UNITED STATES
PATENT AND TRADEMARK OFFICE

P.O. Box 1450
Alexandria, VA 22313 - 1450
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ELECTRONIC ACKNOWLEDGEMENT RECEIPT

APPLICATION #	RECEIPT DATE / TIME	ATTORNEY DOCKET #
17/885,920	**10/08/2024 02:15:04 PM Z ET**	**14850089COB**

Title of Invention

ELECTROLYTE AND ELECTROCHEMICAL DEVICE

Application Information

APPLICATION TYPE	Utility - Nonprovisional Application under 35 USC 111(a)	PATENT #	11799131
CONFIRMATION #	7924	FILED BY	Nathan Lord
PATENT CENTER #	67466934	FILING DATE	08/11/2022
CUSTOMER #	62008	FIRST NAMED INVENTOR	Kefei WANG
CORRESPONDENCE ADDRESS	-	AUTHORIZED BY	Timothy Maier

Documents

TOTAL DOCUMENTS: 6

DOCUMENT	PAGES	DESCRIPTION	SIZE (KB)
US11799131 Statement by Remaining Inventor - WU.pdf	1	Oath or Declaration filed	182 KB
US11799131 Statement by Remaining Inventor - WANG.pdf	1	Oath or Declaration filed	186 KB
US11799131 Statement by Removed Inventor - ZENG.pdf	1	Oath or Declaration filed	173 KB
US11799131 Statement by Remaining Inventor - