μm. The thickness of the active material layer may be an arbitrary value, and is not particularly limited ([0064]). In the case of the use for a portable electronic device, an electric bicycle, an electric assist bicycle, a stationary charger, an electric vehicle, a hybrid vehicle or the like, from the standpoint of battery capacity and weight, it is preferable that the active material layer that is positioned on at least one surface of the current collector be about 5 to 200 μm in thickness ([0064]).

According to the MPEP, “in the case where the claimed ranges "overlap or lie inside ranges disclosed by the prior art" a prima facie case of obviousness exists”. In re Wertheim, 541 F.2d 257, 191 USPQ 90 (CCPA 1976); In re Woodruff, 919 F.2d 1575, 16 USPQ2d 1934 (Fed. Cir. 1990). MPEP 2144.05. It would have been obvious to the skilled artisan to select the overlapping portion of the disclosed ranges as the skilled artisan would have had a reasonable expectation of achieving the desired effect disclosed by Tanaka.

18. Claim 9 is/are rejected under 35 U.S.C. 103 as being unpatentable over Tanaka et al. (US 2016/0294015) as applied to claim 1 above, in view of Yamafuku et al. (US 2015/0147624).

Regarding claim 9, Tanaka discloses all of the claim limitations as set forth above. Tanaka further discloses the insulating layer comprises at least one of a polymer ([0048]), the polymer is selected from the group consisting of polypropylene([0048]), but does not disclose at least one of inorganic particles, wherein the inorganic particles are selected from the group consisting of aluminum oxide, silicon dioxide, magnesium oxide, titanium oxide, hafnium oxide, tin oxide, cerium dioxide, nickel oxide, zinc oxide, calcium oxide, zirconium dioxide, yttrium oxide, silicon carbide, boehmite, aluminum hydroxide, magnesium hydroxide, calcium hydroxide, barium sulfate and combinations thereof. Tanaka discloses polyimide, glass fiber, polyester, polypropylene, or materials containing them can be used and insulating member 40 can be formed by bonding a tape-like resin member to border part 4 by heat, or by applying a gel-like resin on border part 4 and then drying the resin ([0048], Fig. 2).

Yamafuku teaches a similar energy storage device (abstract). At least one of the electrodes includes a current collecting substrate, an active material layer arranged on the current collecting substrate, an intermediate layer arranged between the current collecting substrate and the active material layer, and an insulating layer arranged on the current collecting substrate

(abstract). Yamafuku teaches an energy storage device having an insulating layer high in insulation properties([0046]). Yamafuku teaches the insulating material include inorganic particles and a resin ([0127]), wherein the inorganic particles are selected from the group consisting of aluminum oxide([0129]), silicon dioxide([0129]), titanium oxide([0129]), boehmite ([0134]), barium sulfate ([0131]) and combinations thereof ([0135]).

It would have been obvious to one of ordinary skill in the art to provide the insulating member of Tanaka with inorganic particles and a resin, wherein the inorganic particles are selected from the group consisting of aluminum oxide, silicon dioxide, titanium oxide, boehmite, barium sulfate and combinations thereof as taught by Yamafuku in order to provide an insulating layer high in insulation properties.

19. Claims 10-13 and 15-19 is/are rejected under 35 U.S.C. 103 as being unpatentable over Tanaka et al. (US 2016/0294015), in view of Yamafuku et al. (US 2015/0147624).

Regarding claim 10, Tanaka discloses an electrochemical device (lithium ion secondary battery 100, Fig. 1, [0031]), comprising an anode(negative electrodes 6, Fig. 1, [0031]), a separator (20, Fig. 1, [0031]) and a cathode (positive electrodes 1, Fig. 1, [0031]), wherein the cathode comprises a cathode current collector(positive electrode current collector 3, Fig. 10, [0074]), having a first surface (see Fig. C as annotated Fig. 10);

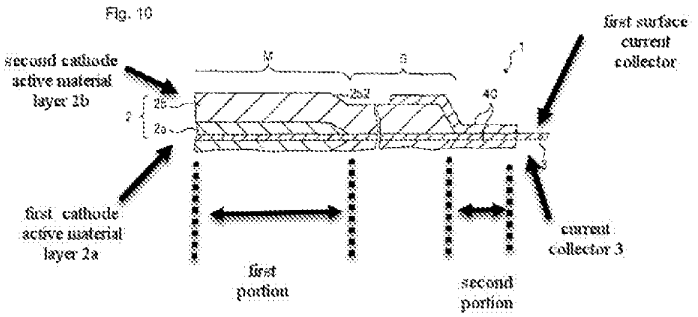

Fig. C

a first cathode active material layer (first active material layer 2a, Fig. 10, [0071]), comprising a first cathode active material(positive electrode active material [0040]); a second cathode active material layer (second active material layer 2b, Fig. 10, [0071]), comprising a second cathode active material(positive electrode active material [0040]); and an insulating layer (insulating member 40, Fig. 10, [0074]), wherein the first cathode active material layer is disposed between the cathode current collector and the second cathode active material layer and covers a first portion of the first surface of the cathode current collector (Fig. C), and the insulating layer covers a second portion of the first surface of the cathode current collector that is different from the first portion (Fig. C); and the separator is disposed between the anode and the cathode (Fig. 1), and the anode, the separator, and the cathode form an electrode assembly ([0031]) but does not disclose the anode, the separator, and the cathode are wound to form an electrode assembly. Tanka teaches an electrode laminate body (battery electrode assembly) in which positive electrodes (positive electrode sheets) 1 and negative electrodes (negative electrode sheets) 6 are alternately laminated with separator 20 interposed therebetween such that layers are formed (Fig. 1, [0031]).

Yamafuku teaches a similar energy storage device (abstract). At least one of the electrodes includes a current collecting substrate, an active material layer arranged on the current collecting substrate, an intermediate layer arranged between the current collecting substrate and the active material layer, and an insulating layer arranged on the current collecting substrate (abstract). Yamafuku teaches a sheet-like positive electrode 3 and a sheet-like negative electrode 5 are overlapped via a separator, after which those are wound to form an electrode assembly as shown in FIG. 7 ([0202]).

It would have been obvious to one of ordinary skill within the art at the time of the effective filing date of the invention to use the anode, the separator, and the cathode are wound to form an electrode assembly as taught by Yamafuku as obvious to try choosing from a finite number of identified, predictable solutions, with a reasonable expectation of success. See MPEP 2143.

Regarding claim 11, modified Tanaka discloses all of the claim limitations as set forth above. Modified Tanaka further discloses a first distance exists between the insulating layer and the first cathode active material layer in a longitudinal direction of the cathode current collector (Tanaka, see Fig. D as annotated Fig. 10),

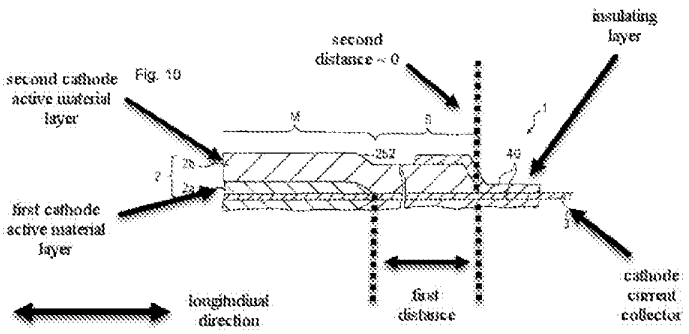

Fig. D

a second distance exists between the insulating layer and the second cathode active material layer in the longitudinal direction of the cathode current collector(Fig. D); and the first distance and the second distance are respectively greater than or equal to 0 (Fig. D)and the second distance is less than or equal to the first distance(Fig. D).

Regarding claim 12, modified Tanaka discloses all of the claim limitations as set forth above. Modified Tanaka further discloses the first distance and the second distance are disposed at a corner of the electrode assembly (Tanaka, in order to prevent the occurrence of a short circuit with negative electrode terminal 16, insulating member 40 is formed so as to cover

border part 4 between the applied part where positive electrode active material layer 2 is formed and the non-applied part where positive electrode active material layer is not formed, Figs. 1 & 2, [0036]).

Regarding claim 13, modified Tanaka discloses all of the claim limitations as set forth above. Modified Tanaka does not explicitly disclose a thickness D of the electrode assembly is from about 1.5 mm to about 50 mm. However, Tanaka discloses the thickness of the active material layer may be an arbitrary value, and is not particularly limited([0064]). In the case of the use for a portable electronic device, an electric bicycle, an electric assist bicycle, a stationary charger, an electric vehicle, a hybrid vehicle or the like, from the standpoint of battery capacity and weight, it is preferable that the active material layer that is positioned on at least one surface of the current collector be about 5 to 200 μm in thickness([0064]).

It would have been obvious to one having ordinary skill in the art to provide the thickness D of the electrode assembly from about 1.5 mm to about 50 mm in order to balance battery capacity and weight, since it has been held that where the general conditions of a claim are disclosed in the prior art, discovering the optimum or workable ranges involves only routine skill in the art. MPEP §2144.05 (II-A).

Regarding claim 15, modified Tanaka discloses all of the claim limitations as set forth above. Modified Tanaka further discloses the second distance between the insulating layer and the second cathode active material layer in the longitudinal direction of the cathode current collector satisfies the following formula: $0 \leq$ the second distance $\leq \pi/2 * D + 4mm$ (second distance is 0 as shown in Fig. D).

Regarding claim 16, Tanaka discloses an electronic device ([0064]), comprising an electrochemical device (lithium ion secondary battery 100, Fig. 1, [0031]), wherein the

electrochemical device comprises an anode(negative electrodes 6, Fig. 1, [0031]), a separator (20, Fig. 1, [0031]) and a cathode (positive electrodes 1, Fig. 1, [0031]), wherein the cathode comprises a cathode current collector(positive electrode current collector 3, Fig. 10, [0074]), having a first surface (see Fig. E as annotated Fig. 10);

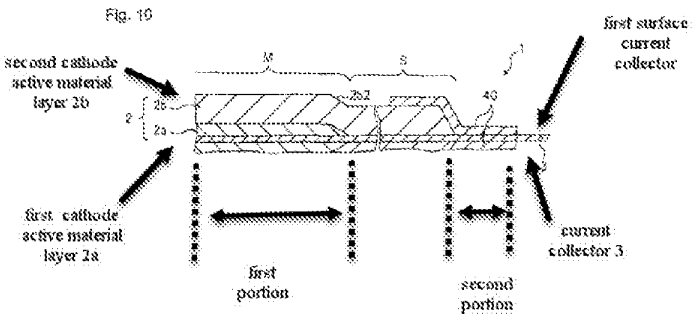

Fig. E

a first cathode active material layer (first active material layer 2a, Fig. 10, [0071]), comprising a first cathode active material(positive electrode active material [0040]); a second cathode active material layer (second active material layer 2b, Fig. 10, [0071]), comprising a second cathode active material(positive electrode active material [0040]); and an insulating layer (insulating member 40, Fig. 10, [0074]), wherein the first cathode active material layer is disposed between the cathode current collector and the second cathode active material layer and covers a first portion of the first surface of the cathode current collector (Fig. E), and the insulating layer covers a second portion of the first surface of the cathode current collector that is different from the first portion (Fig. E); and the separator is disposed between the anode and the cathode (Fig. 1), and the anode, the separator, and the cathode form an electrode assembly ([0031]) but does not disclose the anode, the separator, and the cathode are wound to form an electrode assembly. Tanka teaches an electrode laminate body (battery electrode assembly) in which positive electrodes (positive electrode sheets) 1 and negative electrodes (negative electrode sheets) 6 are

alternately laminated with separator 20 interposed therebetween such that layers are formed (Fig. 1, [0031]).

Yamafuku teaches a similar energy storage device (abstract). At least one of the electrodes includes a current collecting substrate, an active material layer arranged on the current collecting substrate, an intermediate layer arranged between the current collecting substrate and the active material layer, and an insulating layer arranged on the current collecting substrate (abstract). Yamafuku teaches a sheet-like positive electrode 3 and a sheet-like negative electrode 5 are overlapped via a separator, after which those are wound to form an electrode assembly as shown in FIG. 7 ([0202]).

It would have been obvious to one of ordinary skill within the art at the time of the effective filing date of the invention to use the anode, the separator, and the cathode are wound to form an electrode assembly as taught by Yamafuku as obvious to try choosing from a finite number of identified, predictable solutions, with a reasonable expectation of success. See MPEP 2143.

Regarding claim 17, Tanaka discloses all of the claim limitations as set forth above. Tanaka further discloses a first distance exists between the insulating layer and the first cathode active material layer in a longitudinal direction of the cathode current collector (see Fig. F as annotated Fig. 10),

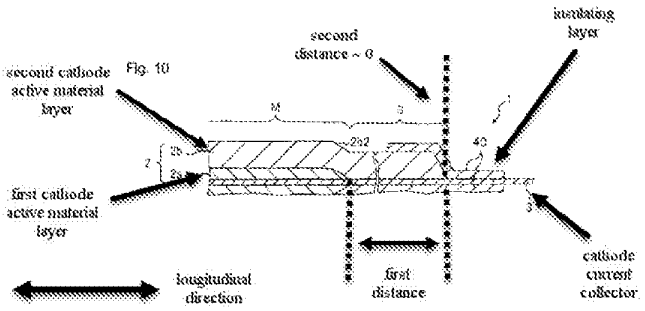

Fig. F

a second distance exists between the insulating layer and the second cathode active material layer in the longitudinal direction of the cathode current collector(Fig. F); and the first distance and the second distance are respectively greater than or equal to 0 (Fig. F)and the second distance is less than or equal to the first distance(Fig. F).

Regarding claim 18, modified Tanaka discloses all of the claim limitations as set forth above. Modified Tanaka further discloses the first distance and the second distance are disposed at a comer of the electrode assembly (Tanaka, in order to prevent the occurrence of a short circuit with negative electrode terminal 16, insulating member 40 is formed so as to cover border part 4 between the applied part where positive electrode active material layer 2 is formed and the non-applied part where positive electrode active material layer is not formed, Figs. 1 & 2, [0036]).

Regarding claim 19, modified Tanaka discloses all of the claim limitations as set forth above. Modified Tanaka does not explicitly disclose a thickness D of the electrode assembly is from about 1.5 mm to about 50 mm. However, Tanaka discloses the thickness of the active material layer may be an arbitrary value, and is not particularly limited([0064]). In the case of the use for a portable electronic device, an electric bicycle, an electric assist bicycle, a stationary charger, an electric vehicle, a hybrid vehicle or the like, from the standpoint of battery capacity and weight, it is preferable that the active material layer that is positioned on at least one surface of the current collector be about 5 to 200 μm in thickness([0064]).

It would have been obvious to one having ordinary skill in the art to provide the thickness D of the electrode assembly from about 1.5 mm to about 50 mm in order to balance battery capacity and weight, since it has been held that where the general conditions of a claim are

disclosed in the prior art, discovering the optimum or workable ranges involves only routine skill in the art. MPEP §2144.05 (II-A).

Allowable Subject Matter

20. Claim 6 is objected to as being dependent upon a rejected base claim, but would be allowable if rewritten in independent form including all of the limitations of the base claim and any intervening claims and the rejections under 35 U.S.C. 112(b) or 35 U.S.C. 112 (pre-AIA), second paragraph, set forth in this Office Action on claims 3, 5, and 6 are overcome.

In particular the allowable limitation is a thickness of the insulating layer is greater than a thickness of the first cathode active material layer.

In the instant invention, since the thickness of the insulating layer is greater than the thickness of the first cathode active material layer on the bottom layer of the active material layer, when the second cathode active material layer is coated on the first cathode active material layer, the second cathode active material layer easily overlaps with the insulating layer due to fluctuations in processing tolerance, and the insulating layer covers above or below the second cathode active material layer([0037] US 2020/0144605). The thickness of the first cathode active material layer 12 is less than or equal to the thickness of the insulating layer 14(Fig. 1, [0048]). In some embodiments of the present application, the thickness of the insulating layer 14 is greater than about 0.1 μm to achieve a certain insulating effect([0048]).

Tanaka discloses a difference between an average thickness at a multi-layer part where both active material layers are laminated on current collector and a thickness of the active material layer at a part where the insulating member is positioned on active material layer is 50% or more of a thickness of the insulating member (abstract, Fig. 2). It is desirable that insulating member 40 be smaller than the average thickness of multi-layer part M of positive electrode

active material 2 (Fig. 3, [0051]). The thickness of insulating member 40, preferably, is 90% or less of the average thickness of multi-layer part M of positive electrode active material 2, and more preferably, is 60% or less of the average thickness of multi-layer part M([0051]). Tanaka does not disclose, teach or render obvious the noted claim limitation.

21. Claim 14 is objected to as being dependent upon a rejected base claim, but would be allowable if rewritten in independent form including all of the limitations of the base claim and any intervening claims and the rejection under 35 U.S.C. 112(b) or 35 U.S.C. 112 (pre-AIA), second paragraph, set forth in this Office Action on claim 13 is overcome.

In particular the allowable limitation is the first distance between the insulating layer and the first cathode active material layer in the longitudinal direction of the cathode current collector satisfies the following formula: $0 \leq$ the first distance $\leq \pi/2 * D + 4mm$.

In the instant invention, 4 mm in the above formula is an allowable error range (i.e., a processing tolerance) of the error generated when the electrode assembly is processed, and the numerical range of the processing tolerance can be adjusted according to the actual operation process without being limited thereto ([0061]). The arrangement of the first distance 15 and the second distance 16 effectively avoids the overlapping of the first cathode active material layer 12, the second cathode active material layer 13 and the insulating layer 14, thereby enhancing the reliability of the cathode in the preparation process, and lowering the possibility of a rupture of the second cathode active material in the second cathode active material layer 13 during the cold pressing technique(Fig. 2, [0041]). The first distance is from about 0 mm to about 83 mm, which ensures the reliability of the cathode in the preparation process and does not lower the safety performance of the cathode in the nail penetration test ([0044]).

Tanaka discloses the distance between the end part (termination position) of the applied part of the first active material layer and the end part (termination position) of the applied part of the second active material layer, that is, the length of single-layer part S where the insulating member is formed, may be an arbitrary value, and is not particularly limited([0066]). Taking into account the energy density per unit volume of the battery electrode assembly, the distance, preferably, is 0.5 to 5 mm, and more preferably, is 0.5 to 3 mm([0066]). In this case, it is allowable to arbitrarily select whether the end part of the applied part of the second active material layer is positioned on the first active material layer such that single-layer part S is configured by the first active material layer similarly to the exemplary embodiment (FIGS. 2 to 3), or whether the end part of the applied part of the second active material layer is positioned on the current collector beyond the end part of the applied part of the first active material layer such that single-layer part S is configured by the second active material layer similarly to another exemplary embodiment (FIG. 10, [0066]). However, Tanaka does not disclose, teach or render obvious the noted claim limitation.

22. Claim 20 is objected to as being dependent upon a rejected base claim, but would be allowable if rewritten in independent form including all of the limitations of the base claim and any intervening claims and the rejection under 35 U.S.C. 112(b) or 35 U.S.C. 112 (pre-AIA), second paragraph, set forth in this Office Action on claim 19 is overcome.

In particular the allowable limitation is the first distance between the insulating layer and the first cathode active material layer in the longitudinal direction of the cathode current collector satisfies the following formula: $0 \leq$ the first distance $\leq \pi/2 * D + 4mm$; and the second distance between the insulating layer and the second cathode active material layer in the longitudinal direction of the cathode current collector satisfies the following formula: $0 \leq$ the second distance

$\leq \pi/2$ *D + 4mm. The reasons for allowance are substantially the same as provided in paragraph 21 above and apply herein.

Conclusion

Any inquiry concerning this communication or earlier communications from the examiner should be directed to VICTORIA HOM LYNCH whose telephone number is (571)272-0489. The examiner can normally be reached on 7:30 AM - 4:30 PM EST M-F.

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, Miriam Stagg can be reached on 571-270-5256. 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.

/VICTORIA H LYNCH/
Examiner, Art Unit 1724

Notice of References Cited	Application/Control No. 16/298,738	Applicant(s)/Patent Under Reexamination SU et al.	
	Examiner VICTORIA H LYNCH	Art Unit 1724	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-20160294015-A1	10-2016	TANAKA; Shin	H01M10/0585	1/1
*	B	US-20150147624-A1	05-2015	YAMAFUKU; Taro	H01M10/0585	429/121
	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.

Index of Claims	Application/Control No.	Applicant(s)/Patent Under Reexamination
	16/298,738	SU et al.
	Examiner	Art Unit
	VICTORIA H LYNCH	1724

✓	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	06/03/2020								
	1	✓								
	2	✓								
	3	✓								
	4	✓								
	5	✓								
	6	O								
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	16	✓								
	17	✓								
	18	✓								
	19	✓								
	20	O								

Search Notes	Application/Control No.	Applicant(s)/Patent Under Reexamination
	16/298,738	SU et al.
	Examiner	Art Unit
	VICTORIA H LYNCH	1724

CPC - Searched*		
Symbol	**Date**	**Examiner**
H01M10/052, H01M10/0525, H01M10/0587, H01M10/4235, H01M2004/028, H01M4/13, H01M4/131, H01M4/136, H01M4/366, H01M4/525, H01M4/5825, H01M4/623, H01M4/625, H01M4/667 + text	06/02/2020	VL

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**
Assignee search	06/02/2020	VL
Inventors search	06/02/2020	VL
Consult East search strategy expert Ron Jorgensen	06/02/2020	VL
East search	06/02/2020	VL

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

/VICTORIA H LYNCH/ Examiner, Art Unit 1724	

EAST Search History

EAST Search History (Prior Art)

Ref #	Hits	Search Query	DBs	Default Operator	Plurals	Time Stamp
S1	1	"16298738"	US-PGPUB; USPAT	OR	ON	2020/06/02 11:24
S2	2	"14485976"	US-PGPUB; USPAT	OR	ON	2020/06/02 13:52
S3	6	("20060238162" | "20080107968" | "20080160410" | "20080241696" | "20110165462" | "20120156560").PN. OR ("10122011").URPN.	US-PGPUB; USPAT; USOCR	OR	ON	2020/06/02 13:52
S4	45	"2013051040"	FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2020/06/02 13:58
S5	0	"2016093859"	US-PGPUB; USPAT; USOCR	OR	ON	2020/06/02 14:01
S6	1	"20160093859"	US-PGPUB; USPAT; USOCR	OR	ON	2020/06/02 14:02
S7	2	"20120058375"	US-PGPUB; USPAT; USOCR	OR	ON	2020/06/02 14:03
S8	2	"20060115736"	US-PGPUB; USPAT; USOCR	OR	ON	2020/06/02 14:04
S9	2	"20040202928"	US-PGPUB; USPAT; USOCR	OR	ON	2020/06/02 14:05
S10	15	("20030224242" | "4610956" | "5631102" | "6387564").PN. OR ("7258948").URPN.	US-PGPUB; USPAT; USOCR	OR	ON	2020/06/02 14:07
S11	2	"20150147624"	US-PGPUB; USPAT; USOCR	OR	ON	2020/06/02 14:12
S12	1	"16298738"	US-PGPUB; USPAT; USOCR	OR	ON	2020/06/02 14:18
S13	50,230	((H01M10/052 OR H01M10/0525 OR H01M10/0587 OR H01M10/4235 OR H01M2004/028 OR H01M4/13 OR H01M4/131 OR H01M4/136 OR H01M4/366 OR H01M4/525 OR	US-PGPUB; USPAT; USOCR	OR	ON	2020/06/02 14:19

		H01M4/5825 OR H01M4/623 OR H01M4/625 OR H01M4/667).CPC.)				
S14	8,051	((H01M4/366).CPC.)	US-PGPUB; USPAT; USOCR	OR	ON	2020/06/02 14:20
S15	7,658	S14 and (active material with insulat$5)	US-PGPUB; USPAT; USOCR	OR	ON	2020/06/02 14:20
S16	7,630	S15 and (@pd or @ptad or @prad or @ad or @rlad)<"20181105"	US-PGPUB; USPAT; USOCR	OR	ON	2020/06/02 14:22
S17	7,605	S14 and (active material near3 (first second double multi$5 multiple) with insulat$5)	US-PGPUB; USPAT; USOCR	OR	ON	2020/06/02 14:23
S18	7,577	S17 and (@pd or @ptad or @prad or @ad or @rlad)<"20181105"	US-PGPUB; USPAT; USOCR	OR	ON	2020/06/02 14:24
S19	6,250	S14 and ((cathode positive) near3 active material near3 (first second double multi$5 multiple) with insulat$5)	US-PGPUB; USPAT; USOCR	OR	ON	2020/06/02 14:24
S20	19	S14 and ((cathode positive) near3 active near material near3 (first second double multi$5 multiple) with insulat$5)	US-PGPUB; USPAT; USOCR	OR	ON	2020/06/02 14:25
S21	17	S20 and (@pd or @ptad or @prad or @ad or @rlad)<"20181105"	US-PGPUB; USPAT; USOCR	OR	ON	2020/06/02 14:25
S22	43	((("NINGDE") near3 ("AMPEREX") near3 ("TECHNOLOGY") near3 ("LIMITED"))).AS,AANM.	USPAT	OR	ON	2020/06/02 14:30
S23	4	((("SU") near3 ("Xinru"))).INV.	US-PGPUB; USPAT; USOCR	OR	ON	2020/06/02 14:30
S24	2	((("LI") near3 ("Baozhang"))).INV.	US-PGPUB; USPAT; USOCR	OR	ON	2020/06/02 14:30
S25	8	((("SU") near3 ("Yisong"))).INV.	US-PGPUB; USPAT; USOCR	OR	ON	2020/06/02 14:30
S26	10	((("XIAO") near3 ("Zhiwen"))).INV.	US-PGPUB; USPAT; USOCR	OR	ON	2020/06/02 14:31
S27	3	(S22 S23 S24 S25 S26) and (active near material with insulat$5)	US-PGPUB; USPAT; USOCR	OR	ON	2020/06/02 14:31
S28	12,503	((("NINGDE"))).AS,AANM.	FPRS; EPO; JPO;	OR	ON	2020/06/02 14:33

			DERWENT; IBM_TDB			
S29	9	((("SU") near3 ("Xinru"))).INV.	FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2020/06/02 14:33
S30	83	((("LI") near3 ("Baozhang"))).INV.	FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2020/06/02 14:33
S31	17	((("SU") near3 ("Yisong"))).INV.	FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2020/06/02 14:33
S32	92	((("XIAO") near3 ("Zhiwen"))).INV.	FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2020/06/02 14:34
S33	0	(S28 S29 S30 S31 S32) and (acitve near material) and insulat$5	FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2020/06/02 14:34
S34	87	(S28 S29 S30 S31 S32) and (active near material) and insulat$5	FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2020/06/02 14:34
S35	62	S34 and (@pd or @ptad or @prad or @ad or @rlad)<"20181105"	FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2020/06/02 14:35
S36	1,052	((cathode positive) near3 active near material near3 (first second double multi$5 multi$2layer$3 layer$4 multiple) with insulat$5)	US-PGPUB; USPAT; USOCR	OR	ON	2020/06/02 14:45
S37	1	S1 and S36	US-PGPUB; USPAT; USOCR	OR	ON	2020/06/02 14:46
S38	1,030	S36 and h01m.cpcl.	US-PGPUB; USPAT; USOCR	OR	ON	2020/06/02 14:46
S39	912	S38 not fuel adj cell$1	US-PGPUB; USPAT; USOCR	OR	ON	2020/06/02 14:46
S40	911	S39 and (@pd or @ptad or @prad or @ad or @rlad)<"20181105"	US-PGPUB; USPAT; USOCR	OR	ON	2020/06/02 14:47

S41	318	(lithium near cobaltate or lithium near iron near phosphate or lithium near manganese near iron near phosphate or sodium near iron near phosphate or lithium near vanadium near phosphate or sodium near vanadium near phosphate or oxy$1lithium$1vanadium near phosphate or oxy$1sodium$1vanadium near phosphate or lithium near vanadate or lithium near manganate or lithium near nickelate or lithium near nickel near cobalt near manganese near oxide or lithium$1rich near manganese$1based near material or lithium near nickel near cobalt near aluminum near oxide or lithium near titanate) and S40	US-PGPUB; USPAT; USOCR	OR	ON	2020/06/02 14:59
S42	98	((cathode positive) near3 active near material near3 (first second double multi$5 multi$2layer$3 multiple) with insulat$5)	US-PGPUB; USPAT; USOCR	OR	ON	2020/06/02 15:02
S43	96	S42 and (@pd or @ptad or @prad or @ad or @rlad)<"20181105"	US-PGPUB; USPAT; USOCR	OR	ON	2020/06/02 15:03
S44	10	("20050175892" | "20050277022" | "20060269835" | "20080280197" | "20100035144" | "20110217576" | "20110274953" | "20130316209" | "20150125738" | "5591522").PN. OR ("10411243").URPN.	US-PGPUB; USPAT; USOCR	OR	ON	2020/06/02 15:39
S45	4	("20040202928" | "20080280197" | "20110020703" | "20120202105").PN.	US-PGPUB; USPAT	OR	ON	2020/06/02 15:51
S46	927	((cathode positive) and active near material and (first second double multi$5 multi$2layer$3 multiple) and insulat$5)	FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2020/06/02 16:16
S47	492	S46 and h01m.cpcl.	FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2020/06/02 16:17
S48	487	S47 and (@pd or @ptad or @prad or @ad or @rlad)<"20181105"	FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2020/06/02 16:17
S49	477	S48 not fuel adj cell$1	FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2020/06/02 16:18
S50	6	"2010262773"	FPRS; EPO; JPO;	OR	ON	2020/06/02 17:12

			DERWENT; IBM_TDB			
S51	6	"2015147624"	FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2020/06/02 18:16
S52	0	"2015147624"	US-PGPUB; USPAT; USOCR	OR	ON	2020/06/02 18:16
S53	2	"20150147624"	US-PGPUB; USPAT; USOCR	OR	ON	2020/06/02 18:16
S54	1	"20160294015"	US-PGPUB; USPAT; USOCR	OR	ON	2020/06/02 18:57
S55	1	"20160294015"	US-PGPUB; USPAT; USOCR	OR	ON	2020/06/03 11:04
S56	1	S55 and (thickness with insulating)	US-PGPUB; USPAT; USOCR	OR	ON	2020/06/03 11:57
S57	1	"20160294015"	US-PGPUB; USPAT; USOCR	OR	ON	2020/06/03 13:19
S58	1	S57 and (thickness with electrode near assembly)	US-PGPUB; USPAT; USOCR	OR	ON	2020/06/03 13:19
S59	1	S57 and (thickness with battery)	US-PGPUB; USPAT; USOCR	OR	ON	2020/06/03 13:24

6/3/2020 2:58:27 PM
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Bibliographic Data

Application No: 16/298,738

Foreign Priority claimed: (•) Yes ( ) No

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

Verified and Acknowledged: /VICTORIA H LYNCH/ Examiner's Signature [ ] Initials

Title: CATHODE, ELECTROCHEMICAL DEVICE AND ELECTRONIC DEVICE COMPRISING SAME

FILING or 371(c) DATE	CLASS	GROUP ART UNIT	ATTORNEY DOCKET NO.
03/11/2019	429	1724	LEEL-0101
RULE			

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CONTINUING DATA

FOREIGN APPLICATIONS

CHINA 201811308841.3 11/05/2018

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03/26/2019

STATE OR COUNTRY

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UNITED STATES

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In re U.S. Patent Application of	)	**Confirmation No. 3478**
	)	
SU et al.	)	**Art Unit 1724**
	)	
Application Number: 16/298,738	)	**Examiner**
	)	**Victoria Hom LYNCH**
Filed: March 11, 2019	)	
	)	
For: CATHODE ELECTROCHEMICAL DEVICE AND ELECTRONIC DEVICE COMPRISING THE SAME	)	
	)	
Attorney Docket No. LEEL-0101	)	

Commissioner of Patents
PO Box 1450
Alexandria, VA 22313-1450

INFORMATION DISCLOSURE STATEMENT

Sir:

Pursuant to 37 C.F.R. §§ 1.56 and 1.97, this Information Disclosure Statement is being submitted in connection with the above-identified patent application. A listing of documents to be published on the face of any patent granted from this application is submitted herewith on the accompanying Form PTO-1449. Any other documents or information submitted for consideration by the Examiner are listed in this paper. A copy of each non-US or foreign patent or non-patent publication or any portion thereof listed or herein identified is submitted herewith.

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[ ] **(a)** Concurrently with the filing of the new U.S. application of the above-identified U.S. patent application, whereby it is believed that no fee is due; OR

[ ] **(b)** Before three months from the filing date; or after three months of the filing date in the above-identified U.S. patent application but before the mailing date of the first Office Action on the merits of the above-identified application, whereby it is believed that no fee is due; OR

[X] **(c)** After three months from the filing date of the above-identified U.S. patent application and after the mailing date of the first Office Action on the merits of the above-identified application, but prior to the issuance of any Final Action or Notice of Allowance sent in

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[ ] **(d)** After the issuance of a Final Action or Notice of Allowance, but before the payment of the Issue Fee, whereby Applicant(s) hereby submit the requisite certification hereinbelow, and the attached authorization for the payment of the requisite fee.

2. In accordance with the requirements of 37 C.F.R. §1.97, and Parts 1(c) or 1(d) above, Applicant(s) hereby certify that:

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The Examiner is requested to acknowledge receipt and consideration of the information provided in this paper in accordance with prescribed procedures.

Respectfully submitted,

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Application Number	16298738
Filing Date	2019-03-11
First Named Inventor	Dongyang GUO
Art Unit	1724
Examiner Name	Victoria Hom LYNCH
Attorney Docket Number	LEEL-0101

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	1	20160093859	A1	2016-03-31	Kawaguchi et al.	
	2	20120058375	A1	2012-03-08	Tanaka et al.	
	3	20060115736	A1	2006-06-01	Hashimoto et al.	
	4	20040202928	A1	2004-10-14	Miyamoto et al.	

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	Application Number	16298738
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	First Named Inventor	Dongyang GUO
	Art Unit	1724
	Examiner Name	Victoria Hom LYNCH
	Attorney Docket Number	LEEL-0101

Examiner Initial*	Cite No	Foreign Document Number[3]	Country Code[2]	Kind Code[4]	Publication Date	Name of Patentee or Applicant of cited Document	Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear	T[5]
	1	2013051040	JP	A	2013-03-14	GS Yuasa Corp.	English abstract	☒
	2	2876711	EP	A1	2015-05-27	GS Yuasa International Ltd.		☒

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Examiner Initials*	Cite No	Include name of the author (in CAPITAL LETTERS), title of the article (when appropriate), title of the item (book, magazine, journal, serial, symposium, catalog, etc), date, pages(s), volume-issue number(s), publisher, city and/or country where published.	T[5]
	1	Extended European Search Report mailed March 12, 2020 in counterpart European application 19207088.6, 7 pages	☒

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*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	16298738
	Filing Date	2019-03-11
	First Named Inventor	Dongyang GUO
	Art Unit	1724
	Examiner Name	Victoria Hom LYNCH
	Attorney Docket Number	LEEL-0101

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).

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☒ 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	/juan.carlos.a.marquez/	Date (YYYY-MM-DD)	2020-06-11
Name/Print	Juan Carlos A. Marquez	Registration Number	34072

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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(19) Europäisches Patentamt
European Patent Office
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(11) EP 2 876 711 A1

(12) EUROPEAN PATENT APPLICATION

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H01M 4/62 *(2006.01)* ***H01M 4/66*** *(2006.01)*
H01M 10/0525 *(2010.01)* ***H01M 10/0585*** *(2010.01)*
H01M 4/133 *(2010.01)* ***H01M 4/36*** *(2006.01)*
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(54) Energy storage device and energy storage module

(57) There is provided an energy storage device having an insulating layer excellent in insulation properties. There is provided an energy storage device including an electrode assembly having a pair of electrodes overlapped with each other. At least one of the electrodes includes a current collecting substrate, an active material layer arranged on the current collecting substrate, an intermediate layer arranged between the current collecting substrate and the active material layer, and an insulating layer arranged on the current collecting substrate. The active material layer contains an active material and a first binder. The intermediate layer contains a carbonaceous material and a second binder. The insulating layer contains an insulating material and a third binder. The second binder is a nonaqueous binder. The third binder is an aqueous binder.

EP 2 876 711 A1

Printed by Jouve, 75001 PARIS (FR)

Description

FIELD

[0001] The present invention relates to an energy storage device and an energy storage module.

BACKGROUND

[0002] In recent years, as a power source for a vehicle such as an automobile and a motorcycle, a variety of equipment such as a portable terminal and a notebook personal computer, an energy storage device capable of discharging and charging, which includes a battery such as a lithium ion battery and a nickel metal hydride battery, and a capacitor such as an electric double layer capacitor, has been employed.

[0003] As such an energy storage device, an energy storage device provided with an electrode assembly for a lithium ion secondary battery in which the electrode assembly has a pair of sheet-like electrodes and a separator arranged between the pair of electrodes has hitherto been known.

[0004] In this type of energy storage device, each of the pair of electrodes of the electrode assembly has current collecting foil and an active material layer which is arranged at one face of the current collecting foil and contains an active material.

Moreover, in this type of energy storage device, in the electrode assembly, the electrodes are opposite to each other so that the respective active material layers are adjacent to each other via a separator.

[0005] In this type of energy storage device, the separator of the electrode assembly may shrink, and moreover, a foreign substance may intrude into a space between the electrodes of the electrode assembly. This can cause a minute short circuit between the electrodes in this type of energy storage device.

[0006] In contrast, in order to prevent a minute short circuit between the electrodes, an energy storage device which has an insulating layer on one electrode of an electrode assembly has been known (JP-A-2013-045659).

[0007] However, in the above-mentioned energy storage device, it is desirable that insulation properties of the insulating layer be further enhanced.

SUMMARY

[0008] An object of the present invention is to provide an energy storage device having an insulating layer excellent in insulation properties and an energy storage module.

[0009] An energy storage device according to an aspect of the present invention includes an electrode assembly having a pair of electrodes overlapped with each other. At least one of the electrodes includes a current collecting substrate, an active material layer arranged on the current collecting substrate, an intermediate layer arranged between the current collecting substrate and the active material layer, and an insulating layer arranged on the current collecting substrate. The active material layer contains an active material and a first binder. The intermediate layer contains a carbonaceous material and a second binder. The insulating layer contains an insulating material and a third binder. The second binder is a nonaqueous binder. The third binder is an aqueous binder.

BRIEF DESCRIPTION OF THE DRAWINGS

[0010]

Fig. 1 is a cross-sectional view schematically illustrating a cross section of an electrode assembly in accordance with one embodiment;
Fig. 2 is a cross-sectional view schematically illustrating a cross section of an electrode assembly in accordance with another embodiment;
Fig. 3 is a cross-sectional view schematically illustrating a cross section of an electrode assembly in accordance with another embodiment;
Fig. 4 is a cross-sectional view schematically illustrating a cross section of an electrode assembly in accordance with another embodiment;
Fig. 5 is a cross-sectional view schematically illustrating a cross section of an electrode assembly in accordance with another embodiment;
Fig. 6 is a cross-sectional view schematically illustrating a cross section of an electrode assembly in accordance with another embodiment;
Fig. 7 is a view schematically illustrating an outer appearance of an electrode assembly;
Fig. 8 is a schematic view schematically illustrating an outer appearance of a nonaqueous electrolyte secondary battery as an example of an energy storage device;
Fig. 9 is a schematic view schematically illustrating the inside of a case for a nonaqueous electrolyte secondary battery as an example of an energy storage device;
Fig. 10 is a cross-sectional view taken along the line III-III in Fig. 9;
Fig. 11 is a cross-sectional view schematically illustrating a cross section of a nonaqueous electrolyte secondary battery as an example of an energy storage device; and
Fig. 12 is a schematic view schematically illustrating an outer appearance of an example of an energy storage module.

DESCRIPTION OF EMBODIMENT

[0011] An energy storage device according to an aspect of the present invention includes an electrode assembly having a pair of electrodes overlapped with each other. At least one of the electrodes includes a current collecting substrate, an active material layer arranged on

the current collecting substrate, an intermediate layer arranged between the current collecting substrate and the active material layer, and an insulating layer arranged on the current collecting substrate. The active material layer contains an active material and a first binder. The intermediate layer contains a carbonaceous material and a second binder. The insulating layer contains an insulating material and a third binder. The second binder is a nonaqueous binder. The third binder is an aqueous binder.

[0012] In an aspect of the energy storage device according to the present invention, the first binder is a nonaqueous binder.

[0013] In another aspect of the energy storage device according to the present invention, the active material layer contains a carbonaceous material.

[0014] In another aspect of the energy storage device according to the present invention, the insulating material comprises inorganic particles.

[0015] In another aspect of the energy storage device according to the present invention, each of the pair of electrodes includes at least the active material layer and the active material layers are each arranged to face each other. The insulating layer of one electrode is arranged to face at least a part of the end edge of the active material layer in the other electrode.

[0016] In another aspect of the energy storage device according to the present invention, in one electrode, the insulating layer is arranged to cover the face of the active material layer which is opposed to the other electrode.

[0017] In another aspect of the energy storage device according to the present invention, in one electrode, the insulating layer is arranged to cover the face of the current collecting substrate which is opposed to the other electrode.

[0018] In another aspect of the energy storage device according to the present invention, the intermediate layer has an intermediate layer-protruding portion protruded outside from the end edge of the active material layer. The insulating layer is arranged to cover the intermediate layer-protruding portion while being in contact with the current collecting substrate.

[0019] In another aspect of the energy storage device according to the present invention, the pair of electrodes correspond to a positive electrode and a negative electrode, respectively. The positive electrode has a positive active material layer as the active material layer, the intermediate layer, and the insulating layer. The negative electrode has a negative active material layer as the active material layer. The negative active material layer has an end edge arranged outside from the end edge of the positive active material layer facing the negative active material layer. The intermediate layer has an intermediate layer-protruding portion protruded outside from the end edge of the positive active material layer. The insulating layer is arranged to face the end edge of the negative active material layer and is arranged to cover a surface of the intermediate layer-protruding portion which faces the negative electrode while covering the end edge of the positive active material layer.

[0020] In an aspect of an energy storage module according to the present invention, the module includes the above-described energy storage device and a bus bar member electrically connected to the energy storage device.

[0021] A method for producing an energy storage device according to an aspect of the present invention is a method for producing an energy storage device including an electrode assembly having a pair of electrodes overlapped with each other. The method includes an intermediate layer-forming step of applying a composition for an intermediate layer containing a carbonaceous material and a nonaqueous binder to a current collecting substrate of at least one of the electrodes. The method further includes an active material layer-forming step of applying a composite containing an active material and a nonaqueous binder on the intermediate layer. The method further includes an insulating layer-forming step of applying a composition for an insulating layer containing an insulating material and an aqueous binder on at least one of the intermediate layer, the active material layer and the current collecting substrate.

[0022] In an aspect of the method for producing an energy storage device according to the present invention, the active material layer-forming step and the insulating layer-forming step are simultaneously performed.

[0023] In another aspect of the method for producing an energy storage device according to the present invention, the composite contains a carbonaceous material.

[0024] In another aspect of the method for producing an energy storage device according to the present invention, the insulating material contains inorganic particles.

[0025] In another aspect of the method for producing an energy storage device according to the present invention, in the insulating layer-forming step, the composition for an insulating layer is applied on a portion of the intermediate layer on which the composite is not applied.

[0026] Hereinafter, one embodiment of the electrode assembly according to the aspect of the present invention will be described with reference to the drawings.

[0027] An energy storage device of the present embodiment includes an electrode assembly having a pair of electrodes overlapped with each other. At least one of the electrodes includes a current collecting substrate, an active material layer arranged on the current collecting substrate, an intermediate layer arranged between the current collecting substrate and the active material layer, and an insulating layer arranged on the current collecting substrate. The active material layer contains an active material and a first binder. The intermediate layer contains a carbonaceous material and a second binder. The insulating layer contains an insulating material and a third binder. The first binder and the second binder are nonaqueous binders. The third binder is an aqueous binder.

[0028] In the energy storage device of the present embodiment, at least one of a pair of electrodes 3 and 5 in an electrode assembly 2 includes an active material layer

3b or 5b, an intermediate layer 6, and an insulating layer 7 in contact with at least the intermediate layer, mentioned above. A binder contained in the insulating layer 7 is an aqueous binder, and each of binders contained in the active material layers 3b and 5b and the intermediate layer 6 is a nonaqueous binder. Furthermore, the intermediate layer 6 contains a hydrophobic carbonaceous material.

Thus, the aqueous binder contained in the insulating layer 7 is relatively high in polarity, and on the other hand, the nonaqueous binders contained in the active material layers 3b and 5b and the intermediate layer 6 and the carbonaceous material contained in the intermediate layer 6 are lower in polarity than the aqueous binder contained in the insulating layer 7. That is, the aqueous binder is low in affinity with the nonaqueous binder and the carbonaceous material, and the nonaqueous binder and the carbonaceous material are high in affinity to each other.

[0029] In the intermediate layer 6, the nonaqueous binder and the carbonaceous material, which are high in affinity to each other, are contained. Thus, the nonaqueous binder prevents the carbonaceous material from moving to the outside of the intermediate layer 6. Moreover, in the insulating layer 7, the aqueous binder, which is low in affinity with the carbonaceous material, is contained. Thus, the aqueous binder can prevent the carbonaceous material from moving into the insulating layer 7.

[0030] Since the carbonaceous material is prevented from intruding into the insulating layer 7, it is possible to prevent the lowering in insulation properties of the insulating layer 7 caused by the intrusion of the carbonaceous material. Thus, it is possible to provide an energy storage device having an insulating layer high in insulation properties.

[0031] The nonaqueous binder is contained in the active material layers 3b and 5b, and therefore, even in the case where the carbonaceous material contained in the intermediate layer 6 moves into the active material layers 3b and 5b, it is possible to prevent the carbonaceous material from moving into the insulating layer 7 through the active material layers 3b and 5b.

[0032] In the energy storage device of the present embodiment, the carbonaceous material is contained as a conductive additive in the active material layers 3b and 5b. In the active material layers 3b and 5b, the nonaqueous binder and the carbonaceous material, which are high in affinity to each other, are contained. Thus, the nonaqueous binder prevents the carbonaceous material from moving to the outside of the active material layers 3b and 5b. Moreover, in the insulating layer 7, the aqueous binder, which is low in affinity with the carbonaceous material, is contained. Thus, the aqueous binder can prevent the carbonaceous material contained in the active material layers 3b and 5b from moving into the insulating layer 7.

[0033] In the energy storage device of the present embodiment, inorganic particles are contained as an insulating material in the insulating layer 7. In the case where the carbonaceous material is contained in the intermediate layer 6 or the active material layers 3b and 5b and the inorganic particles are contained in the insulating layer 7, the carbonaceous material is relatively high in hydrophobicity and the inorganic particles are relatively high in hydrophilicity, and thus the inorganic particles having hydrophilicity prevent the carbonaceous material from moving into the insulating layer 7.

[0034] In the energy storage device of the present embodiment, as shown in Fig. 1 to Fig. 3, each of a pair of electrodes 3 and 5 in an electrode assembly 2 includes at least a current collecting substrate 3a or 5a and an active material layer 3b or 5b, and the active material layers 3b and 5b are each overlapped so as to face each other.

Moreover, an insulating layer 7 of one electrode is arranged so as to face at least a part of the end edge of the active material layer 5b in the other electrode.

[0035] As shown in Fig. 2, in one electrode 3 including an insulating layer 7, the insulating layer 7 may be arranged so as to further cover the face of the current collecting substrate 3a, which faces the other electrode 5.

[0036] As shown in Fig. 3, in one electrode 3 including an insulating layer 7, the insulating layer 7 may be arranged so as to further cover the face of the active material layer 3b, which faces the other electrode 5.

[0037] As shown in Figs. 1 to 3, an intermediate layer 6 may have an intermediate layer-protruding portion 6a protruded outside from the end edge of the active material layer 3b or 5b. The intermediate layer 6 has the intermediate layer-protruding portion 6a, and therefore, even the end edge of the active material layer 3b or 5b can be in contact with the intermediate layer 6. As a result thereof, the peel strength of the active material layer 3b or 5b is enhanced.

[0038] As shown in Figs. 1 to 3, an insulating layer 7 may be arranged so as to cover an intermediate layer-protruding portion 6a. The insulating layer 7 covers the intermediate layer-protruding portion 6a, and therefore, the contact area with the intermediate layer 6 is increased. Meanwhile, in the insulating layer 7, an aqueous binder, which is low in affinity with the carbonaceous material, is contained. Thus, the aqueous binder can prevent the carbonaceous material from moving into the insulating layer 7.

[0039] As shown in Figs. 2 and 3, an insulating layer 7 may be arranged so as to cover an intermediate layer-protruding portion 6a while being in contact with a current collecting substrate 3a or 5a. That is, the insulating layer 7 may be arranged so as to cover the end edge of the intermediate layer 6. At the end edge of the intermediate layer 6, the intermediate layer 6 is exposed by the thickness of the intermediate layer 6. Thus, the insulating layer 7 covers the end edge of the intermediate layer 6, and therefore, the contact area with the intermediate layer 6 is increased. Meanwhile, in the insulating layer 7, an

aqueous binder, which is low in affinity with the carbonaceous material, is contained. Thus, the aqueous binder can prevent the carbonaceous material from moving into the insulating layer 7.

[0040] As shown in Fig. 3, an insulating layer 7 may be arranged so as to cover an active material layer 3b or 5b and an intermediate layer-protruding portion 6a while being in contact with a current collecting substrate 3a or 5a. The insulating layer 7 may be arranged so as to cover only a part of the active material layer 3b or 5b.

[0041] For more details, for example, as shown in Fig. 1 to Fig. 3, an electrode assembly 2 in the energy storage device of the present embodiment includes a sheet-like positive electrode 3 and a sheet-like negative electrode 5 overlapped with the positive electrode 3 as a pair of electrodes. Moreover, the electrode assembly 2 includes a separator 4 arranged between the positive electrode 3 and the negative electrode 5.

[0042] For example, the electrode assembly 2 in the energy storage device 1 of the present embodiment forms a nonaqueous electrolyte secondary battery 1 such as a lithium ion secondary battery.

[0043] A negative electrode 5 includes a negative current collecting substrate 5a as a current collecting substrate, and moreover, includes a negative active material layer 5b, which contains a negative active material, as an active material layer.

In the meantime, a positive electrode 3 includes a positive current collecting substrate 3a as a current collecting substrate, and moreover, includes a positive active material layer 3b, which contains a positive active material and is arranged at least at one surface of the positive current collecting substrate 3a, as an active material layer. Furthermore, the positive electrode 3 includes an intermediate layer 6, which contains a carbonaceous material and is arranged between the positive current collecting substrate 3a and the positive active material layer 3b, and an insulating layer 7, which contains an insulating material.

The positive electrode 3 and the negative electrode 5 are overlapped via a separator 4 so that the negative active material layer 5b and the positive active material layer 3b face each other.

[0044] The intermediate layer 6, the positive active material layer 3b, and the insulating layer 7 in the positive electrode 3 each contain a binder. The binder contained in the insulating layer 7 is an aqueous binder, and each of the binders contained in the positive active material layer 3b and the intermediate layer 6 is a nonaqueous binder.

[0045] Since the binder contained in the insulating layer 7 is an aqueous binder, and each of the binders contained in the positive active material layer 3b and the intermediate layer 6 is a nonaqueous binder, the affinity between the aqueous binder and the nonaqueous binder is relatively low. Moreover, as described above, the aqueous binder is low in affinity with the carbonaceous material, and the nonaqueous binder is high in affinity with the carbonaceous material. Thus, as described above, the aqueous binder can prevent the carbonaceous material from moving into the insulating layer 7. Thus, it is possible to sufficiently enhance the insulation performance of the insulating layer 7. In the case where the aqueous binder contained in the insulating layer 7 is a binder which is soluble in water, the binder can more effectively prevent the carbonaceous material from moving into the insulating layer 7, and thus the aqueous binder is preferably a binder which is soluble in water (hereinafter, also referred to as water-soluble binder).

[0046] The binder contained in the insulating layer 7 is an aqueous binder which is dispersible or soluble in water.

As the aqueous binder, a water-soluble binder (aqueous binder which is soluble in water) having a solubility of not less than 1 part by mass thereof in 100 parts by mass of water at 20°C is preferred.

[0047] As the aqueous binder, preferred is at least one kind selected from the group consisting of polyethylene oxide (polyethylene glycol), polypropylene oxide (polypropylene glycol), polyvinyl alcohol, polyacrylic acid, polymethacrylic acid, polytetrafluoroethylene (PTFE), a styrene butadiene rubber (SBR), polyolefin, a nitrile-butadiene rubber and cellulose, and more preferred is at least one water-soluble binder selected from the group consisting of polyethylene oxide (polyethylene glycol), polypropylene oxide (polypropylene glycol), polyvinyl alcohol, polyacrylic acid and polymethacrylic acid.

[0048] On the other hand, the nonaqueous binder is a binder which is lower in water solubility than the aqueous binder.

As the nonaqueous binder, a binder having a solubility of less than 1 part by mass thereof in 100 parts by mass of water at 20°C is preferred.

[0049] Examples of the nonaqueous binder include polyvinylidene fluoride (PVDF), a copolymer of vinylidene fluoride and hexafluoropropylene, a copolymer of ethylene and vinyl alcohol, polyacrylonitrile, polyphosphazene, polysiloxane, polyvinyl acetate, polymethyl methacrylate, polystyrene, polycarbonate, polyamide, polyimide, polyamideimide, a crosslinked polymer of cellulose and chitosan pyrrolidone carboxylate, and a derivative of chitin or chitosan.

[0050] Examples of the derivative of chitosan include a polymer compound, glyceryl chitosan, and a crosslinked body of chitosan.

[0051] The nonaqueous binder contained in the intermediate layer 6 is preferably at least one kind selected from the group consisting of polyvinylidene fluoride, a derivative of chitosan and a polyimide in that they are higher in affinity with the carbonaceous material and capable of further preventing the carbonaceous material from diffusing into the insulating layer 7.

The nonaqueous binder contained in the positive active material layer 3b is preferably at least one kind selected from the group consisting of polyvinylidene fluoride, a copolymer of ethylene and vinyl alcohol and polymethyl

methacrylate in that they are excellent in binding property or low in electrical resistance.

[0052] The electrode assembly 2 is formed in a belt-like shape. Moreover, for example, as shown in Fig. 7, the electrode assembly 2 is wound to be used.

As shown in Fig. 1 to Fig. 3 which are cross-sectional views obtained by cutting the electrode assembly 2 along the width direction of the electrode, the electrode assembly 2 includes a sheet-like positive electrode 3, a sheet-like negative electrode 5 and a sheet-like separator 4 arranged between the positive electrode 3 and the negative electrode 5.

[0053] The positive electrode 3 is formed in a rectangular shape such as a belt-like shape. The thickness of the positive electrode 3 is usually 35 to 250 μm.

[0054] For example, as shown in Fig. 1 to Fig. 3, the positive electrode 3 has a belt-like positive current collecting substrate 3a, a belt-like positive active material layer 3b arranged at the negative electrode 5 side from the positive current collecting substrate 3a, an intermediate layer 6 arranged between the positive current collecting substrate 3a and the positive active material layer 3b, and a belt-like insulating layer 7 covering at least one of the side faces (end faces) in the width direction of the intermediate layer 6.

The positive active material layer 3b is arranged so as to face the separator 4 and so as to be in contact with the separator 4 directly or via the insulating layer 7.

[0055] For example, as shown in Fig. 1 to Fig. 3, the negative electrode 5 has a belt-like negative current collecting substrate 5a, and a belt-like negative active material layer 5b arranged at the positive electrode 3 side from the negative current collecting substrate 5a.

The negative active material layer 5b of the negative electrode 5 is arranged so as to face the separator 4 and so as to be in contact with the separator 4. The thickness of the negative electrode 5 is usually 35 to 250 μm.

[0056] The separator 4 is formed in, for example, a belt-like shape and arranged between the positive electrode 3 and the negative electrode 5 in order to prevent the electrical connection between the positive electrode 3 and the negative electrode 5. The thickness of the separator 4 is usually 5 to 50 μm.

[0057] In the electrode assembly 2, for example, as shown in Fig. 1 to Fig. 3, the negative active material layer 5b has an end edge arranged outside from the end edge of the positive active material layer 3b facing the negative active material layer 5b.

[0058] For example, as shown in Fig. 1 to Fig. 3, the intermediate layer 6 has an intermediate layer-protruding portion 6a protruded outside from the end edge of the positive active material layer 3b, and the intermediate layer-protruding portion 6a is arranged so as to face the end edge of the negative active material layer 5b.

[0059] For example, as shown in Fig. 1 to Fig. 3, the insulating layer 7 is arranged so as to face the end edge of the negative active material layer 5b, and furthermore, the insulating layer 7 is arranged so as to cover the negative electrode 5 side of the intermediate layer-protruding portion 6a while being in contact with the end edge of the positive active material layer 3b.

[0060] Preferably, in the electrode assembly 2, as shown in Fig. 1 to Fig. 3, in the width direction of the electrode, both end edges of the negative active material layer 5b are arranged outside from both end edges of the positive active material layer 3b, respectively. That is, at both sides in the width direction of the positive electrode and the negative electrode, the respective end edges of the negative active material layer 5b are protruded outside from the respective end edges of the positive active material layer 3b.

The electrode assembly 2 has such a configuration, and therefore, ion components such as Li ions which have moved from the positive active material layer 3b to the negative electrode 5 side at the time of charging can be sufficiently occluded into the negative active material in the negative active material layer 5b.

[0061] Moreover, at one side in the width direction of the electrode assembly 2, the end edge of the negative active material layer 5b is arranged inside from the end edge of the intermediate layer 6 of the positive electrode 3, and outside from the end edge of the positive active material layer 3b of the positive electrode 3. That is, the negative active material layer 5b is protruded outside from the end edge of the positive active material layer 3b, and the intermediate layer 6 is protruded outside from the protruding end edge of the negative active material layer 5b. Furthermore, the protruding portion of such an intermediate layer (intermediate layer-protruding portion 6a) faces the end edge of the negative active material layer 5b.

[0062] Furthermore, at one side in the width direction of the electrode assembly 2, at least a part of the insulating layer 7 in the positive electrode 3 faces the end edge of the negative active material layer 5b. Thus, a short circuit caused by a foreign substance which has intruded into the end portion of the electrode assembly 2 can be prevented by the insulating layer 7.

In this connection, although a short circuit caused by a foreign substance can also be prevented by the separator 4, there is a case where a foreign substance breaks through the separator. Even in such a case, it is possible to prevent a short circuit by the insulating layer 7.

In this connection, there is a case where a short circuit is not only caused by a foreign substance but also caused accompanied with the contact between the positive electrode 3 and the negative active material layer 5b by shrinkage or displacement of the separator. Even in such a case, it is possible to prevent a short circuit by the insulating layer 7.

[0063] Meanwhile, at least at a part of the other side in the width direction of the electrode assembly 2, the end edge of the negative active material layer 5b is arranged outside from the end edge of the positive electrode 3. Moreover, the negative current collecting substrate 5a has a portion protruded outside from the end

edge of the negative active material layer 5b. That is, the end edge of the negative current collecting substrate 5a is protruded outside from the end edge of the negative active material layer 5b.

Such a configuration makes it easy to take in and out the electricity from the current collecting substrate (negative current collecting substrate 5a).

[0064] Although the material for the positive current collecting substrate 3a is not particularly limited, for example, aluminum is employed. The shape of the positive current collecting substrate 3a is usually a foil-like shape. The thickness of the positive current collecting substrate 3a is usually 5 to 50 μm.

[0065] For example, the positive active material layer 3b extends along at least one surface of the positive current collecting substrate 3a.

The positive active material layer 3b contains a positive active material, a conductive additive, and a binder. The thickness of the positive active material layer 3b is usually 30 to 200 μm.

[0066] Examples of the positive active material include a material capable of occluding and releasing lithium ions.

The positive active material is usually formed in a particle-like shape.

[0067] Examples of the positive active material include a composite oxide represented by Li_xMO_y (M represents at least one transition metal) (such as Li_xCoO_2, Li_xNiO_2, $Li_xMn_2O_4$, Li_xMnO_3, $Li_xNi_yCo_{(1-y)}O_2$, $Li_xNi_yMn_zCo_{(1-y-z)}O_2$, and $Li_xNi_yMn_{(2-y)}O_4$).

Moreover, examples of the positive active material include a polyanion compound represented by $Li_w-Me_x(XO_y)_z$ (Me represents at least one transition metal and examples of X include P, Si, B and V) (such as $LiFePO_4$, $LiMnPO_4$, $LiNiPO_4$, $LiCoPO_4$, $Li_3V_2(PO_4)_3$, Li_2MnSiO_4, and Li_2CoPO_4F).

An element in these compounds or a part of the polyanion may be substituted with another element or anionic species.

Moreover, the surface of the positive active material may be coated with a metal oxide such as ZrO_2, MgO and Al_2O_3 or carbon.

Furthermore, although examples of the positive active material include disulfide, a conductive polymer compound such as polypyrrole, polyaniline, polyparastyrene, polyacetylene and a polyacene-based material, and a pseudo graphite structure carbonaceous material, the positive active material is not limited thereto.

As the positive active material, these compounds may be used alone and may be used as a mixture of two or more thereof.

[0068] The conductive additive is not particularly limited, and examples thereof include a carbonaceous material such as ketjen black, acetylene black, graphite, and coke powder.

[0069] For the binder contained in the positive active material layer 3b, both of the aqueous binder and the nonaqueous binder described above can be used. As the binder contained in the positive active material layer 3b, the nonaqueous binder is preferred.

[0070] In the positive electrode 3, the positive active material layer 3b may be formed at each of both faces of the positive current collecting substrate 3a.

[0071] It is preferred that the intermediate layer 6 have sufficient adhesive properties to the current collecting substrate (positive current collecting substrate 3a). That is, it is preferred that the intermediate layer 6 have a sufficiently high peel strength to the current collecting substrate.

It is preferred that the intermediate layer 6 be higher in electron conductivity than the active material layer (positive active material layer 3b).

[0072] The intermediate layer 6 contains at least a carbonaceous material as a conductive material, and a binder.

Since the intermediate layer 6 contains a carbonaceous material, the intermediate layer 6 forms an electronic path between the positive current collecting substrate 3a and the positive active material layer 3b. Moreover, since the intermediate layer 6 contains a binder (binding agent), the peeling of each of the positive current collecting substrate 3a and the positive active material layer 3b can be prevented.

In this connection, the thickness of the intermediate layer 6 is usually 0.1 to 10 μm.

[0073] The carbonaceous material usually has an electrical conductivity of not less than 10^{-6} S/m.

[0074] Examples of the carbonaceous material include carbon black and graphite.

[0075] For example, an electrode comprises the insulating layer 7 in order to prevent a short circuit between electrodes (between the positive electrode 3 and the negative electrode 5).

The insulating layer 7 contains at least an insulating material and a binder.

[0076] For example, as shown in Fig. 1, the insulating layer 7 is arranged so as to face the end edge of the negative active material layer 5b, and furthermore, arranged so as to cover the negative electrode 5 side of the intermediate layer-protruding portion 6a while being in contact with the end edge (end face) of the positive active material layer 3b.

The insulating layer 7 is arranged in this way, and therefore the insulating layer 7 exists at a position facing the end edge of the negative active material layer 5b. Thus, it is possible to prevent a short circuit caused by a foreign substance, which has intruded into the end portion of the electrode assembly 2, by the insulating layer 7.

In this connection, there is a case where a short circuit is not only caused by a foreign substance but also caused accompanied with the contact between the positive electrode 3 and the negative active material layer 5b caused by contraction or displacement of the separator. Even in such a case, it is possible to prevent a short circuit by the insulating layer 7.

[0077] Moreover, for example, as shown in Fig. 2, it is

preferred that the insulating layer 7 be arranged so as to cover the negative electrode 5 side of the intermediate layer-protruding portion 6a while being in contact with the positive current collecting substrate 3a outside from the intermediate layer-protruding portion 6a.

The insulating layer 7 is arranged in this way, and therefore the positive current collecting substrate 3a facing the end edge of the negative active material layer 5b is further widely covered with the insulating layer 7. Thus, it is possible to further surely prevent a short circuit caused by a foreign substance which has intruded into the end portion of the electrode assembly 2.

In this connection, there is a case where a short circuit is not only caused by a foreign substance but also caused accompanied with the contact between the positive current collecting substrate 3a and the negative active material layer 5b caused by contraction or displacement of the separator. Even in such a case, it is possible to prevent a short circuit by the insulating layer 7.

[0078] Moreover, for example, as shown in Fig. 3, the insulating layer 7 may be arranged so as to further cover the face of the positive active material layer 3b which faces the negative electrode 5.

The insulating layer 7 arranged in this way is formed by a porous material so that Li ions and the like can move between the positive electrode 3 and the negative electrode 5.

In the case where the electrical resistance of the insulating layer 7 is higher than the electrical resistance of the active material layer (positive active material layer 3b), the insulating layer 7 is formed as mentioned above, and thus it is possible to suppress a short circuit caused by the contact between the active material layer (positive active material layer 3b) and the counter electrode (negative electrode 5). In the case where the electrical resistance of the negative active material layer 5b is smaller than that of the positive active material layer 3b, it is preferred that the above-mentioned insulating layer 7 be formed on the negative electrode rather than the positive electrode.

[0079] The insulating material is higher in electrical resistance than the carbonaceous material.

For details, the insulating material has an electrical conductivity of less than 10^{-6} S/m.

[0080] Examples of the insulating material include inorganic particles and a resin.

[0081] Examples of the inorganic particles include oxide particles, nitride particles, ion crystal particles, covalent crystal particles, clay particles, and particles of substances derived from mineral resources and artificial substances thereof.

Examples of fine oxide particles include particles made from iron oxide, SiO_2, Al_2O_3, TiO_2, $BaTiO_2$, ZrO, an alumina-silica composite oxide, and the like.

Examples of the nitride particles include particles made from aluminum nitride, silicon nitride, and the like.

Examples of the ion crystal particles include particles made from calcium fluoride, barium fluoride, barium sulfate, and the like.

Examples of the covalent crystal particles include particles made from silicon, diamond, and the like.

Examples of the clay particles include particles made from talc, montmorillonite, and the like.

Examples of the particles made from substances derived from mineral resources or artificial substances thereof include particles made from boehmite (hydrated alumina), zeolite, apatite, kaolin, mullite, spinel, olivine, sericite, bentonite, mica, and the like.

[0082] As the inorganic particles, one kind of particles mentioned above, a mixture thereof, or a composite thereof can be employed.

As the inorganic particles, preferred is at least one kind of SiO_2 particles, Al_2O_3 particles, boehmite (hydrated alumina), and alumina-silica composite oxide particles.

[0083] The separator 4 allows the passage of an electrolyte solution 9 (described below) while preventing the electrical connection between the positive electrode 3 and the negative electrode 5.

From the viewpoint of being capable of further surely preventing a short circuit, it is preferred that the width of the separator 4 be greater than the width of the positive active material layer 3b. Moreover, the width of the separator 4 is preferably greater than the width of the negative active material layer 5b.

The thickness of the separator 4 is usually 5 to 50 μm.

[0084] The separator 4 may be made of a single layer and may be made of a plurality of layers.

[0085] Although the material for the negative current collecting substrate 5a is not particularly limited, for example, copper is employed.

The shape of the negative current collecting substrate 5a is usually a foil-like shape. The thickness of the negative current collecting substrate 5a is usually 5 to 50 μm.

[0086] For example, the negative active material layer 5b extends along at least one surface of the negative current collecting substrate 5a.

The negative active material layer 5b contains a negative active material and a binder, and can further contain a conductive additive. The thickness of the negative active material layer 5b is usually 30 to 200 μm.

[0087] The negative active material is a substance capable of contributing to the electrode reaction of charge reaction and discharge reaction in the negative electrode 5. The negative active material is usually formed in a particle-like shape.

[0088] The negative active material is not particularly limited, and for example, a carbon-based substance such as amorphous carbon, hardly graphitized carbon, easily graphitized carbon, and graphite can be used.

[0089] As the binder contained in the negative active material layer 5b, the same binder as the above-described binder contained in the positive active material layer 3b is employed.

[0090] In this connection, in the negative electrode 5, the negative active material layer 5b may be formed at each of both faces of the negative current collecting sub-

strate 5a.

[0091] In the electrode assembly 2 mentioned above, as shown in Fig. 1 to Fig. 3, the intermediate layer 6 has an intermediate layer-protruding portion 6a. On the other hand, as shown in Fig. 4, the electrode assembly 2 may have no intermediate layer-protruding portion 6a in the intermediate layer 6. That is, in the electrode assembly 2, the intermediate layer 6 and the positive active material layer 3b may be formed so as to have the same length in the width direction, and each of both end edges in the width direction of the intermediate layer 6 and each of both end edges in the widthwise direction of the positive active material layer 3b may be overlapped with each other in the thickness direction.

[0092] Moreover, in the electrode assembly 2 mentioned above, as shown in Fig. 1 to Fig. 3, both end edges in the width direction of the negative active material layer 5b are arranged outside from both end edges of the positive active material layer, respectively. However, in the electrode assembly 2, as shown in Fig. 5, the positive active material layer 3b and the negative active material layer 5b may be formed so as to have the same length in the width direction, and both end edges in the width direction of the positive active material layer 3b may be opposite to both end edges in the width direction of the negative active material layer 5b, respectively.

[0093] Moreover, in the electrode assembly 2 mentioned above, as shown in Fig. 1 to Fig. 3, the positive electrode 3 includes the intermediate layer 6, but, in an electrode assembly 2, as shown in Fig. 6, the negative electrode 5 may include the intermediate layer 6.

In this connection, the embodiments of the intermediate layer 6 and the insulating layer 7 in the positive electrode 3 described in Fig. 1 to Fig. 3, and the binders contained in respective layers of the positive electrode 3 can be similarly employed as those for the negative electrode 5.

[0094] One example of an energy storage device 1 of the present embodiment includes a nonaqueous electrolyte secondary battery 1 shown in Fig. 8 to Fig. 11.

[0095] As shown in Fig. 8 to Fig. 11, the nonaqueous electrolyte secondary battery 1 mentioned above includes the above-described electrode assembly 2. For example, the electrode assembly 2 forms the nonaqueous electrolyte secondary battery 1 in such a winding state as shown in Fig. 7.

For details, the nonaqueous electrolyte secondary battery mentioned above includes a case 8, an electrolyte solution 9 accommodated in the case 8, two external gaskets 12 attached on the outer face of the case 8, an electrode assembly 2 accommodated in the case 8, two current collecting parts 10 electrically connected to the electrode assembly 2, and two external terminals 11 electrically connected to the two current collecting parts 10, respectively.

[0096] As shown in Fig. 8, the case 8 has a case main body 8a which has an opening in one direction and accommodates the electrode assembly 2, and a plate-like lid body 8b which closes the opening of the case main body 8a. For example, the case main body 8a and the lid body 8b are formed by an aluminum-based metal material such as aluminum and an aluminum alloy, and are welded to each other.

[0097] For example, the shape seen from one side of the lid body 8b is a rectangular shape. The lid body 8b is formed so as to air-tightly close the opening of the case main body 8a.

Moreover, two openings are formed in the lid body 8b.

[0098] On the outer face of the lid body 8b, two external gaskets 12 are attached. An opening is formed in each of the external gaskets 12. The lid body 8b and the external gaskets 12 are arranged so that one opening of the lid body 8b and the opening of one external gasket 12 are continued to each other. The same holds true for the other opening of the lid body 8b and the opening of the other external gasket 12. Inside the openings continued to each other, parts of respective external terminals 11 are arranged. Moreover, an insulating member which is not illustrated is further arranged between each of the external terminals 11 and the lid body 8b, and each of the external terminals 11 and the lid body 8b are insulated with the insulating member.

[0099] The external terminals 11 are each connected to the two current collecting parts 10, which are connected to the electrode assembly 2, respectively. Moreover, each of the current collecting parts 10 is electrically connected to the electrode assembly 2. That is, each of the external terminals 11 is electrically connected to the electrode assembly 2 via each of the two current collecting parts 10.

For example, the external terminal 11 is formed by an aluminum-based metal material such as aluminum and an aluminum alloy.

[0100] With regard to the external gasket 12, the current collecting part 10, and the external terminal 11, there are ones for the positive electrode and ones for the negative electrode.

The external gasket 12, the current collecting part 10, and the external terminal 11 for the positive electrode are each arranged at one end side in the longitudinal direction of the lid body 8b. On the other hand, the external gasket 12, the current collecting part 10, and the external terminal 11 for the negative electrode are each arranged at the other end side in the longitudinal direction of the lid body 8b.

[0101] As shown in Fig. 11, the electrode assembly 2 is accommodated inside the case main body 8a of the case 8.

Inside the case 8, one electrode assembly 2 may be accommodated, and a plurality of electrode assemblies may be accommodated. In the latter case, the plurality of electrode assemblies are electrically connected in parallel to each other.

[0102] As shown in Fig. 11, the electrolyte solution 9 as an electrolyte is accommodated inside the case main body 8a, and the electrode assembly 2 is immersed in the electrolyte solution 9. That is, the electrode assembly

2 and the electrolyte solution 9 are included inside the case main body 8a.

[0103] The electrolyte solution 9 (nonaqueous electrolyte) is prepared by dissolving an electrolyte salt in an organic solvent.

Examples of the organic solvent include nonaqueous solvents such as ethylene carbonate, propylene carbonate, butylene carbonate, trifluoropropylene carbonate, γ-butyrolactone, γ-valerolactone, sulfolane, 1,2-dimethoxyethane, 1,2-diethoxyethane, tetrahydrofuran, 2-methyltetrahydrofuran, 2-methyl-1,3-dioxolane, dioxolane, fluoroethyl methyl ether, ethylene glycol diacetate, propylene glycol diacetate, ethylene glycol dipropionate, propylene glycol dipropionate, methyl acetate, ethyl acetate, propyl acetate, butyl acetate, methyl propionate, ethyl propionate, propyl propionate, dimethyl carbonate, diethyl carbonate, ethyl methyl carbonate, methyl propyl carbonate, ethyl propyl carbonate, dipropyl carbonate, methyl isopropyl carbonate, ethyl isopropyl carbonate, diisopropyl carbonate, dibutyl carbonate, acetonitrile, fluoroacetonitrile, alkoxy- and halogen-substituted cyclic phosphazenes or linear phosphazenes including ethoxypentafluoro cyclotriphosphazene, diethoxytetrafluoro cyclotriphosphazene, phenoxypentafluoro cyclotriphosphazene and the like, phosphoric acid esters including triethyl phosphate, trimethyl phosphate, trioctyl phosphate and the like, boric acid esters including triethyl borate, tributyl borate and the like, N-methyloxazolidinone, and N-ethyloxazolidinone.

[0104] No particular limitation is put on the electrolyte salt, and examples thereof include ionic compounds such as $LiClO_4$, $LiBF_4$, $LiAsF_6$, $LiPF_6$, $LiCF_3SO_3$, $LiN(SO_2CF_3)_2$, $LiN(SO_2C_2F_5)_2$, $LiN(SO_2CF_3)(SO_2C_4F_9)$, LiSCN, LiBr, LiI, Li_2SO_4, $Li_2B_{10}Cl_{10}$, $NaClO_4$, NaI, NaSCN, NaBr, $KClO_4$ and KSCN, and mixtures of two or more thereof.

[0105] In this connection, the electrolyte solution 9 (nonaqueous electrolyte) can further contain a known additive.

As the electrolyte solution 9 (nonaqueous electrolyte), a solvent prepared by mixing ethylene carbonate, dimethyl carbonate and methyl ethyl carbonate is preferred in that the conductivity of Li ions is heightened.

[0106] Subsequently, the method for producing a nonaqueous electrolyte secondary battery 1 as one example of the energy storage device of the present embodiment will be described.

[0107] For example, an electrode assembly 2 constituting the nonaqueous electrolyte secondary battery 1 is produced by overlapping (superimposing) a sheet-like positive electrode 3 and a sheet-like negative electrode 5 via a separator 4.

Moreover, the nonaqueous electrolyte secondary battery 1 is produced by accommodating the prepared electrode assembly 2 and an electrolyte solution 9 in a case 8.

[0108] For details, for example, the method for producing an electrode assembly 2 includes a negative electrode-preparing step of preparing a negative electrode 5, a positive electrode-preparing step of preparing a positive electrode 3, and an overlapping step of overlapping the negative electrode 5 and the positive electrode 3. In the negative electrode-preparing step, a negative active material layer 5b is formed from a negative composite containing a negative active material and a solvent. The positive electrode-preparing step includes an intermediate layer-forming step of forming an intermediate layer 6, a positive active material layer-forming step of forming a positive active material layer 3b, and an insulating layer-forming step of forming an insulating layer 7. The intermediate layer 6 is formed by applying a composition for an intermediate layer containing a carbonaceous material, a nonaqueous binder and a solvent to one face of a positive current collecting substrate 3a. A positive active material layer 3b is formed by applying a positive composite containing a positive active material, a nonaqueous binder and a solvent on the intermediate layer. An insulating layer 7 is formed from a composition for an insulating layer containing an insulating material, an aqueous binder and a solvent.

In the positive active material layer-forming step, in order to form an intermediate layer-protruding portion 6a, the positive composite can be applied so that at least a part of the intermediate layer is protruded outside from the applied positive composite.

In the insulating layer-forming step, the composition for an insulating layer can be applied so that the end edge of the positive active material layer and the composition for an insulating layer to be applied are in contact with each other. Moreover, the composition for an insulating layer can be applied so that the exposed face of a portion protruded outside of the intermediate layer is covered.

In the overlapping step, a positive electrode 3 and a negative electrode 5 can be overlapped so that the formed negative active material layer 5b and the formed positive active material layer 3b face each other, and furthermore, at least a part of the end edge of the negative active material layer 5b faces the insulating layer 7.

[0109] In the negative electrode-preparing step, for example, a negative active material and a binder are mixed, and the mixture is added to a solvent and kneaded to prepare a negative composite. The negative composite is applied to one face of a belt-like negative current collecting substrate 5a. The negative composite is applied so that the width of the negative active material layer 5b is wider than that of the positive active material layer 3b in the width direction of the negative current collecting substrate 5a. Then, the solvent is evaporated from the applied negative composite.

Thus, a negative electrode 5 in which the negative active material layer 5b is formed on the negative current collecting substrate 5a is prepared.

[0110] In the positive electrode-preparing step, each of an intermediate layer-forming step, a positive active material layer-forming step, and an insulating layer-forming step is performed.

[0111] In the intermediate layer-forming step, for ex-

ample, a carbonaceous material and a nonaqueous binder are mixed, and the mixture is added to a solvent and kneaded to prepare a composition for an intermediate layer. The composition for an intermediate layer is applied to one face of a positive current collecting substrate 3a. Furthermore, the solvent is evaporated from the applied composition for an intermediate layer.

In the intermediate layer-forming step, for example, a composition for an intermediate layer is applied to one face of a positive current collecting substrate 3a so that a belt-like portion on which the composition for an intermediate layer is not applied is left at one side in the width direction of the belt-like positive current collecting substrate 3a.

[0112] In the positive active material layer-forming step, for example, a positive active material, a carbonaceous material as a conductive additive, and a nonaqueous binder are mixed, and the mixture is added to a solvent and kneaded to prepare a positive composite. The positive composite is applied on the intermediate layer. Then, the solvent is evaporated from the applied positive composite.

When the positive composite is applied on the intermediate layer, the intermediate layer may still contain a solvent or the solvent may have been already evaporated from the intermediate layer by drying.

In the positive active material layer-forming step, for example, a positive composite is applied on the intermediate layer so that a belt-like portion on which the positive composite is not applied is left at a side where a portion on which the composition for an intermediate layer is not applied is provided in the positive current collecting substrate 3a.

[0113] In the insulating layer-forming step, for example, an insulating material and an aqueous binder are mixed, and the mixture is added to a solvent and kneaded to prepare a composition for an insulating layer. The composition for an insulating layer is applied on the intermediate layer. Then, the solvent is evaporated from the applied composition for an insulating layer.

When the composition for an insulating layer is applied, the positive active material layer or the intermediate layer may still contain a solvent or the solvent may have been already evaporated from the positive active material layer or the intermediate layer by drying.

In the insulating layer-forming step, for example, a composition for an insulating layer is applied on a portion on which the positive composite is not applied in the intermediate layer.

Moreover, in the insulating layer-forming step, for example, a composition for an insulating layer can be applied so as to further cover a part of the positive current collecting substrate 3a.

Moreover, in the insulating layer-forming step, for example, furthermore, a composition for an insulating layer can be applied so as to thoroughly cover the surface of the positive active material layer.

[0114] In the positive electrode-preparing step, each step can be separately performed. Specifically, in the intermediate layer-forming step, the solvent is evaporated from the intermediate layer, after which a positive active material layer-forming step can be performed. Then, in the positive active material layer-forming step, the solvent is evaporated from the positive composite, after which an insulating layer-forming step can be performed.

[0115] On the other hand, in the positive electrode-preparing step, the composition for an intermediate layer is applied in the intermediate layer-forming step, after which a positive active material layer-forming step and an insulating layer-forming step can be simultaneously performed. That is, before the solvent is completely evaporated from the intermediate layer, a positive composite and a composition for an insulating layer can be simultaneously applied along the longitudinal direction of the belt-like current collecting substrate so that the positive composite and the composition for an insulating layer are adjacent to each other.

In the positive electrode-preparing step, even when a positive composite and a composition for an insulating layer are simultaneously applied in this way, the positive composite contains the above-mentioned nonaqueous binder and the composition for an insulating layer contains the above-mentioned aqueous binder. Thus, the affinity between the respective binders is relatively low and the respective binders can be thus prevented from moving between the applied positive composite and the applied composition for an insulating layer.

Moreover, when the composition for an intermediate layer contains a carbonaceous material and the composition for an insulating layer contains inorganic particles, the carbonaceous material is relatively high in hydrophobicity and the inorganic particles are relatively high in hydrophilicity, and thus the inorganic particles having hydrophilicity can prevent the carbonaceous material from moving into the composition for an insulating layer.

[0116] In this connection, as the application methods in the positive electrode-preparing step and the negative electrode-preparing step, a general method is employed.

[0117] In the overlapping step, a positive electrode 3, a negative electrode 5 and a separator 4 are overlapped in a state where the respective longitudinal directions are aligned. Specifically, a positive electrode 3 and a negative electrode 5 are disposed so that the positive active material layer 3b and the negative active material layer 5b face each other, and a separator 4 is disposed between the positive electrode 3 and the negative electrode 5. Furthermore, the positive electrode 3 and the negative electrode 5 are disposed and overlapped so that the end edge of the negative active material layer 5b faces the insulating layer 7 of the positive electrode 3 at one side in the width direction of the negative current collecting substrate 5a.

[0118] For example, a nonaqueous electrolyte secondary battery is produced in the following manner.

That is, a current collecting part 10 is attached to each of the positive electrode 3 and the negative electrode 5

in the prepared electrode assembly 2. Next, the electrode assembly 2 and the current collecting parts 10 attached to the electrode assembly 2 are disposed inside the case main body 8a of the case 8. In the case where there are a plurality of electrode assemblies 2, for example, the current collecting parts 10 of the electrode assemblies 2 are electrically connected in parallel to each other to be disposed inside the case main bodies 8a. Then, by caulking of rivet or welding, the external terminal 11 inside the external gasket 12 attached to the lid body 8b and the current collecting parts 10 are connected, after which the lid body 8b is attached to the case main body 8a.

[0119] Subsequently, an electrolyte solution 9 is injected into the case 8 through a liquid injection hole provided in the case 8. Then, the liquid injection hole is sealed. As the electrolyte solution 9, for example, an electrolyte solution prepared by blending $LiPF_6$ into a mixed solvent of ethylene carbonate (EC) : dimethyl carbonate (DMC) : ethyl methyl carbonate (EMC) = 3 : 2 : 5 (volume ratio) is employed. Furthermore, a known additive may be added to the electrolyte solution 9.

[0120] As stated above, a nonaqueous electrolyte secondary battery can be produced.

[0121] In the above-mentioned embodiment, a sheet-like positive electrode 3 and a sheet-like negative electrode 5 are overlapped via a separator, after which those are wound to form an electrode assembly as shown in Fig. 7. However, the electrode assembly of the present embodiment is not limited to a winding type assembly, and for example, the electrode assembly may be a stacked type assembly prepared by stacking a plurality of positive electrodes and a plurality of negative electrodes. With regard to the positive electrode or the negative electrode which forms a stacked type electrode assembly, an intermediate layer-protruding portion 6a and an insulating layer 7 may be arranged at both end parts in the width direction and both end parts in the longitudinal direction orthogonal to the width direction.

[0122] In the above-mentioned embodiment, although a nonaqueous electrolyte secondary battery as an energy storage device is described as an example, the energy storage device in accordance with one embodiment of the present invention is not limited to the nonaqueous electrolyte secondary battery, and for example, the energy storage device may be a capacitor. The energy storage device in accordance with one embodiment of the present invention is preferably a nonaqueous electrolyte secondary battery, more preferably a lithium ion secondary battery. Moreover, the energy storage device in accordance with one embodiment of the present invention may be a capacitor, and specifically, a lithium ion capacitor or an ultracapacitor.

[0123] Moreover, the present invention relates not only to the above-mentioned energy storage device but also to an energy storage module including at least one energy storage device mentioned above.

For example, an energy storage module 20 in accordance with one embodiment of the present invention includes a plurality of energy storage devices exemplified above. Moreover, the energy storage module includes a plurality of bus bar members 13, each of which electrically connects energy storage devices.

[0124] An example of the energy storage module 20 of the present embodiment is shown in Fig. 12.

In the energy storage module 20 of the present embodiment, for example, a plurality of energy storage devices 1 (nonaqueous electrolyte secondary batteries 1), each of which is formed into a rectangular shape in a top view, are arranged so as to line up in the lateral direction of the energy storage device 1 when seen from the upper side.

Moreover, energy storage devices 1 adjacent to each other are in contact with each other.

In the energy storage module 20, energy storage devices 1 adjacent to each other are electrically connected to each other by a bus bar member 13. Then, the energy storage module 20 is constituted so as to be charged and discharged by all the respective energy storage devices 1 forming the module.

[0125] According to a first aspect of the invention, the energy storage device exerts an effect such that the device has an insulating layer excellent in insulation properties.

Claims

1. An energy storage device comprising an electrode assembly having a pair of electrodes overlapped with each other,
   at least one of the electrodes including a current collecting substrate, an active material layer arranged on the current collecting substrate, an intermediate layer arranged between the current collecting substrate and the active material layer, and an insulating layer arranged on the current collecting substrate,
   the active material layer containing an active material and a first binder, the intermediate layer containing a carbonaceous material and a second binder,
   the insulating layer containing an insulating material and a third binder, the second binder being a nonaqueous binder, and
   the third binder being an aqueous binder.

2. The energy storage device according to claim 1, wherein the first binder is a nonaqueous binder.

3. The energy storage device according to claim 2, wherein the active material layer contains a carbonaceous material.

4. The energy storage device according to any one of claims 1 to 3, wherein the insulating material comprises inorganic particles.

5. The energy storage device according to any one of

claims 1 to 4, wherein each of the pair of electrodes includes at least the active material layer and the active material layers are each arranged to face each other, and
the insulating layer of one electrode is arranged to face at least a part of the end edge of the active material layer in the other electrode.

6. The energy storage device according to any one of claims 1 to 5, wherein, in one electrode, the insulating layer is arranged to cover the face of the active material layer, the face of the active material layer facing the other electrode.

7. The energy storage device according to any one of claims 1 to 6, wherein, in one electrode, the insulating layer is arranged to cover the face of the current collecting substrate, the face of the current collecting substrate facing the other electrode.

8. The energy storage device according to any one of claims 1 to 7, wherein the intermediate layer has an intermediate layer-protruding portion protruded outside from the end edge of the active material layer, and
the insulating layer is arranged to cover the intermediate layer-protruding portion while being in contact with the current collecting substrate.

9. The energy storage device according to any one of claims 1 to 7, wherein the pair of electrodes corresponds to a positive electrode and a negative electrode, respectively;
the positive electrode has a positive active material layer as the active material layer, the intermediate layer, and the insulating layer;
the negative electrode has a negative active material layer as the active material layer;
the negative active material layer has an end edge arranged outside from the end edge of the positive active material layer facing the negative active material layer;
the intermediate layer has an intermediate layer-protruding portion protruded outside from the end edge of the positive active material layer; and
the insulating layer is arranged to face the end edge of the negative active material layer and is arranged to cover a surface of the intermediate layer-protruding portion, the surface of the intermediate layer-protruding portion facing the negative electrode while covering the end edge of the positive active material layer.

10. An energy storage module comprising:

the energy storage device according to any one of claims 1 to 9; and
a bus bar member electrically connected to the energy storage device.

11. A method for producing an energy storage device including an electrode assembly having a pair of electrodes overlapped with each other, the method comprising:

an intermediate layer-forming step of applying a composition for an intermediate layer containing a carbonaceous material and a nonaqueous binder to a current collecting substrate of at least one of the electrodes;
an active material layer-forming step of applying a composite containing an active material and a nonaqueous binder on the intermediate layer; and
an insulating layer-forming step of applying a composition for an insulating layer containing an insulating material and an aqueous binder on the intermediate layer or the active material layer.

12. The method for producing an energy storage device according to claim 11, wherein the active material layer-forming step and the insulating layer-forming step are simultaneously performed.

13. The method for producing an energy storage device according to claim 11 or 12, wherein the composite contains a carbonaceous material.

14. The method for producing an energy storage device according to any one of claims 11 to 13, wherein the insulating material contains inorganic particles.

15. The method for producing an energy storage device according to any one of claims 11 to 14, wherein, in the insulating layer-forming step, the composition for an insulating layer is applied on a portion of the intermediate layer on which the composite is not applied.

FIG. 1

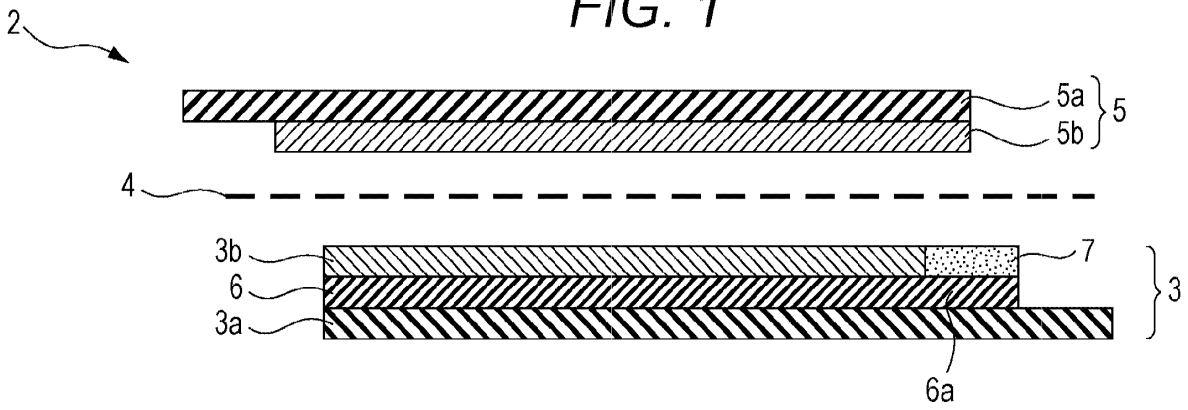


FIG. 2

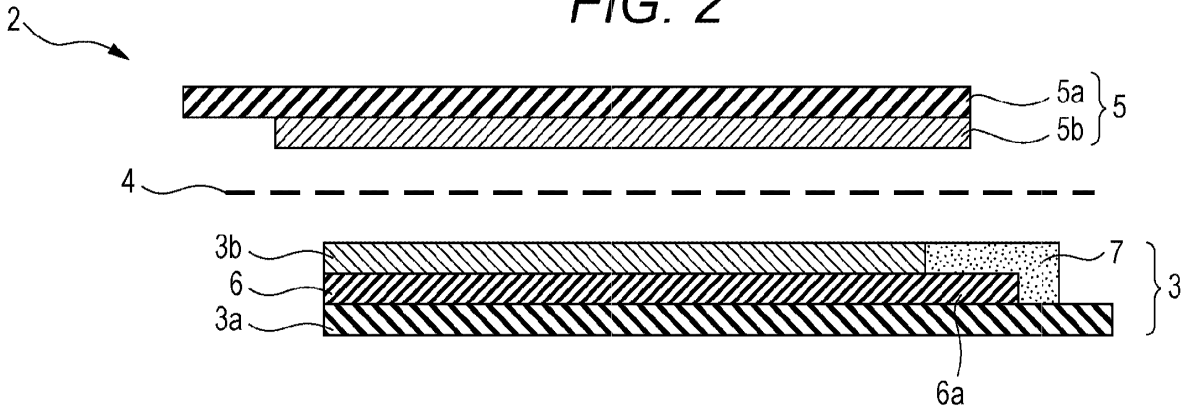


FIG. 3

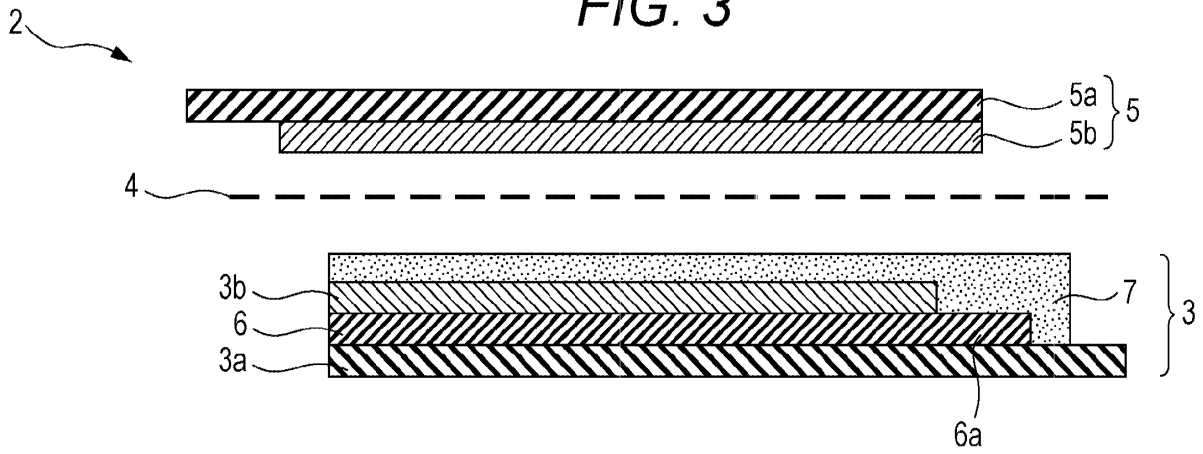


FIG. 4

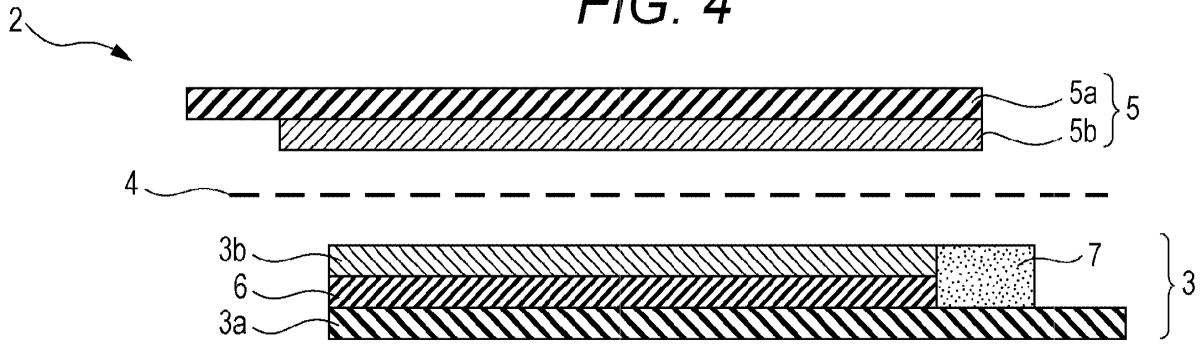


FIG. 5

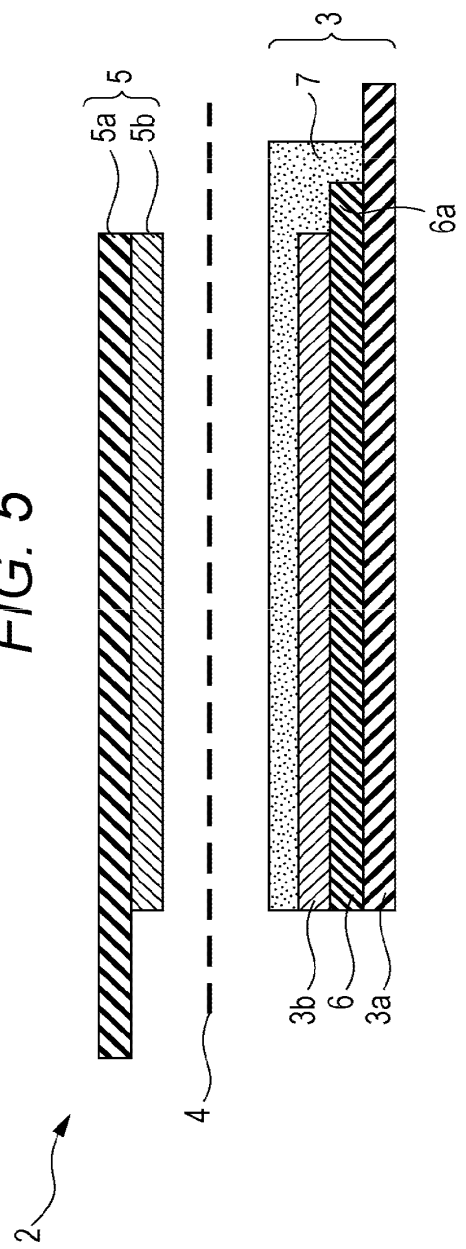


FIG. 6

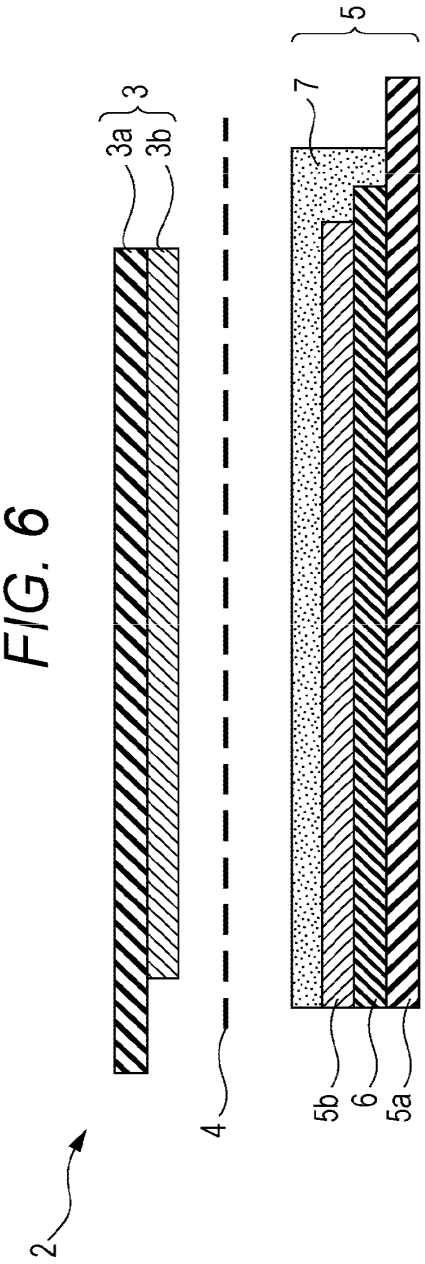


FIG. 7

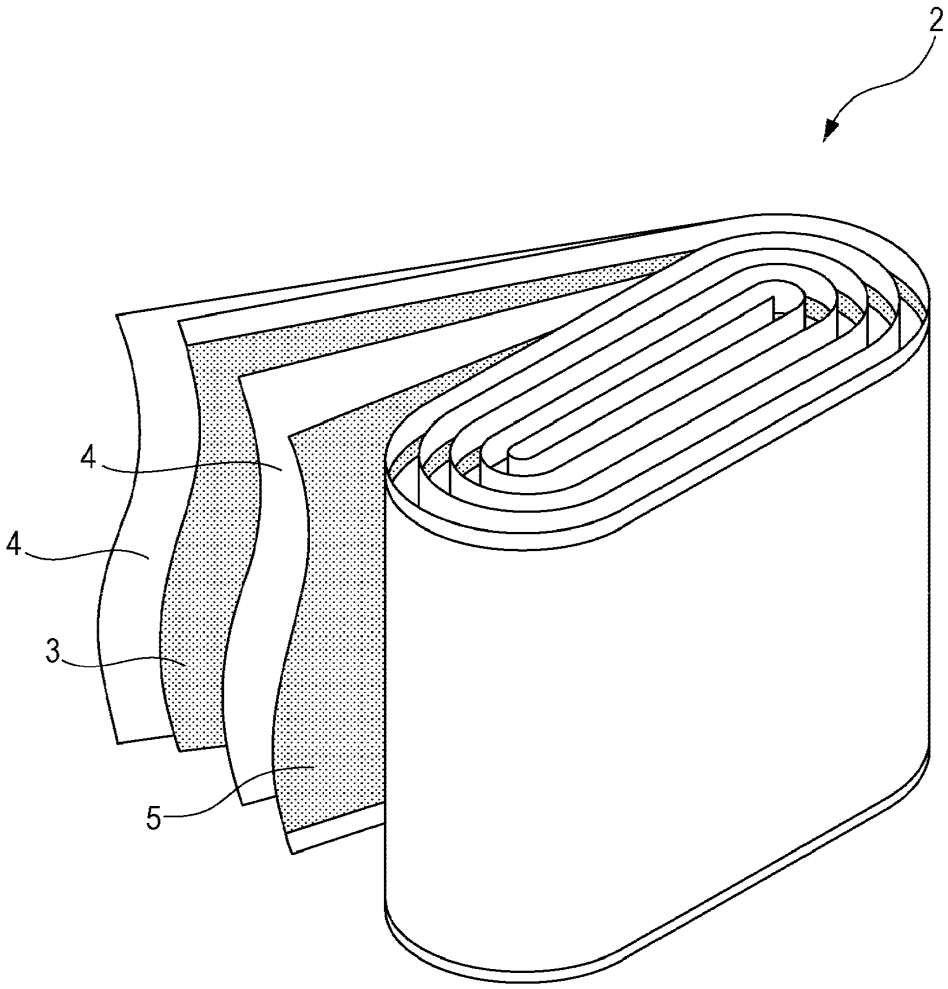


FIG. 8

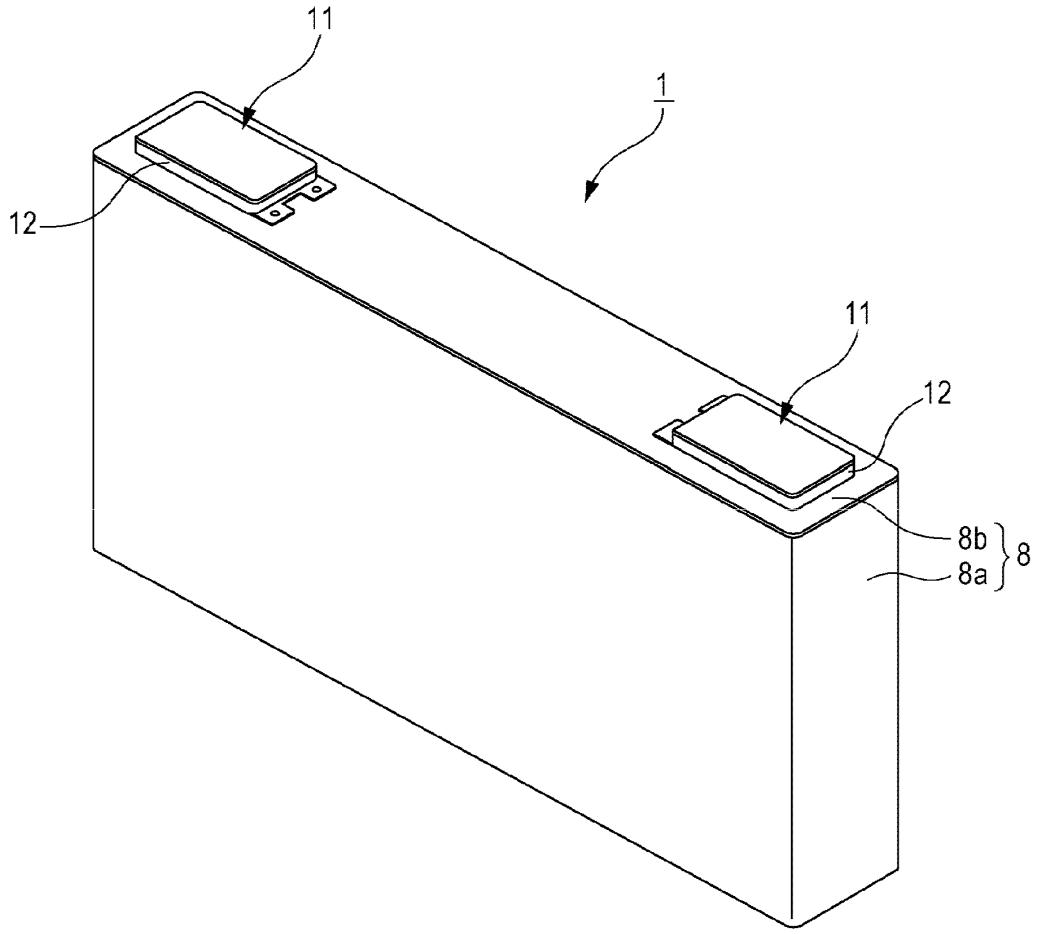


FIG. 9

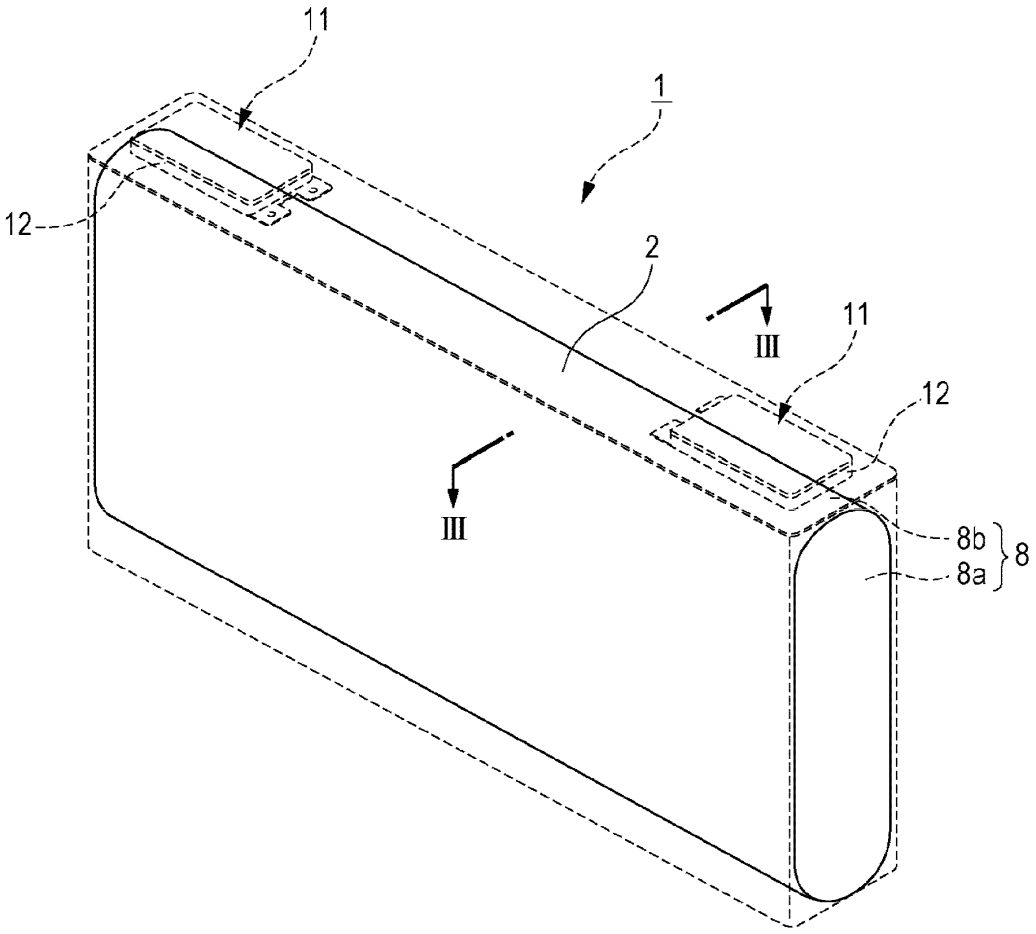


FIG. 10

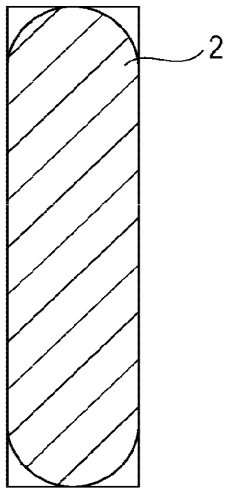


FIG. 11

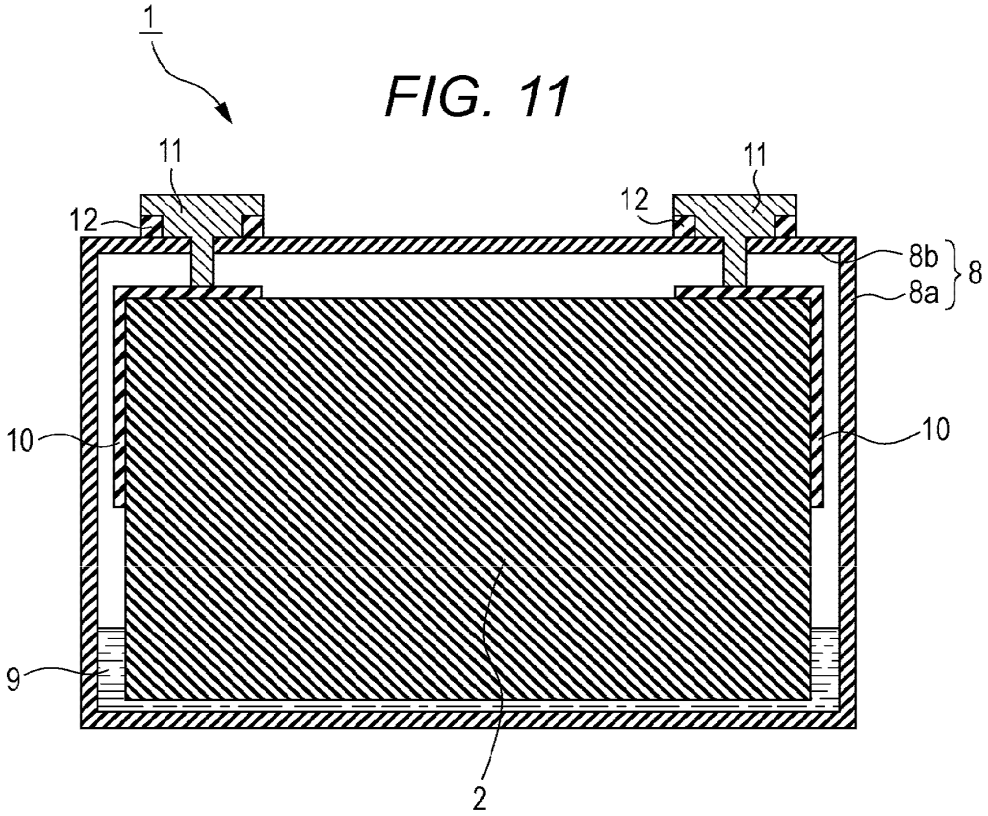
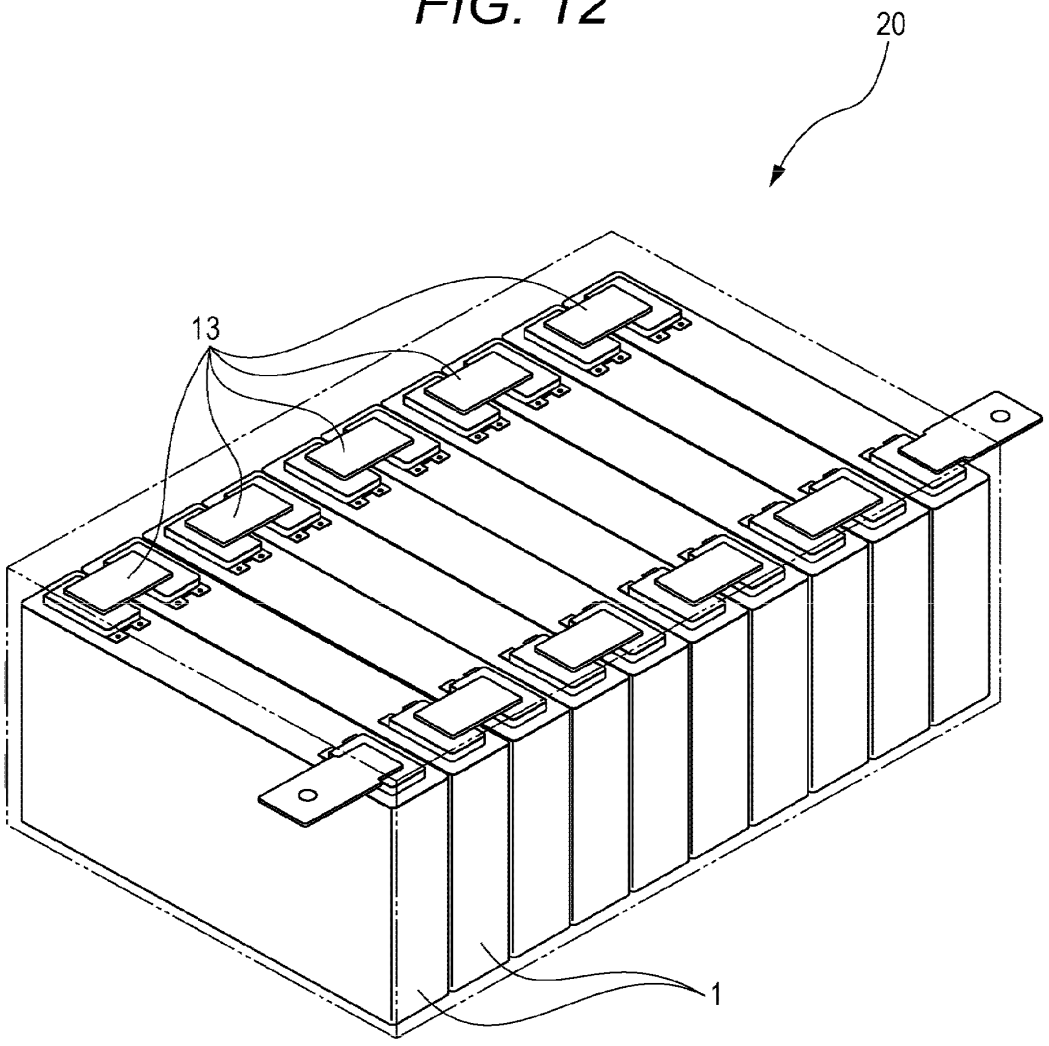


FIG. 12



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EUROPEAN SEARCH REPORT

Application Number
EP 14 19 2598

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Place of search	Date of completion of the search	Examiner
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- JP 2013045659 A **[0006]**

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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

In re U.S. Patent Application of	)	**Confirmation No. 3478**
	)	
SU et al.	)	**Art Unit 1724**
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Commissioner of Patents
P.O. Box 1450
Alexandria, VA 22313-1450

LETTER

Sir:

The below-identified communications are submitted in the above-captioned application or proceeding:

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Respectfully submitted,

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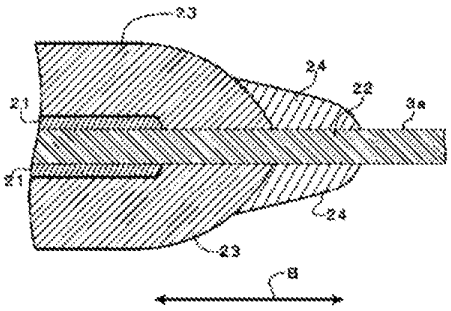
最終頁に続く

(54)【発明の名称】電池用電極の製造方法及び電池用電極

(57)【要約】
【課題】電池の電極において、箔状電極板と活物質層との間に導電体層を配置する構成としながらも、箔状電極板の撓みを可及的に抑制できるようにする。
【解決手段】導電性を有する箔状電極板２２上における、箔状電極板２２の表面を露出させる未塗工部３ａの形成位置以外の領域に、導電体層２１と活物質層２３とを順次に重ねて積層させて、電池の電極を作製する場合において、活物質層２３の形成領域における未塗工部３ａの存在側の端縁部の少なくとも一部において、上層側の活物質層２３の端縁が、下層側の導電体層２１の端縁よりも未塗工部３ａ側に位置する状態で導電体層２１と活物質層２３とを積層し、未塗工部３ａに対して、押圧力を作用させて延伸させると共に、活物質層２３を形成した領域に対して押圧力を作用させる。
【選択図】図１



【特許請求の範囲】
【請求項１】
導電性を有する箔状電極板上における、前記箔状電極板の表面を露出させる未塗工部の形成位置以外の領域に、導電体層と活物質層とを順次に重ねて積層させて、電池の電極を作製する電池用電極の製造方法であって，
前記活物質層の形成領域における前記未塗工部の存在側の端縁部の少なくとも一部において，上層側の前記活物質層の端縁が，下層側の前記導電体層の端縁よりも前記未塗工部側に位置する活物質層はみ出し部を形成する工程と、
前記はみ出し部に隣接する前記未塗工部に対して、押圧力を作用させて延伸させる未塗工部押圧工程と、
前記活物質層を形成した領域に対して押圧力を作用させる活物質層押圧工程とを有する電池用電極の製造方法。
【請求項２】
前記活物質層はみ出し部において、前記活物質層の端縁と前記導電体層の端縁との距離が２ｍｍ以下に設定されている請求項１記載の電池用電極の製造方法。
【請求項３】
前記箔状電極板は長尺帯状に形成され，前記導電体層及び前記活物質層は，前記箔状電極板の幅方向端部に前記未塗工部が位置する状態で、前記箔状電極板の長手方向に延びる帯状に形成され、
前記活物質層と前記未塗工部との境界部分の略全長に亘る範囲が前記活物質層はみ出し部として設定されている請求項１又は２記載の電池用電極の製造方法。
【請求項４】
導電性を有する箔状電極板上における、前記箔状電極板の表面を露出させる未塗工部の形成位置以外の領域に、導電体層と活物質層とが順次に重ねて積層された電池用電極であって、
前記活物質層の形成領域における前記未塗工部の存在側の端縁部の少なくとも一部において，上層側の前記活物質層の端縁が，下層側の前記導電体層の端縁よりも前記未塗工部側に位置する活物質層はみ出し部が形成され，
前記活物質層の形成領域と前記未塗工部とが、夫々延伸されている電池用電極。
【請求項５】
前記活物質層はみ出し部において、前記活物質層の端縁と前記導電体層の端縁との距離が２ｍｍ以下に設定されている請求項４記載の電池用電極。
【発明の詳細な説明】
【技術分野】
【０００１】
本発明は、導電性を有する箔状電極板上における、前記箔状電極板の表面を露出させる未塗工部の形成位置以外の領域に、導電体層と活物質層とを順次に重ねて積層させて、電池の電極を作製する電池用電極の製造方法、及び、電池用電極に関する。
【背景技術】
【０００２】
かかる電池用電極は、電池の主要部分である発電要素を構成するものであり、発電要素においては、正極側及び負極側の夫々について箔状電極板の上に活物質層を積層して電極とし、正極側の電極と負極側の電極とを、セパレータを挟んだ状態で，交互に重ねた構成とする場合が多い。
この電池用の電極においては、箔状電極板に活物質を積層する際、箔状電極板と活物質との材料の選択によっては、両者の密着性を必ずしも十分には確保できない場合もある。
このような場合、下記特許文献１に記載のように，箔状電極板と活物質層との間に、両者の密着性を改善して，接触抵抗を低減するための薄い導電体層（いわゆる、アンダーコート層）を配置する構成とすることが考えられている。
箔状電極板と活物質層との間に導電体層を配置することで，活物質層の接着強度が向上

し、電池容量や寿命特性を向上させることができる。
【０００３】
一方、上記のアンダーコート層を形成する技術とは全く別の観点から電池容量を増大させる技術として、箔状電極板に塗布等により活物質を形成した後に、活物質層の形成領域をプレス加工して、活物質層を高密度化する技術がある。
活物質層を高密度化することで，電池筐体の容積に対する活物質の内蔵量を増大させ、電池筐体の容積に対する電池容量を増大させることができるのであるが、その反面、活物質を塗布した箔状電極板が取り扱い辛いものとなってしまう不都合もある。
箔状電極板には、通常、電気配線のために活物質層を塗布していない未塗工部が形成されるが、活物質層の形成領域をプレス加工したときに、未塗工部の領域も含めてプレス加工しても、活物質層の厚みのために、未塗工部には押圧力がほとんど作用しない状態となる。
このため、活物質層の形成領域はプレス加工の押圧力によって延伸されるが、未塗工部はほとんど延伸されないことになり、この結果、箔状電極板に撓みが発生して、箔状電極板が取り扱い辛いものとなってしまうのである。
この箔状電極板の撓みを防止するために、活物質層の形成領域に対してプレス加工を行うだけでなく、未塗工部に対しても適切な押圧力が作用する状態でプレス加工を施すことで、未塗工部の延伸不足分を補償して、延伸の状態を活物質層の形成領域とバランスさせて、箔状電極板の撓みを防止する技術が考えられている。
【先行技術文献】
【特許文献】
【０００４】
【特許文献１】特開２００８－６００６０号公報
【発明の概要】
【発明が解決しようとする課題】
【０００５】
しかしながら、上述した，箔状電極板と活物質層との間に薄い導電体層を配置する技術と、活物質層の形成領域及び未塗工部の夫々に適切な押圧力が作用する状態でプレス加工を施す技術とを併用すると、電極の製造工程において弊害が発生する場合がある。
すなわち、箔状電極板への導電体層の形成態様としては，導電体層の形成目的を考慮して、上層側の活物質層の形成領域には確実に導電体層が存在するように設定され、通常、導電体層の形成領域を活物質層の形成領域よりも広くして、導電体層の形成領域に活物質層の形成領域が完全に含まれるように設定している。
従って、箔状電極板上において、活物質層を形成していない未塗工部と、活物質層の形成領域との境界部においては、下層側の導電体部分が露出している領域が存在することになる。
【０００６】
上述のように、導電体層が形成されている状態で、活物質層の形成領域に対するプレス加工と、未塗工部に対するプレス加工とを行おうとすると、導電体層は薄い層ではあっても未塗工部に比較するとある程度の厚さを有するので、未塗工部に対して有効にプレス加工を行うためには、導電体層が露出している領域を避けてプレス加工を行う必要がある。
又、活物質層の形成領域に対するプレス加工では、活物質層の形成領域と導電体層の露出領域との厚さの差によって、導電体層が露出している領域に対しては有効に押圧力が作用しないことになる。
従って，活物質層の形成領域と未塗工部との間に、プレス加工による押圧力が作用しない領域が存在することになり，プレス加工を施した活物質層の形成領域とプレス加工を施した未塗工部との間隔が必要以上に空いて、未塗工部をプレス加工する効果が著しく減殺され、箔状電極板が撓んでしまうことになる。
本発明は、かかる実情に鑑みてなされたものであって、その目的は、箔状電極板と活物質層との間に導電体層を配置する構成としながらも、箔状電極板の撓みを可及的に抑制で

きるようにする点にある。
【課題を解決するための手段】
【０００７】
本出願の第１の発明は、導電性を有する箔状電極板上における、前記箔状電極板の表面を露出させる未塗工部の形成位置以外の領域に、導電体層と活物質層とを順次に重ねて積層させて，電池の電極を作製する電池用電極の製造方法において、前記活物質層の形成領域における前記未塗工部の存在側の端縁部の少なくとも一部において、上層側の前記活物質層の端縁が、下層側の前記導電体層の端縁よりも前記未塗工部側に位置する活物質層はみ出し部を形成する工程と、前記はみ出し部に隣接する前記未塗工部に対して、押圧力を作用させて延伸させる未塗工部押圧工程と、前記活物質層を形成した領域に対して押圧力を作用させる活物質層押圧工程とを有する。
【０００８】
すなわち、箔状電極板上での、導電体層と活物質層との積層形態として、上層側の活物質層の端縁が、下層側の導電体層の端縁よりも未塗工部側に位置して，活物質層が導電体層よりも未塗工部側にはみ出す状態で積層する。
これによって、未塗工部に未塗工部押圧工程を適用して，未塗工部を延伸させる際には、導電体層の存在を気にかけることなく，活物質層の形成領域に対する活物質層押圧工程による延伸効果と的確にバランスするように未塗工部に対する押圧位置を設定することができる。
尚、活物質層における導電体層の形成領域からはみ出した部分には、箔状電極板との間に導電体層が存在しないのであるが、導電体層が存在しないからと言って、その部分が電池動作に全く寄与しない訳ではなく、多少電池容量等を低下させるに留まる。
しかも，活物質層における導電体層の形成領域からのはみ出し部分は，大面積にする必要はなく、必要最小限の面積で良いので，活物質層全体から見た電池容量の低下はわずかなものである。
【０００９】
又、本出願の第２の発明は、上記第１の発明の構成に加えて，前記活物質層はみ出し部において，前記活物質層の端縁と前記導電体層の端縁との距離が２ｍｍ以下に設定されている。
すなわち，導電体層からの活物質層のはみ出し幅を、２ｍｍ以下に設定することで，活物質層と箔状電極板との接着強度の低下を十分に抑制できることを実験により確認できた。
【００１０】
又，本出願の第３の発明は，上記第１又は第２の発明の構成に加えて、前記箔状電極板は長尺帯状に形成され，前記導電体層及び前記活物質層は，前記箔状電極板の幅方向端部に前記未塗工部が位置する状態で、前記箔状電極板の長手方向に延びる帯状に形成され、
前記活物質層と前記未塗工部との境界部分の略全長に亘る範囲が前記活物質層はみ出し部として設定されている。
すなわち、長尺帯状の箔状電極板上に，それの長手方向に延びる状態で導電体層及び活物質層を帯状に形成する場合において、箔状電極板の長手方向に延びる活物質層と未塗工部との境界部分の略全長に亘って、未塗工部を効果的に延伸させることが可能となる。
【００１１】
又、本出願の第４の発明は、導電性を有する箔状電極板上における、前記箔状電極板の表面を露出させる未塗工部の形成位置以外の領域に，導電体層と活物質層とが順次に重ねて積層された電池用電極において，前記活物質層の形成領域における前記未塗工部の存在側の端縁部の少なくとも一部において、上層側の前記活物質層の端縁が、下層側の前記導電体層の端縁よりも前記未塗工部側に位置する活物質層はみ出し部が形成され、前記活物質層の形成領域と前記未塗工部とが、夫々延伸されている。
すなわち、箔状電極板上での、導電体層と活物質層との積層形態として，上層側の活物質層の端縁が、下層側の導電体層の端縁よりも未塗工部側に位置して，活物質層が導電体

層よりも未塗工部側にはみ出す状態で積層する。
これによって、未塗工部を延伸させる際には、導電体層の存在を気にかけることなく、活物質層の形成領域に対する延伸と的確にバランスするように未塗工部に対する押圧位置を設定することができる。
【００１２】
又、本出願の第５の発明は、上記第４の発明の構成に加えて、前記活物質層はみ出し部において、前記活物質層の端縁と前記導電体層の端縁との距離が２ｍｍ以下に設定されている。
すなわち、導電体層からの活物質層のはみ出し幅を、２ｍｍ以下に設定することで、活物質層と箔状電極板との接着強度の低下を十分に抑制することができる。
【発明の効果】
【００１３】
上記第１の発明によれば、未塗工部に未塗工部押圧工程を適用して、未塗工部を延伸させる際には、導電体層の存在を気にかけることなく、活物質層の形成領域に対する活物質層押圧工程による延伸効果と的確にバランスするように未塗工部に対する押圧位置を設定することができるので、箔状電極板と活物質層との間に導電体層を配置する構成としながらも，箔状電極板の撓みを可及的に抑制できる。
又、上記第２の発明によれば、導電体層から活物質層がはみ出す構成とした場合でも、活物質層と箔状電極板との接着強度の低下を十分に抑制できる。
【００１４】
又、上記第３の発明によれば，箔状電極板を長尺帯状とした場合において、効果的に撓みを抑制することができる。
又、上記第４の発明によれば、活物質層の形成領域と未塗工部とをバランス良く延伸させることができるので、箔状電極板と活物質層との間に導電体層を配置する構成としながらも、箔状電極板の撓みを可及的に抑制できる。
又、本出願の第５の発明によれば、導電体層から活物質層がはみ出す構成とした場合でも，活物質層と箔状電極板との接着強度の低下を十分に抑制できる。
【図面の簡単な説明】
【００１５】
【図１】本発明の実施の形態にかかる要部拡大断面図
【図２】本発明の実施の形態にかかる電極箔の製造過程を示す図
【図３】本発明の実施の形態にかかる電極箔の製造過程を示す図
【図４】本発明の実施の形態にかかる電極箔の製造過程を示す図
【図５】本発明の実施の形態にかかる電極箔の製造過程を示す図
【図６】本発明の実施の形態にかかる電極箔に対するプレス加工工程の概略説明図
【図７】本発明の実施の形態にかかる電極箔に対するプレス加工を示す図
【図８】本発明の実施の形態にかかる発電要素の構成を示す斜視図
【図９】本発明の実施の形態にかかる実験データを示すグラフ
【図１０】本発明の実施の形態にかかる実験データを示すグラフ
【図１１】本発明の実施の形態にかかる電池の内部構造を示す斜視図
【図１２】本発明の実施の形態にかかる電池の外観斜視図
【図１３】本発明の別実施形態にかかる電極箔の製造過程を示す図
【図１４】剥離強度の測定方法を説明する図
【発明を実施するための形態】
【００１６】
以下、本発明の電池用正極側電極の製造方法の実施の形態を図面に基づいて説明する。
本実施の形態では、電池として二次電池の１例である非水電解液二次電池（より具体的にはリチウムイオン電池）を例示して、その製造方法を説明する。
【００１７】
〔非水電解液二次電池ＲＢの構成〕

図１２の斜視図に示すように、本実施の形態の非水電解液二次電池ＲＢは、有底筒状（より具体的には有底矩形筒状）の缶体１の開放面に蓋部２を被せて溶接して構成した電池筐体ＢＣ（以下において、単に「筐体ＢＣ」と称する）を有している。蓋部２は、短冊状の長方形の板材にて形成され、それの筐体ＢＣ外方側となる面に正極の電極端子である端子ボルト５と負極の電極端子である端子ボルト７とが取り付けられている。

缶体１は蓋部２の形状に合わせて扁平形状の直方体であり、従って、筐体ＢＣ全体としても扁平な略直方体形状を有している。

【００１８】

筐体ＢＣの内方側には、図１１において２点鎖線で示す発電要素３と集電体４，６とが電解液に浸される状態で収納配置されている。図１１は、缶体１を除いた状態で、下方側から見上げた斜視図として、筐体ＢＣの内方側を示している。

集電体４，６は，発電要素３と端子ボルト５，７とを電気的に接続するための部材であり、何れも導電体にて形成されている。

集電体４と集電体６とは、略同一形状のものが対称に配置される関係となっているが、材質が異なる。正極側の集電体４はアルミニウムにて形成され，負極側の集電体６は銅にて形成されている。

【００１９】

集電体４，６は、上記の金属材料からなる幅狭の略矩形板状部材を，所定の形状に屈曲形成して構成しており、端子ボルト５，７の配置面である蓋部２の表面に沿って延びる形状の部分と、蓋部２の長手方向端部付近で下方側（端子ボルト５，７の存在側と反対側）へ９０度屈曲して、蓋部２の筐体ＢＣ内方側の面の法線方向に延びる部分とが連なる略Ｌ字状の屈曲形状を有している。集電体４，６の縦姿勢部分において、更に発電要素３側に屈曲させて、発電要素３と接続するための接続部４ａ，６ａが形成されている。

略Ｌ字状の集電体４，６は，蓋部２と，その蓋部２の長手方向の端部に直交姿勢で連なる缶体１の幅狭の側面とに沿う姿勢で配置されている。

【００２０】

発電要素３は，詳しくは後述するが，何れも導電性を有する材料で長尺帯状の形状に形成された正極側の箔状電極板（以下において，「箔状正極板」と称する）及び負極側の箔状電極板（以下において、「箔状負極板」と称する）の夫々に活物質を塗布して正極側電極及び負極側電極を作製し、それらを同じく長尺のセパレータを挟んで積層状態で巻回した、いわゆる巻回型の発電要素として構成されている。

発電要素３は、上記のように巻回した状態で、正極側電極の未塗工部３ａ（正極活物質が塗布されずに箔状正極板が露出している部分）が側方（箔状正極板の長手方向と直交する方向）に突出し、負極側電極の未塗工部３ｂ（負極活物質が塗布されずに箔状負極板が露出している部分）が反対側の側方（箔状負極板の長手方向と直交する方向）に突出している。

本実施の形態の発電要素３は、扁平形状に正極側電極及び負極側電極等を巻回して，扁平形状の筐体ＢＣに適合させている。

発電要素３の缶体１内での配置姿勢は，正極側電極等の巻回軸心が蓋部２の長手方向と平行となる姿勢としており、図１１に概略的に示すように，正極側電極の未塗工部３ａの位置に集電体４の接続部４ａが入り込み，負極側電極の未塗工部３ｂの位置に集電体６の接続部６ａが入り込む位置関係としている。

正極側電極の未塗工部３ａは束ねられた状態で集電体４の接続部４ａに溶接され、負極側電極の未塗工部３ｂは束ねられた状態で集電体６の接続部６ａに溶接され，集電体４，６で発電要素３を支持している。

【００２１】

上述のように金属製（具体的には、アルミニウム製）の蓋部２に取り付けられている正極側の端子ボルト５は正極側の集電体４に電気的に接続され、負極側の端子ボルト７は負極側の集電体６に電気的に接続されている。

正極側の集電体４は、端子ボルト５の頭部側に一体形成されているリベット８を経て端

子ボルト５に電気的に接続され、リベット８は，集電体４，集電体４及びリベット８と蓋部２との間の電気的絶縁のための下部ガスケット１２，蓋部２，リベット８を含む端子ボルト５と蓋部２との間の電気的絶縁のための上部ガスケット１１を貫通した状態で、筐体ＢＣ内方側端部でかしめられ、これによって集電体４を蓋部２に固定している。

負極側も同様の構成であり，負極側の集電体６は，端子ボルト７の頭部側に一体形成されているリベット１５を経て端子ボルト７に電気的に接続され、リベット１５は、集電体６，集電体６及びリベット１５と蓋部２との間の電気的絶縁のための下部ガスケット１８，蓋部２，リベット１５を含む端子ボルト７と蓋部２との間の電気的絶縁のための上部ガスケット１７を貫通した状態で，筐体ＢＣ内方側端部でかしめられ，これによって集電体６を蓋部２に固定している。

上部ガスケット１１，１７及び下部ガスケット１２，１８は、蓋部２と蓋部２を貫通するリベット８，１５との間の気密シールの機能も果たしている。

【００２２】

〔非水電解液二次電池ＲＢの製造工程〕

次に、上記構成の二次電池ＲＢの製造工程を、発電要素３の電極板の製造工程を主体に説明する。

〔正極側電極の製造工程〕

先ず、発電要素３の正極側電極の製造工程について説明する。

正極側電極は、上述のように、箔状正極板に正極活物質を塗布して作製しており、本実施の形態では，耐酸化性に優れるアルミニウム箔を箔状正極板として用いる。本実施の形態では，このアルミニウム箔は，幅が１６０ｍｍの長尺帯状に形成しており、アルミニウム箔の厚さは１２μｍ～２５μｍで良いが、１５μｍの厚さとすることが好適である。アルミニウム箔以外では，チタン、ステンレス鋼，ニッケル及び導電性高分子等を箔状に形成して箔状正極板として用いることができる。

上記の箔状正極板に塗布する正極活物質は、本実施の形態では、リン酸鉄リチウム（ＬｉＦｅＰＯ$_4$）を使用しており、それとの関係で、箔状正極板と正極活物質層との間に、正極活物質層の付着強度を向上させて接触抵抗の低減等を図るための導電体層（いわゆる、「アンダーコート層」）を塗布しており、導電体層と正極活物質層とを順次に重ねて積層させている。

本実施の形態では、この導電体層を形成するための塗布剤として、アセチレンブラック１０重量％，グリセル化キトサン４．５重量％，ピロリメット酸４．５重量％及びＮＭＰ（Ｎ－メチル－２－ピロリドン）８１重量％を混合してスラリー状としたものを使用しており、この塗布剤を箔状正極板の表裏両面に塗布する。

【００２３】

図２（ａ）に、箔状正極板であるアルミニウム箔２２の表面に導電体層２１を形成した状態を、平面視で示す。

図２（ａ）において、矢印Ｂは長尺帯状のアルミニウム箔２２の幅方向を示しており、その幅方向両端部に上記の未塗工部３ａとなるエリアが設定されている。導電体層２１は、その未塗工部３ａの形成位置以外の幅方向中央領域において，アルミニウム箔２２の長手方向（図２（ａ）において、矢印Ａで示す方向）に延びる帯状に形成されている。幅方向両端部の導電体層２１が形成されない部分の幅（アルミニウム箔２２の幅方向での長さ）は、本実施の形態では，夫々１０ｍｍに設定している。

尚、図２（ｂ）は、後工程での処理状態との対比のために、図２（ａ）において２点鎖線Ｄで囲んで概略的な位置を示す部分の拡大図を示すものである。

アルミニウム箔２２は長尺帯状であり、ロール状に巻き取られた状態のアルミニウム箔２２を、アルミニウム箔２２の長手方向（図２（ａ）において、矢印Ａで示す方向）に送り搬送して、搬送されるアルミニウム箔２２上に、グラビアコートにより導電体層２１を塗布する。導電体層２１の塗布厚は、本実施の形態では、乾燥後に導電体層２１の厚さが１μｍ～２μｍとなるように設定している。

本実施の形態では，２条分の正極側電極を同時処理で作製する。すなわち、アルミニウ

ム箔２２は、幅方向（図２（ａ）において、矢印Ｂで示す方向）の長さが、正極側電極の幅の２倍の幅であり、正極側電極の製造工程の最終工程で、図２において１点鎖線Ｃで示す幅方向中央位置で切断して、２条分の正極側電極に分離する。

導電体層２１の塗布位置は、アルミニウム箔２２の幅方向（矢印Ｂで示す方向）端縁位置を光学的に検出して、その位置情報に基づいて、アルミニウム箔２２の幅方向中央位置と、導電体層２１の塗布幅の中央位置とが一致するように，高精度に制御されている。

導電体層２１は、塗布後に乾燥処理される。

以上の導電体層２１の塗布工程を、アルミニウム箔２２の反対側の面でも繰り返す。

【００２４】

導電体層２１が塗布され，更に、乾燥された後、次に、導電体層２１の上に塗り重ねる状態で活物質層と短絡防止層とを塗布する。

本実施の形態では、上述のように、正極活物質としてリン酸鉄リチウム（ＬｉＦｅＰＯ$_4$）を使用している。

短絡防止層は、発電要素３として組み立てたときに，正極側電極において、正極活物質が塗布されていない部分のうち、負極側電極の負極活物質層と対向する部分に塗布形成することで、正極側電極の未塗工部３ａと負極側電極とが対向してしまうことのないようにするためのものである。短絡防止層を備えることによって、異物等の侵入によってセパレータが破られたような場合でも、負極活物質層と箔状正極板とが接触して発熱等の事象が発生してしまことを防止できる。

この短絡防止層は正極活物質層の塗布後に塗布するのであるが、正極活物質層の塗布と短絡防止層の塗布とを一連に行い、正極活物質層が乾燥していない状態で短絡防止層を塗布している。このようにすることで、短絡防止層の剥離強度を高めることができる。

【００２５】

先ず、正極活物質層の塗布について説明する。

正極活物質層は、マイクロサイズ粒子のＬｉＦｅＰＯ$_4$の粉体８７重量％と、導電助剤であるアセチレンブラック５重量％と、結着剤であるポリフッ化ビリニデン（ＰＶＤＦ）８重量％との混合物に、ＮＭＰ（Ｎ－メチル－２－ピロリドン）を加えてペースト状とした正極合剤ペーストを，導電体層２１が塗布されたアルミニウム箔２２の表裏両面に塗布して，導電体層２１とアルミニウム箔２２の積層構造を形成する。

尚、上記のマイクロサイズ粒子のＬｉＦｅＰＯ$_4$は、Ｄ５０（メディアン径）が２０μｍのものを使用しており、全てのＬｉＦｅＰＯ$_4$粒子は，層厚が約１ｎｍのカーボンコート層で被覆されている。ＬｉＦｅＰＯ$_4$粒子の粒子径には、このカーボンコート層も含めている。

塗布の工程は，導電体層２１の塗布工程と同様であり、導電体層２１を形成したアルミニウム箔２２を、それの長手方向に送り搬送して、搬送されるアルミニウム箔２２の導電体層２１の上に上記のペーストをダイコートにより塗布することで、アルミニウム箔２２の長手方向に延びる帯状の正極活物質層２３を形成し、図３（ａ）に示す状態とする。

正極活物質層２３は、図３（ａ）に示すように、アルミニウム箔２２の長手方向（図３（ａ）において，矢印Ａで示す方向）に延びる帯状に塗布している。正極活物質層２３の塗布厚は，４０μｍ～１３０μｍで良く、本実施の形態では１３０μｍとしている。

正極活物質層２３の塗布位置は、アルミニウム箔２２の幅方向（図３（ａ）において，矢印Ｂで示す方向）端縁位置あるいは導電体層２１の幅方向端縁位置を光学的に検出して、その位置情報に基づいて、アルミニウム箔２２や導電体層２１の幅方向中央位置と、正極活物質層２３の塗布幅の中央位置とが一致するように高精度に制御されている。

【００２６】

正極活物質層２３の塗布幅（図３（ａ）において，矢印Ｂで示す方向での塗布幅）は、アルミニウム箔２２の幅方向両端部に未塗工部３ａとなるアルミニウム箔２２の露出領域が位置する状態で、導電体層２１を完全に覆う塗布幅に設定している。

図３（ａ）における２点鎖線Ｄで囲む領域付近を拡大したものを、図２（ｂ）と対応させて、図３（ｂ）に示している。

図２（ｂ）における導電体層２１の端縁を、図３（ｂ）において破線Ｅで示しており、上層側の正極活物質層２３の幅方向（矢印Ｂで示す方向）の端縁は、破線Ｅで示す下層側の導電体層２１の端縁よりも、未塗工部３ａとなるアルミニウム箔２２が露出する領域側に位置して、正極活物質層２３が導電体層２１からはみ出している。

説明の便宜上，この正極活物質層２３が導電体層２１の形成位置からアルミニウム箔２２の露出領域側へはみ出している部分を「活物質層はみ出し部」と称する場合がある。

本実施の形態では、アルミニウム箔２２の長手方向において、導電体層２１及び正極活物質層２３の塗布範囲の全長に亘って、正極活物質層２３が導電体層２１からはみ出しており、正極活物質層と未塗工部との境界部分の略全長に亘る範囲が前記活物質層はみ出し部として設定されている。

アルミニウム箔２２の幅方向（矢印Ｂで示す方向）における、正極活物質層２３の端縁位置と導電体層２１の端縁位置（破線Ｅで示す位置）との距離Ｗ（図３（ｂ）参照）は、２ｍｍ以下となるように、正極活物質層２３の塗布幅を設定している。

【００２７】

正極活物質層２３の塗布後、同一の搬送経路において、引き続いて短絡防止層の塗布を行う。

短絡防止層は，電気的絶縁部材の微粒子を結着剤と混合し、更に、それを適宜の液体と混合してペースト状として、正極活物質層２３が塗布されたアルミニウム箔２２の表裏両面に塗布する。

上記の電気的絶縁部材の微粒子としては、Al_2O_3，SiO_2，ZrO_2，TiO_2，ＭｇＯ等の無機粒子の他、ポリイミド粉末等の有機粒子を用いることができる。これらのうち、安定性や取り扱いの容易さ等から、Al_2O_3を使用するのが好ましく、特に，箔状正極板との密着性や接合強度等の観点からγ型アルミナ粒子が好ましい。

上記微粒子の粒径は、一次粒径の中央値で１ｎｍ～２０００ｎｍのものが使用できるが，箔状正極板と密着性や接合強度の観点からは、１ｎｍ～２００ｎｍのものを使用するのが好ましく、１ｎｍ～２０ｎｍであることが更に好ましい。

電気的絶縁部材の微粒子と混合する結着剤としては、ポリフッ化ビリニデン（ＰＶＤＦ），ポリイミド，ポリアミドイミド等を用いることができるが、箔状正極板との密着性や接合強度の観点からは、ＰＶＤＦを用いることが好ましい。

本実施の形態では、粒径５ｎｍ，比表面積９６m^2／ｇ，タップ密度０．０４ｇ／cm^3のγ型アルミナ粒子２．１ｋｇを、結着剤であるＰＶＤＦを１２％含有したＮＭＰ溶液２１．３９ｇ（ＰＶＤＦ量として２．５６７ｋｇ）をＮＭＰ６．０ｋｇに溶解した液に混合し、均一に分散させて、スラリー状の短絡防止剤ペーストとした。

短絡防止層２４の構成材料としては、上述のような電気的絶縁部材である必要は必ずしもないが，十分に電気抵抗が高いことが必要であり、少なくともアルミニウム箔２２よりも電気抵抗の大きくなければ意味がない。

【００２８】

塗布の工程は、正極活物質層２３等の塗布工程と同様であり、正極活物質層２３等が塗布された状態で送り搬送されているアルミニウム箔２２に対して、ダイコートにより短絡防止層２４を塗布し，図４（ａ）に示す状態とする。

図４（ｂ）は，図２（ｂ）及び図３（ｂ）と対応させて、図４（ａ）において２点鎖線Ｄで示す領域付近を拡大して示している。

短絡防止層２４の塗布位置は、アルミニウム箔２２の幅方向（図４（ａ）において、矢印Ｂで示す方向）における正極活物質層２３の両端位置において、正極活物質層２３の端縁に重なると共に、正極活物質層２３の端縁からアルミニウム箔２２の露出部分側へ設定幅の範囲に亘る状態で、アルミニウム箔２２の長手方向（図４（ａ）において，矢印Ａで示す方向）に延びる帯状に塗布している。

【００２９】

正極活物質層２３と短絡防止層２４との境界付近を、アルミニウム箔２２の長手方向視の拡大断面図として示す図１に示すように、短絡防止層２４は、正極活物質層２３と未塗

Abstract of JP2013051040A

PROBLEM TO BE SOLVED: To enable flexure of a foil like electrode plate to be suppressed as much as possible in an electrode for a battery while a conductive layer is arranged between the foil like electrode plate and the active material layer. SOLUTION: When the electrode for the battery is manufactured by laminating the conductive layer 21 and the active material layer 23 in order in a region other than a formation region of an uncoated part 3a which causes a surface of a foil like electrode plate 22 having conductivity to be exposed, the conductive layer 21 and the active material layer 23 are laminated in the state that an end edge of the active material layer 23 of an upper layer side is positioned closer to the uncoated part 3a side than an end edge of the conductive layer 21 of a lower layer side, in at least a part of end edge parts in the formation region of the active material layer 23 at an existing side of the uncoated part 3a, and then the uncoated part 3a is subjected to pressing force to be extended as well as the formation region of the active material layer 23 being subjected to pressing force.

PTO/SB/06 (09-11)
Approved for use through 1/31/2014. OMB 0651-0032
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE
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PATENT APPLICATION FEE DETERMINATION RECORD Substitute for Form PTO-875	Application or Docket Number 16/298,738	Filing Date 03/11/2019	☐ 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

		(Column 1)		(Column 2)	(Column 3)			
AMENDMENT	09/08/2020	CLAIMS REMAINING AFTER AMENDMENT		HIGHEST NUMBER PREVIOUSLY PAID FOR	PRESENT EXTRA		RATE ($)	ADDITIONAL FEE ($)
	Total (37 CFR 1.16(i))	* 19	Minus	** 20	= 0		x $100 =	0
	Independent (37 CFR 1.16(h))	* 3	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

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

* If the entry in column 1 is less than the entry in column 2, write "0" in column 3.	LIE
** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 20, enter "20".	/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.

Electronic Acknowledgement Receipt

EFS ID:	40496615
Application Number:	16298738
International Application Number:	
Confirmation Number:	3478
Title of Invention:	CATHODE, ELECTROCHEMICAL DEVICE AND ELECTRONIC DEVICE COMPRISING SAME
First Named Inventor/Applicant Name:	Xinru SU
Customer Number:	38327
Filer:	Juan Carlos A. Marquez
Filer Authorized By:	
Attorney Docket Number:	LEEL-0101
Receipt Date:	08-SEP-2020
Filing Date:	11-MAR-2019
Time Stamp:	17:10:53
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	Transmittal Letter	LEEL-101_Claim_calculation_Response_OA_06092020.pdf	216117 d7a0d34735c5704802346f6159f48798c3b70dd4	no	2
Warnings:					

Information:					
2	Amendment/Req. Reconsideration-After Non-Final Reject	LEEL-101_Response_OA_06092020.pdf	304232 faf3ff370f230956a25a3fdf2bfce88c0cf9e2bd	no	8
Warnings:					
Information:					
			Total Files Size (in bytes):	520349	

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

In re U.S. Patent Application of	)	**Confirmation No. 3478**
	)	
SU et al.	)	
	)	**Art Unit 1724**
Application Number: 16/298,738	)	
	)	
Filed: March 11, 2019	)	**Examiner:**
	)	**Victoria Hom Lynch**
For: CATHODE ELECTROCHEMICAL DEVICE AND ELECTRONIC DEVICE COMPRISING THE SAME	)	
	)	
Attorney Docket No. LEEL-0101	)	

Mail Stop Amendment
Commissioner of Patents
P.O. Box 1450
Alexandria, VA 22313-1450

COVER LETTER

Sir:

[x] The fee for submission of claims is calculated as shown below:

FOR	TOTAL WITH NEW CLAIMS ADDED	TOTAL CURRENTLY ON FILE	CLAIMS ALREADY PAID	RATE	CALCULATION
Total Claims	19	20	(Over 20)	x $100	0
Independent Claims	3	3	(Over 3)	x $460	0
Multiple Dependent Claim(s)				+ $820	0
REDUCTION FOR FILING BY SMALL ENTITY (note 37 C.F.R. §§ 1.9, 1.27, 1.28).				x ½	
			TOTAL		$0

In addition, the below-identified communications are submitted in the above-captioned application or proceeding:

[x] Response to Non-Final Office Action (with claim amendments and arguments)
[ ] Terminal Disclaimer
[ ] Information Disclosure Statement
[ ] ___ sheet of replacement drawings
[ ] Other:

[ ] Applicant(s) hereby request and petition that the time for taking action in this case be extended pursuant to 37 C.F.R. § 1.136(a) for:

[ ] **one (1) month** [ ] **two (2) months** [ ] **three (3) months**

The fee set in 37 C.F.R. § 1.17 for the extension of time is **$**_____ for a large/small entity.

[ ] Payment of **$**_____ is made by Deposit Account via the EFS payment system.

[X] The Commissioner is hereby authorized to charge any additional fees associated with this communication, including fees under 37 C.F.R. § 1.16 and 1.17, or credit any overpayment to **Deposit Account Number 60-0155**.

Respectfully submitted,

/juan.carlos.a.marquez/

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September 8, 2020

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re U.S. Patent Application of	)	**Confirmation No. 3478**
	)	
SU et al.	)	
	)	**Art Unit 1724**
Application Number: 16/298,738	)	
	)	
Filed: March 11, 2019	)	**Examiner:**
	)	**Victoria Hom Lynch**
For: CATHODE ELECTROCHEMICAL DEVICE AND ELECTRONIC DEVICE COMPRISING THE SAME	)	
	)	
Attorney Docket No. LEEL-0101	)	

Mail Stop Amendment
Commissioner of Patents
P.O. Box 1450
Alexandria, VA 22313-1450

RESPONSE AND AMENDMENT UNDER 37 C.F.R. § 1.111

Sir:

This is in response to the Office Action mailed on June 9, 2020, the period of response to which is set to expire on September 9, 2020. Please amend and reconsider the above-referenced application as follows:

IN THE CLAIMS:

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

1. (Currently amended) A cathode, comprising:

a cathode current collector, having a first surface;

a first cathode active material layer, comprising a first cathode active material;

a second cathode active material layer, comprising a second cathode active material; and

an insulating layer, wherein

the first cathode active material layer is disposed between the cathode current collector and the second cathode active material layer and covers a first portion of the first surface of the cathode current collector, and the insulating layer covers a second portion of the first surface of the cathode current collector that is different from the first portion,

wherein a thickness of the insulating layer is greater than a thickness of the first cathode active material layer.

2. (Original) The cathode according to claim 1, wherein a first distance exists between the insulating layer and the first cathode active material layer in a longitudinal direction of the cathode current collector, a second distance exists between the insulating layer and the second cathode active material layer in the longitudinal direction of the cathode current collector; and the first distance and the second distance are respectively greater than or equal to 0 and the second distance is less than or equal to the first distance.

3. (Currently amended) The cathode according to claim 1, wherein the second cathode active material layer completely covers [[the]] a surface of the first cathode active material layer.

4. (Original) The cathode according to claim 2, wherein the first distance is from about 0 mm to about 83 mm.

5. (Original) The cathode according to claim 1, wherein the thickness of the first cathode active material layer is from about 0.1 μm to about 20 μm.

6. (Cancelled).

7. (Original) The cathode according to claim 1, wherein the first cathode active material and the second cathode active material are each independently selected from the group consisting of lithium cobaltate, lithium iron phosphate, lithium manganese iron phosphate, sodium iron phosphate, lithium vanadium phosphate, sodium vanadium phosphate, oxy-lithium-vanadium phosphate, oxy-sodium-vanadium phosphate, lithium vanadate, lithium manganate, lithium nickelate, lithium nickel cobalt manganese oxide, lithium-rich manganese-based material, lithium nickel cobalt aluminum oxide, lithium titanate and combinations thereof.

8. (Original) The cathode according to claim 1, wherein the first cathode active material layer and the second cathode active material layer each further comprise a binder and a conductive agent, wherein the binder is selected from the group consisting of polyvinylidene fluoride, a vinylidene fluoride-hexafluoropropylene copolymer, polyamide, polyacrylonitrile, polyacrylate ester, polyacrylic acid, polyacrylate salt, sodium carboxymethyl cellulose, polyvinylpyrrolidone, polyvinyl ether, polymethyl methacrylate, polytetrafluoroethylene, polyhexafluoropropylene, styrene butadiene rubber and combinations thereof; and

the conductive agent is selected from the group consisting of carbon nanotubes, conductive carbon black, acetylene black, graphene, Ketjen black, carbon fibers and combinations thereof.

9. (Original) The cathode according to claim 1, wherein the insulating layer comprises at least one of inorganic particles and a polymer, wherein the inorganic particles are selected from the group consisting of aluminum oxide, silicon dioxide, magnesium oxide, titanium oxide, hafnium oxide, tin oxide, cerium dioxide, nickel oxide, zinc oxide, calcium oxide, zirconium dioxide, yttrium oxide, silicon carbide, boehmite, aluminum hydroxide,

magnesium hydroxide, calcium hydroxide, barium sulfate and combinations thereof; and

the polymer is selected from the group consisting of a homopolymer of vinylidene fluoride, a copolymer of vinylidene fluoride, a copolymer of hexafluoropropylene, polystyrene, polyphenylacetylene, sodium poly(vinyl acid), potassium poly(vinyl acid), polymethyl methacrylate, polyethylene, polypropylene, polytetrafluoroethylene and combinations thereof.

10. (Currently amended) An electrochemical device, comprising an anode, a separator and a cathode, wherein the cathode comprises a cathode current collector, having a first surface; a first cathode active material layer, comprising a first cathode active material; a second cathode active material layer, comprising a second cathode active material; and an insulating layer, wherein the first cathode active material layer is disposed between the cathode current collector and the second cathode active material layer and covers a first portion of the first surface of the cathode current collector, and the insulating layer covers a second portion of the first surface of the cathode current collector that is different from the first portion,

wherein a thickness of the insulating layer is greater than a thickness of the first cathode active material layer; and

the separator is disposed between the anode and the cathode, and the anode, the separator, and the cathode are wound to form an electrode assembly.

11. (Original) The electrochemical device according to claim 10, wherein a first distance exists between the insulating layer and the first cathode active material layer in a longitudinal direction of the cathode current collector, a second distance exists between the insulating layer and the second cathode active material layer in the longitudinal direction of the cathode current collector; and the first distance and the second distance are respectively greater than or equal to 0 and the second distance is less than or equal to the first distance.

12. (Original) The electrochemical device according to claim 11, wherein the first distance and the second distance are disposed at a corner of the electrode assembly.

13. (Currently amended) The electrochemical device according to claim 10, wherein [[the]] a thickness D of the electrode assembly is from about 1.5 mm to about 50 mm.

14. (Original) The electrochemical device according to claim 11, wherein the first distance between the insulating layer and the first cathode active material layer in the longitudinal direction of the cathode current collector satisfies the following formula:

$$0 \leq \text{the first distance} \leq \frac{\pi}{2}D + 4\text{mm}.$$

15. (Original) The electrochemical device according to claim 11, wherein the second distance between the insulating layer and the second cathode active material layer in the longitudinal direction of the cathode current collector satisfies the following formula:

$$0 \leq \text{ the second distance } \leq \frac{\pi}{2}D + 4\text{mm}.$$

16. (Currently amended) An electronic device, comprising an electrochemical device, wherein the electrochemical device comprises an anode, a separator and a cathode, wherein the cathode comprises a cathode current collector, having a first surface; a first cathode active material layer, comprising a first cathode active material; a second cathode active material layer, comprising a second cathode active material; and an insulating layer, wherein the first cathode active material layer is disposed between the cathode current collector and the second cathode active material layer and covers a first portion of the first surface of the cathode current collector, and the insulating layer covers a second portion of the first surface of the cathode current collector that is different from the first portion,

wherein a thickness of the insulating layer is greater than a thickness of the first cathode active material layer; and

the separator is disposed between the anode and the cathode, and the anode, the separator, and the cathode are wound to form an electrode assembly.

17. (Original) The electronic device according to claim 16, wherein a first distance exists between the insulating layer and the first cathode active material layer in a longitudinal

direction of the cathode current collector, a second distance exists between the insulating layer and the second cathode active material layer in the longitudinal direction of the cathode current collector; and the first distance and the second distance are respectively greater than or equal to 0 and the second distance is less than or equal to the first distance.

18. (Original) The electronic device according to claim 17, wherein the first distance and the second distance are disposed at a corner of the electrode assembly.

19. (Currently amended) The electronic device according to claim 16, wherein [[the]] a thickness D of the electrode assembly is from about 1.5 mm to about 50 mm.

20. (Currently amended) The [[e]] electronic device according to claim 17, wherein the first distance between the insulating layer and the first cathode active material layer in the longitudinal direction of the cathode current collector satisfies the following formula:

$$0 \leq \text{the first distance} \leq \frac{\pi}{2}D + 4\text{mm}; \text{ and}$$

the second distance between the insulating layer and the second cathode active material layer in the longitudinal direction of the cathode current collector satisfies the following formula:

$$0 \leq \text{ the second distance } \leq \frac{\pi}{2}D + 4\text{mm}.$$

REMARKS

The above amendments to the above-captioned application along with the following remarks are being submitted as a full and complete response to the Office Action dated June 9, 2020 (USPTO Paper No. 20200602). In view of the above amendments and the following remarks, the Examiner is respectfully requested to give due reconsideration to this application, to indicate the allowability of the claims, and to pass this case to issue.

Status of the Claims

As outlined above, Claims 1-5 and 7-20 stand for consideration in this application, wherein Claims 1, 3, 10, 13, 16 and 19-20 are being amended to more particularly point out and distinctly claim the subject invention; Claim 6 is being canceled without prejudice or disclaimer. Any and all amendments to the specification and/or to the claims are fully supported throughout the disclosure of the invention. Applicant submits that no new matter is being introduced into this application through the submission of this response.

Formality Objections and Rejections

The Examiner objected to Claim 20 for a minor drafting error. Further, Claims 3, 5, 6, 13 and 19 were rejected under 35 U.S.C §112(b) or 35 U.S.C §112(pre-AIA), as allegedly being indefinite for failing to particularly point out and distinctly claim the subject matter.

As outlined above, the claims are being amended to more particularly point out and distinctly claim the subject invention. As such, Applicant will submit that the Examiner's formality objection and rejection have been obviated and/or rendered moot.

Prior Art Rejections

Claims 1-4, 7 and 8 were rejected under 35 U.S.C §102(a)(1) as allegedly being anticipated by Tanaka *et al.* (U.S. Patent Publication No. 2016/0294015). Claim 5 was rejected under 35 U.S.C §103 as allegedly being unpatentable over Tanaka *et al.* Claim 9 was rejected under 35 U.S.C §103 as allegedly being unpatentable over Tanaka *et al.*, and further in view of Yamafuku *et al.* (U.S. Patent Publication No. 2015/0147624). Claims 10-13 and 15-19 were rejected under 35 U.S.C §103 as allegedly being unpatentable over Tanaka *et al.*, in view of Yamafuku *et al.*

(U.S. Patent Publication No. 2015/0147624). Applicant has reviewed the above-noted rejections and hereby respectfully traverses.

Applicant respectfully submits that the above-noted rejections have been obviated and/or rendered moot by the amendment of Claims 1, 10 and 16 incorporating the subject matter previous recited in Claim 6 that was indicated as allowable. See *Office Action*, pages 16-17.

Claims 1, 10 and 16 are thus allowable. Since Claims 2-5, 7-9, 11-15 and 17-20 directly or indirectly depend from Claims 1, 10 or 16 and recite additional features therefore, these dependent claims are patentable over the cited references.

Conclusion

In view of all the above, Applicant respectfully submits that certain clear and distinct differences as discussed exist between the present invention as now claimed and the prior art as a whole. These differences are more than sufficient that the present invention as now claimed would not have been anticipated nor rendered obvious given the prior art. Rather, the present invention as a whole is distinguishable, and thereby allowable over the prior art.

Favorable reconsideration of this application as amended is respectfully solicited. Should there be any outstanding issues requiring discussion that would further the prosecution and allowance of the above-captioned application, the Examiner is invited to contact the Applicant's undersigned representative at the address and phone number indicated below.

Respectfully submitted,

/juan.carlos.a.marquez/

Juan Carlos A. Marquez
Registration Number 34,072

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Customer No. 38327

September 8, 2020

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

NOTICE OF ALLOWANCE AND FEE(S) DUE

38327 7590 10/30/2020

Juan Carlos A. Marquez
Marquez Intellectual Property Law Office PLLC
1629 K Street, NW
Suite 300
Washington, DC 20006

EXAMINER
LYNCH, VICTORIA HOM

ART UNIT	PAPER NUMBER
1724	

DATE MAILED: 10/30/2020

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
16/298,738	03/11/2019	Xinru SU	LEEL-0101	3478

TITLE OF INVENTION: CATHODE, ELECTROCHEMICAL DEVICE AND ELECTRONIC DEVICE COMPRISING SAME

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	02/01/2021

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

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

HOW TO REPLY TO THIS NOTICE:

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

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

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

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

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

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

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

PART B - FEE(S) TRANSMITTAL

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

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

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

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

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

38327 7590 10/30/2020

Juan Carlos A. Marquez
Marquez Intellectual Property Law Office PLLC
1629 K Street, NW
Suite 300
Washington, DC 20006

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.
16/298,738	03/11/2019	Xinru SU	LEEL-0101	3478

TITLE OF INVENTION: CATHODE, ELECTROCHEMICAL DEVICE AND ELECTRONIC DEVICE COMPRISING SAME

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	02/01/2021

EXAMINER	ART UNIT	CLASS-SUBCLASS
LYNCH, VICTORIA HOM	1724	429-405000

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 _____
2 _____
3 _____

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

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

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

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

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

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

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

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

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

❑ Applicant certifying micro entity status. See 37 CFR 1.29

❑ Applicant asserting small entity status. See 37 CFR 1.27

❑ Applicant changing to regular undiscounted fee status.

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

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

Authorized Signature _____ Date _____

Typed or printed name _____ Registration No. _____

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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
16/298,738	03/11/2019	Xinru SU	LEEL-0101	3478

38327 7590 10/30/2020

Juan Carlos A. Marquez
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1629 K Street, NW
Suite 300
Washington, DC 20006

EXAMINER	
LYNCH, VICTORIA HOM	
ART UNIT	PAPER NUMBER
1724	

DATE MAILED: 10/30/2020

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.

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. 16/298,738	Applicant(s) SU et al.	
	Examiner VICTORIA H LYNCH	Art Unit 1724	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 9/8/20.
   ☐ 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 1-5 and 7-20 . 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 6/11/20.
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 _____.

/VICTORIA H LYNCH/
Primary Examiner, Art Unit 1724

DETAILED ACTION

Notice of Pre-AIA or AIA Status

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

Remarks

2. Applicant's amendments submitted on 9/8/20 have been received. Claims 1, 3, 10, 13, 16, 19, and 20 have been amended. Claim 6 has been cancelled.

Claim Objections

3. The objection to claim 20 is withdrawn because the Applicant amended the claim.

Claim Rejections - 35 USC § 112

4. The rejection under 35 U.S.C. 112(b) or 35 U.S.C. 112 (pre-AIA), second paragraph, on claims 3, 5, 6, 13, and 19 is withdrawn because the Applicant amended the claims.

Claim Rejections - 35 USC § 102

5. The rejection under 35 U.S.C. 102(a)(1) as being anticipated by Tanaka et al. (US 2016/0294015) on claim(s) 1-4, 7 and 8 is/are withdrawn because the Applicant amended the claims.

Claim Rejections - 35 USC § 103

6. The rejection under 35 U.S.C. 103 as being unpatentable over Tanaka et al. (US 2016/0294015) on claim 5 is/are withdrawn because the Applicant amended the claims.

7. The rejection under 35 U.S.C. 103 as being unpatentable over Tanaka et al. (US 2016/0294015), in view of Yamafuku et al. (US 2015/0147624) on claim 9 is/are withdrawn because the Applicant amended the claims.

8. The rejection under 35 U.S.C. 103 as being unpatentable over Tanaka et al. (US 2016/0294015), in view of Yamafuku et al. (US 2015/0147624) on claims 10-13 and 15-19 is/are withdrawn because the Applicant amended the claims.

Allowable Subject Matter

9. Claims 1-5 and 7-20 are allowed.

10. The following is an examiner's statement of reasons for allowance: the invention in independent claim 1 is directed to a cathode, comprising a cathode current collector, having a first surface; a first cathode active material layer, comprising a first cathode active material; a second cathode active material layer, comprising a second cathode active material; and an insulating layer, wherein the first cathode active material layer is disposed between the cathode current collector and the second cathode active material layer and covers a first portion of the first surface of the cathode current collector, and the insulating layer covers a second portion of the first surface of the cathode current collector that is different from the first portion, wherein a thickness of the insulating layer is greater than a thickness of the first cathode active material layer. Previously indicated allowable subject matter was incorporated into the independent claim, thus rendering it also allowable. The reasons for allowance are substantially the same as provided in the Office Action mailed 6/9/20 and apply herein.

11. The following is an examiner's statement of reasons for allowance: the invention in independent claim 10 is directed to an electrochemical device, comprising an anode, a separator and a cathode, wherein the cathode comprises a cathode current collector, having a first surface; a first cathode active material layer, comprising a first cathode active material; a second cathode active material layer, comprising a second cathode active material; and an insulating layer, wherein the first cathode active material layer is disposed between

the cathode current collector and the second cathode active material layer and covers a first portion of the first surface of the cathode current collector, and the insulating layer covers a second portion of the first surface of the cathode current collector that is different from the first portion, wherein a thickness of the insulating layer is greater than a thickness of the first cathode active material layer; and the separator is disposed between the anode and the cathode, and the anode, the separator, and the cathode are wound to form an electrode assembly. Previously indicated allowable subject matter was incorporated into the independent claim, thus rendering it also allowable. The reasons for allowance are substantially the same as provided in the Office Action mailed 6/9/20 and apply herein.

12. The following is an examiner's statement of reasons for allowance: the invention in independent claim 16 is directed to an electronic device, comprising an electrochemical device, wherein the electrochemical device comprises an anode, a separator and a cathode, wherein the cathode comprises a cathode current collector, having a first surface; a first cathode active material layer, comprising a first cathode active material; a second cathode active material layer, comprising a second cathode active material; and an insulating layer, wherein the first cathode active material layer is disposed between the cathode current collector and the second cathode active material layer and covers a first portion of the first surface of the cathode current collector, and the insulating layer covers a second portion of the first surface of the cathode current collector that is different from the first portion wherein a thickness of the insulating layer is greater than a thickness of the first cathode active material layer; and the separator is disposed between the anode and the cathode, and the anode, the separator, and the cathode are wound to form an electrode assembly. Previously indicated allowable subject matter was incorporated into the independent claim, thus

rendering it also allowable. The reasons for allowance are substantially the same as provided in the Office Action mailed 6/9/20 and apply herein.

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 VICTORIA HOM LYNCH whose telephone number is (571)272-0489. The examiner can normally be reached on 7:30 AM - 4:30 PM EST M-F.

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, Miriam Stagg can be reached on 571-270-5256. 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.

/VICTORIA H LYNCH/
Primary Examiner, Art Unit 1724

Issue Classification	Application/Control No.	Applicant(s)/Patent Under Reexamination
	16/298,738	SU et al.
	Examiner	**Art Unit**
	VICTORIA H LYNCH	1724

CPC						
Symbol					**Type**	**Version**
H01M	/	4	/	366	F	2013-01-01
H01M	/	4	/	131	I	2013-01-01
H01M	/	4	/	136	I	2013-01-01
H01M	/	4	/	525	I	2013-01-01
H01M	/	4	/	5825	I	2013-01-01
H01M	/	4	/	623	I	2013-01-01
H01M	/	4	/	625	I	2013-01-01
H01M	/	4	/	667	I	2013-01-01
H01M	/	10	/	0525	I	2013-01-01
H01M	/	2004	/	028	A	2013-01-01

CPC Combination Sets							
Symbol					**Type**	**Set**	**Ranking**	**Version**
	/		/					

NONE (Assistant Examiner)	(Date)	**Total Claims Allowed:** 19	
/VICTORIA H LYNCH/ Primary Examiner, Art Unit 1724 (Primary Examiner)	26 October 2020 (Date)	O.G. Print Claim(s) 1	O.G. Print Figure 1

U.S. Patent and Trademark Office — Part of Paper No.: 20201020

Issue Classification	Application/Control No.	Applicant(s)/Patent Under Reexamination
	16/298,738	SU et al.
	Examiner	**Art Unit**
	VICTORIA H LYNCH	1724

INTERNATIONAL CLASSIFICATION				
CLAIMED				
H01M	/	4	/	36

NON-CLAIMED				
	/		/	

US ORIGINAL CLASSIFICATION	
CLASS	**SUBCLASS**

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

NONE (Assistant Examiner)	(Date)	**Total Claims Allowed:** 19	
/VICTORIA H LYNCH/ Primary Examiner, Art Unit 1724 (Primary Examiner)	26 October 2020 (Date)	O.G. Print Claim(s) 1	O.G. Print Figure 1

Issue Classification	Application/Control No.	Applicant(s)/Patent Under Reexamination
	16/298,738	SU et al.
	Examiner	**Art Unit**
	VICTORIA H LYNCH	1724

☐ 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
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	6	13	15												
6	7	15	16												
7	8	16	17												
8	9	17	18												

NONE (Assistant Examiner)	(Date)	**Total Claims Allowed:** 19	
/VICTORIA H LYNCH/ Primary Examiner, Art Unit 1724 (Primary Examiner)	26 October 2020 (Date)	O.G. Print Claim(s) 1	O.G. Print Figure 1

U.S. Patent and Trademark Office Part of Paper No.: 20201020

Search Notes	Application/Control No.	Applicant(s)/Patent Under Reexamination
	16/298,738	SU et al.
	Examiner	Art Unit
	VICTORIA H LYNCH	1724

CPC - Searched*		
Symbol	**Date**	**Examiner**
H01M10/052, H01M10/0525, H01M10/0587, H01M10/4235, H01M2004/028, H01M4/13, H01M4/131, H01M4/136, H01M4/366, H01M4/525, H01M4/5825, H01M4/623, H01M4/625, H01M4/667 + text	06/02/2020	VL

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**
Assignee search	06/02/2020	VL
Inventors search	06/02/2020	VL
Consult East search strategy expert Ron Jorgensen	06/02/2020	VL
East search	06/02/2020	VL
East search updated	10/19/2020	VL

/VICTORIA H LYNCH/ Examiner, Art Unit 1724	

Search Notes	Application/Control No.	Applicant(s)/Patent Under Reexamination
	16/298,738	SU et al.
	Examiner	Art Unit
	VICTORIA H LYNCH	1724

Interference Search			
US Class/CPC Symbol	**US Subclass/CPC Group**	**Date**	**Examiner**
H01M	10/052, 10/0525, 10/0587, 10/4235, 2004/028, 4/13, 4/131, 4/136, 4/366, 4/525, 4/5825, 4/623, 4/625, 4/667	10/20/2020	VL
Y02E	60/10	10/20/2020	VL
	claim search	10/20/2020	VL

/VICTORIA H LYNCH/ Examiner, Art Unit 1724	

Index of Claims	Application/Control No.	Applicant(s)/Patent Under Reexamination
	16/298,738	SU et al.
	Examiner	Art Unit
	VICTORIA H LYNCH	1724

✓	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	06/03/2020	10/20/2020							
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2	2	✓	=							
4	3	✓	=							
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5	5	✓	=							
	6	O	-							
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7	8	✓	=							
8	9	✓	=							
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11	12	✓	=							
14	13	✓	=							
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13	15	✓	=							
15	16	✓	=							
16	17	✓	=							
17	18	✓	=							
19	19	✓	=							
18	20	O	=							

EAST Search History

EAST Search History (Interference)

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L7	3,575	(H01M10/0587).CPC.	US-PGPUB; USPAT	OR	ON	2020/10/20 11:23
L8	3,483	(H01M10/4235).CPC.	US-PGPUB; USPAT	OR	ON	2020/10/20 11:23
L9	6,276	(H01M2004/028).CPC.	US-PGPUB; USPAT	OR	ON	2020/10/20 11:24
L10	5,064	(H01M4/13).CPC.	US-PGPUB; USPAT	OR	ON	2020/10/20 11:24
L11	9,090	(H01M4/131).CPC.	US-PGPUB; USPAT	OR	ON	2020/10/20 11:24
L12	3,307	(H01M4/136).CPC.	US-PGPUB; USPAT	OR	ON	2020/10/20 11:24
L13	8,585	(H01M4/366).CPC.	US-PGPUB; USPAT	OR	ON	2020/10/20 11:25
L14	10,100	(H01M4/525).CPC.	US-PGPUB; USPAT	OR	ON	2020/10/20 11:25
L15	5,075	(H01M4/5825).CPC.	US-PGPUB; USPAT	OR	ON	2020/10/20 11:25
L16	2,396	(H01M4/623).CPC.	US-PGPUB; USPAT	OR	ON	2020/10/20 11:25
L17	6,675	(H01M4/625).CPC.	US-PGPUB; USPAT	OR	ON	2020/10/20 11:26

L18	2,067	(H01M4/667).CPC.	US-PGPUB; USPAT	OR	ON	2020/10/20 11:26
L19	118,330	(Y02E60/10).CPC.	US-PGPUB; USPAT	OR	ON	2020/10/20 11:26
L20	5	(l5 l6 l7 l8 l9 l10 l11 l12 l13 l14 l15 l16 l17 l18 l19) and (cathode near active near material with (first one) with (second two) with insulat$4 with thick$4)	US-PGPUB; USPAT	OR	ON	2020/10/20 11:30
L21	16	(cathode near active near material with (first one) with (second two) with (insulat$4 inorganic polymer) with thick$4).clm.	US-PGPUB; USPAT	OR	ON	2020/10/20 11:44

10/20/2020 11:47:41 AM
C:\Users\vlynch\Documents\EAST\Workspaces\16298738.wsp

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

PTO/SB/08a (03-15)
Approved for use through 07/31/2016. OMB 0651-0031
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE
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INFORMATION DISCLOSURE STATEMENT BY APPLICANT

(Not for submission under 37 CFR 1.99)

Application Number	16298738
Filing Date	2019-03-11
First Named Inventor	Dongyang GUO
Art Unit	1724
Examiner Name	Victoria Hom LYNCH
Attorney Docket Number	LEEL-0101

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	Publication Number	Kind Code[1]	Publication Date	Name of Patentee or Applicant of cited Document	Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear
/V.H.L/	1	20160093859	A1	2016-03-31	Kawaguchi et al.	
/V.H.L/	2	20120058375	A1	2012-03-08	Tanaka et al.	
/V.H.L/	3	20060115736	A1	2006-06-01	Hashimoto et al.	
/V.H.L/	4	20040202928	A1	2004-10-14	Miyamoto et al.	

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INFORMATION DISCLOSURE STATEMENT BY APPLICANT

(Not for submission under 37 CFR 1.99)

Application Number	16298738
Filing Date	2019-03-11
First Named Inventor	Dongyang GUO
Art Unit	1724
Examiner Name	Victoria Hom LYNCH
Attorney Docket Number	LEEL-0101

Examiner Initial*	Cite No	Foreign Document Number[3]	Country Code[2]	Kind Code[4]	Publication Date	Name of Patentee or Applicant of cited Document	Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear	T[5]
/V.H.L/	1	2013051040	JP	A	2013-03-14	GS Yuasa Corp.	English abstract	☒
/V.H.L/	2	2876711	EP	A1	2015-05-27	GS Yuasa International Ltd.		☒

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NON-PATENT LITERATURE DOCUMENTS [Remove]

Examiner Initials*	Cite No	Include name of the author (in CAPITAL LETTERS), title of the article (when appropriate), title of the item (book, magazine, journal, serial, symposium, catalog, etc), date, pages(s), volume-issue number(s), publisher, city and/or country where published.	T[5]
/V.H.L/	1	Extended European Search Report mailed March 12, 2020 in counterpart European application 19207088.6, 7 pages	☒

If you wish to add additional non-patent literature document citation information please click the Add button [Add]

EXAMINER SIGNATURE

Examiner Signature	/VICTORIA H. LYNCH/	Date Considered	10/20/2020

*EXAMINER: Initial if reference considered, whether or not citation is in conformance with MPEP 609. Draw line through a citation if not in conformance and not considered. Include copy of this form with next communication to applicant.

[1] See Kind Codes of USPTO Patent Documents at www.USPTO.GOV or MPEP 901.04. [2] Enter office that issued the document, by the two-letter code (WIPO Standard ST.3). [3] For Japanese patent documents, the indication of the year of the reign of the Emperor must precede the serial number of the patent document. [4] Kind of document by the appropriate symbols as indicated on the document under WIPO Standard ST.16 if possible. [5] Applicant is to place a check mark here if English language translation is attached.

ALL REFERENCES CONSIDERED EXCEPT WHERE LINED THROUGH. /V.H.L/

INFORMATION DISCLOSURE STATEMENT BY APPLICANT

(Not for submission under 37 CFR 1.99)

Application Number	16298738
Filing Date	2019-03-11
First Named Inventor	Dongyang GUO
Art Unit	1724
Examiner Name	Victoria Hom LYNCH
Attorney Docket Number	LEEL-0101

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	/juan.carlos.a.marquez/	Date (YYYY-MM-DD)	2020-06-11
Name/Print	Juan Carlos A. Marquez	Registration Number	34072

This collection of information is required by 37 CFR 1.97 and 1.98. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.14. This collection is estimated to take 1 hour to complete, including gathering, preparing and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

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

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

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

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

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

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

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

Bibliographic Data

Application No: 16/298,738

Foreign Priority claimed: (•) Yes ( ) No

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

Verified and Acknowledged: /VICTORIA H LYNCH/ (Examiner's Signature) V.H.L (Initials)

Title: CATHODE, ELECTROCHEMICAL DEVICE AND ELECTRONIC DEVICE COMPRISING SAME

FILING or 371(c) DATE	CLASS	GROUP ART UNIT	ATTORNEY DOCKET NO.
03/11/2019	429	1724	LEEL-0101
RULE			

APPLICANTS

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Yisong SU, Ningde City, CHINA

Zhiwen XIAO, Ningde City, CHINA

CONTINUING DATA

FOREIGN APPLICATIONS

CHINA CN201811308841.3 11/05/2018

IF REQUIRED, FOREIGN LICENSE GRANTED**

03/26/2019

STATE OR COUNTRY

CHINA

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Juan Carlos A. Marquez
Marquez Intellectual Property Law Office PLLC
1629 K Street, NW
Suite 300
Washington, DC 20006
UNITED STATES

FILING FEE RECEIVED

$1,720

EAST Search History

EAST Search History (Prior Art)

Ref #	Hits	Search Query	DBs	Default Operator	Plurals	Time Stamp
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S9	2	"20040202928"	US-PGPUB; USPAT; USOCR	OR	ON	2020/06/02 14:05
S10	15	("20030224242" | "4610956" | "5631102" | "6387564").PN. OR ("7258948").URPN.	US-PGPUB; USPAT; USOCR	OR	ON	2020/06/02 14:07

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S17	7,605	S14 and (active material near3 (first second double multi$5 multiple) with insulat$5)	US-PGPUB; USPAT; USOCR	OR	ON	2020/06/02 14:23
S18	7,577	S17 and (@pd or @ptad or @prad or @ad or @rlad)<"20181105"	US-PGPUB; USPAT; USOCR	OR	ON	2020/06/02 14:24
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S23	4	((("SU") near3 ("Xinru"))).INV.	US-PGPUB; USPAT; USOCR	OR	ON	2020/06/02 14:30
S24	2	((("LI") near3 ("Baozhang"))).INV.	US-PGPUB; USPAT; USOCR	OR	ON	2020/06/02 14:30

S25	8	((("SU") near3 ("Yisong"))).INV.	US-PGPUB; USPAT; USOCR	OR	ON	2020/06/02 14:30
S26	10	((("XIAO") near3 ("Zhiwen"))).INV.	US-PGPUB; USPAT; USOCR	OR	ON	2020/06/02 14:31
S27	3	(S22 S23 S24 S25 S26) and (active near material with insulat$5)	US-PGPUB; USPAT; USOCR	OR	ON	2020/06/02 14:31
S28	12,503	((("NINGDE"))).AS,AANM.	FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2020/06/02 14:33
S29	9	((("SU") near3 ("Xinru"))).INV.	FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2020/06/02 14:33
S30	83	((("LI") near3 ("Baozhang"))).INV.	FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2020/06/02 14:33
S31	17	((("SU") near3 ("Yisong"))).INV.	FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2020/06/02 14:33
S32	92	((("XIAO") near3 ("Zhiwen"))).INV.	FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2020/06/02 14:34
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S34	87	(S28 S29 S30 S31 S32) and (active near material) and insulat$5	FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2020/06/02 14:34
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S36	1,052	((cathode positive) near3 active near material near3 (first second double multi$5 multi$2layer$3 layer$4 multiple) with insulat$5)	US-PGPUB; USPAT; USOCR	OR	ON	2020/06/02 14:45

S37	1	S1 and S36	US-PGPUB; USPAT; USOCR	OR	ON	2020/06/02 14:46
S38	1,030	S36 and h01m.cpcl.	US-PGPUB; USPAT; USOCR	OR	ON	2020/06/02 14:46
S39	912	S38 not fuel adj cell$1	US-PGPUB; USPAT; USOCR	OR	ON	2020/06/02 14:46
S40	911	S39 and (@pd or @ptad or @prad or @ad or @rlad)<"20181105"	US-PGPUB; USPAT; USOCR	OR	ON	2020/06/02 14:47
S41	318	(lithium near cobaltate or lithium near iron near phosphate or lithium near manganese near iron near phosphate or sodium near iron near phosphate or lithium near vanadium near phosphate or sodium near vanadium near phosphate or oxy$1lithium$1vanadium near phosphate or oxy$1sodium$1vanadium near phosphate or lithium near vanadate or lithium near manganate or lithium near nickelate or lithium near nickel near cobalt near manganese near oxide or lithium$1rich near manganese$1based near material or lithium near nickel near cobalt near aluminum near oxide or lithium near titanate) and S40	US-PGPUB; USPAT; USOCR	OR	ON	2020/06/02 14:59
S42	98	((cathode positive) near3 active near material near3 (first second double multi$5 multi$2layer$3 multiple) with insulat$5)	US-PGPUB; USPAT; USOCR	OR	ON	2020/06/02 15:02
S43	96	S42 and (@pd or @ptad or @prad or @ad or @rlad)<"20181105"	US-PGPUB; USPAT; USOCR	OR	ON	2020/06/02 15:03
S44	10	("20050175892" | "20050277022" | "20060269835" | "20080280197" | "20100035144" | "20110217576" | "20110274953" | "20130316209" | "20150125738" | "5591522").PN. OR ("10411243").URPN.	US-PGPUB; USPAT; USOCR	OR	ON	2020/06/02 15:39
S45	4	("20040202928" | "20080280197" | "20110020703" | "20120202105").PN.	US-PGPUB; USPAT	OR	ON	2020/06/02 15:51
S46	927	((cathode positive) and active near material and (first second double multi$5 multi$2layer$3 multiple) and insulat$5)	FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2020/06/02 16:16

S47	492	S46 and h01m.cpcl.	FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2020/06/02 16:17
S48	487	S47 and (@pd or @ptad or @prad or @ad or @rlad)<"20181105"	FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2020/06/02 16:17
S49	477	S48 not fuel adj cell$1	FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2020/06/02 16:18
S50	6	"2010262773"	FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2020/06/02 17:12
S51	6	"2015147624"	FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2020/06/02 18:16
S52	0	"2015147624"	US-PGPUB; USPAT; USOCR	OR	ON	2020/06/02 18:16
S53	2	"20150147624"	US-PGPUB; USPAT; USOCR	OR	ON	2020/06/02 18:16
S54	1	"20160294015"	US-PGPUB; USPAT; USOCR	OR	ON	2020/06/02 18:57
S55	1	"20160294015"	US-PGPUB; USPAT; USOCR	OR	ON	2020/06/03 11:04
S56	1	S55 and (thickness with insulating)	US-PGPUB; USPAT; USOCR	OR	ON	2020/06/03 11:57
S57	1	"20160294015"	US-PGPUB; USPAT; USOCR	OR	ON	2020/06/03 13:19
S58	1	S57 and (thickness with electrode near assembly)	US-PGPUB; USPAT; USOCR	OR	ON	2020/06/03 13:19
S59	1	S57 and (thickness with battery)	US-PGPUB; USPAT; USOCR	OR	ON	2020/06/03 13:24
S60	4	("20040202928" | "20060115736" | "20120058375" | "20160093859").PN.	US-PGPUB; USPAT	OR	ON	2020/10/19 18:10

10/20/2020 11:47:30 AM
C:\Users\vlynch\Documents\EAST\Workspaces\16298738.wsp

POWER OF ATTORNEY TO PROSECUTE APPLICATIONS BEFORE THE UNITED STATES PATENT AND TRADEMARK OFFICE

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

I hereby revoke all previous powers of attorney given in the application identified in the attached statement under 37 CFR 3.73(c).

I hereby appoint the practitioners of Morgan, Lewis & Bockius LLP, Customer Number **24341** as attorneys or agents to represent the undersigned and to transact all business before the United States Patent and Trademark Office (USPTO) in connection with any and all patent applications and patents assigned only to the undersigned according to the USPTO assignment records or assignment documents attached to this form in accordance with 37 C.F.R. § 3.73(c), said appointment to be to the exclusion of the inventor(s) and their attorney(s) in accordance with the provisions of 37 C.F.R. § 3.71, provided that, if any one of these attorneys ceases being affiliated with the law firm of Morgan, Lewis & Bockius LLP as partner, counsel, or employee, then the appointment of that attorney and all powers derived therefrom shall terminate on the date such attorney ceases being so affiliated.

Assignee Name and Address:

Ningde Amperex Technology Limited
No. 1, Xingang Road, Zhangwan Town
Jiaocheng Zone, Ningde City
Fujian Province, P. R. China 352100

SIGNATURE of Assignee of Record

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

Signature	Hou Yong Li		
Name	Houyong LI	Date	Feb. 24, 2014
Title	IP Manager	Telephone	+86-0593-258-2597

A copy of this form, together with a statement under 37 C.F.R. § 3.73(c) (Form PTO/SB96 or equivalent) is required to be filed in each application in which this form is used. The statement under 37 C.F.R. § 3.73(c) may be completed by one of the practitioners appointed in this form if the appointed practitioner is authorized to act on behalf of the assignee and must identify the application in which this Power of Attorney is to be filed.

DB2/ 24723704.1

Electronic Acknowledgement Receipt

EFS ID:	41375745
Application Number:	16298738
International Application Number:	
Confirmation Number:	3478
Title of Invention:	CATHODE, ELECTROCHEMICAL DEVICE AND ELECTRONIC DEVICE COMPRISING SAME
First Named Inventor/Applicant Name:	Xinru SU
Customer Number:	38327
Filer:	Yalei Sun
Filer Authorized By:	
Attorney Docket Number:	LEEL-0101
Receipt Date:	14-DEC-2020
Filing Date:	11-MAR-2019
Time Stamp:	19:01:33
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		024607-02-5073-US_Assignee_Statementv2.pdf	133697 dcab97d3aa4b23dc577d6e01ec14a2f4bf9a682b	yes	2

	Multipart Description/PDF files in .zip description		
	Document Description	**Start**	**End**
	Assignee showing of ownership per 37 CFR 3.73	1	1
	Power of Attorney	2	2
Warnings:			
Information:			
	Total Files Size (in bytes):	133697	

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.

Electronically filed December 14, 2020

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Application of:	Xinru SU, et al.	Confirmation No.:	3478
Serial No.:	16/298,738	Art Unit	1724
Filed:	March 11, 2019	Examiner:	LYNCH, VICTORIA HOM
For:	CATHODE, ELECTROCHEMICAL DEVICE AND ELECTRONIC DEVICE COMPRISING SAME	Attorney Docket No.:	024607-02-5073-US

STATEMENT UNDER 37 C.F.R. § 3.73(c)

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

Sir:

NINGDE AMPEREX TECHNOLOGY LIMITED, a corporation, states that it is the assignee of the entire right, title and interest in the patent application/patent identified above by virtue of 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 on March 11, 2019 at Reel 048565, Frame 0112, or for which a copy thereof is attached.

The undersigned is authorized to act on behalf of the assignee.

Date: December 14, 2020

/Yalei Sun/ 57,765
Yalei Sun (Reg. No.)

MORGAN, LEWIS & BOCKIUS LLP
1400 Page Mill Road
Palo Alto, CA 94304
(650) 843-4000

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
16/298,738	03/11/2019	Xinru SU	LEEL-0101

CONFIRMATION NO. 3478

24341
Morgan, Lewis & Bockius LLP (PA)
1400 Page Mill Road
Palo Alto, CA 94304-1124

POA ACCEPTANCE LETTER

OC000000122048811

Date Mailed: 12/17/2020

NOTICE OF ACCEPTANCE OF POWER OF ATTORNEY

This is in response to the Power of Attorney filed 12/14/2020.

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**.

/ytdemisse/

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
16/298,738	03/11/2019	Xinru SU	LEEL-0101

CONFIRMATION NO. 3478

POWER OF ATTORNEY NOTICE

38327
Juan Carlos A. Marquez
Marquez Intellectual Property Law Office PLLC
1629 K Street, NW
Suite 300
Washington, DC 20006

OC000000122048787

Date Mailed: 12/17/2020

NOTICE REGARDING CHANGE OF POWER OF ATTORNEY

This is in response to the Power of Attorney filed 12/14/2020.

- 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**.

/ytdemisse/

PART B - FEE(S) TRANSMITTAL

Electronically filed January 6, 2021

Complete and send this form with applicable fee(s), to: Mail
Mail Stop ISSUE FEE
Commissioner of Patents
P.O. Box 1450
Alexandria, Virginia 22313-1450
or Fax (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, advanced 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

MORGAN, LEWIS & BOCKIUS LLP
1400 Page Mill Road
Palo Alto, CA 94304

Note: A certificate of mailing below 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.

Certificate of Mailing

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 facsimile transmitted to the USPTO (571) 273-2885, on the date indicated below.

(Depositor's name)

(Signature)

(Date)

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTY'S DOCKET NO.	CONFIRMATION NO.
16/298,738	03/11/2019	Xinru SU	024607-02-5073-US	3478

TITLE OF INVENTION **CATHODE, ELECTROCHEMICAL DEVICE AND ELECTRONIC DEVICE COMPRISING SAME**

APPLN. TYPE	ENTITY STATUS	ISSUE FEE	PREV. PAID ISSUE FEE	TOTAL FEE(S) DUE	DATE DUE
nonprovisional	UNDISCOUNTED	$1200	0	$1200	02/01/2021

EXAMINER	ART UNIT	CLASS-SUB CLASS
LYNCH, VICTORIA HOM	1724	429-405000

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) 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. **Morgan, Lewis & Bockius 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 has been filed for recordation as set forth in 37 CFR 3.11. Completion of this form is NOT a substitute for filing an assignment.

(A) NAME OF ASSIGNEE: NINGDE AMPEREX TECHNOLOGY LIMITED

(B) RESIDENCE: (CITY and STATE OR COUNTRY) (C) NINGDE CITY, FUJIAN PROVINCE, 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. The following fee(s) are submitted:
☒ Issue Fee
☐ Advanced Order - # of Copies ____

4b. Payment of Fee(s): (**Please first reapply any previously paid issue fee shown above.**)
☐ A check in the amount of the fee(s) enclosed
☐ Payment by credit card. Form PTO-2038 is attached.
☒ The Director is hereby authorized to charge the required fee(s), or credit any overpayment, to Deposit Account Number 50-0310 (order no. 024607-02-5073-US).

5. **Change in Small Entity Status** (from status indicated above)
☐ a. Applicant certifying micro entity status. See 37 CFR 1.29.
NOTE: Absent a valid certification of Micro Entity (see form PTO/SB/15A and 15B), issue fee payment in the micro entity amount will not be accepted at the risk of application abandonment.

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

☐ Applicant changing to regular undiscounted fee 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 sign in accordance with 37 CFR 1.31 and 1.33. See 37 CFR 1.4 for signature requirements and certifications.

Authorized Signature /Yalei Sun/ Date: January 6, 2021

Printed Name: Yalei Sun Registration No. 57,765

Electronic Patent Application Fee Transmittal

Application Number:	16298738
Filing Date:	11-Mar-2019
Title of Invention:	CATHODE, ELECTROCHEMICAL DEVICE AND ELECTRONIC DEVICE COMPRISING SAME
First Named Inventor/Applicant Name:	Xinru SU
Filer:	Yalei Sun/Cheryl Rogers
Attorney Docket Number:	024607-02-5073-US

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:	41573913
Application Number:	16298738
International Application Number:	
Confirmation Number:	3478
Title of Invention:	CATHODE, ELECTROCHEMICAL DEVICE AND ELECTRONIC DEVICE COMPRISING SAME
First Named Inventor/Applicant Name:	Xinru SU
Customer Number:	24341
Filer:	Yalei Sun
Filer Authorized By:	
Attorney Docket Number:	024607-02-5073-US
Receipt Date:	06-JAN-2021
Filing Date:	11-MAR-2019
Time Stamp:	17:55:23
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	E202116H57035699
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	Issue Fee Payment (PTO-85B)	024607-02-5073-US_Issue_Fee_Transmittal.pdf	123419 715f974e4ff574b1f6c6df9ed8d8ec9484c0059d	no	1
Warnings:					
Information:					
2	Fee Worksheet (SB06)	fee-info.pdf	30316 f83376b2be39ba74cab71f91ae1deeeec8021bbb	no	2
Warnings:					
Information:					
		Total Files Size (in bytes):	153735		

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
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Address: COMMISSIONER FOR PATENTS
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Alexandria, Virginia 22313-1450
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APPLICATION NO.	ISSUE DATE	PATENT NO.	ATTORNEY DOCKET NO.	CONFIRMATION NO.
16/298,738	02/09/2021	10916769	024607-02-5073-US	3478

24341 7590 01/20/2021

Morgan, Lewis & Bockius LLP (PA)
1400 Page Mill Road
Palo Alto, CA 94304-1124

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 29 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 City, CHINA;
Xinru SU, Ningde City, CHINA;
Baozhang LI, Ningde City, CHINA;
Yisong SU, Ningde City, CHINA;
Zhiwen XIAO, Ningde City, 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.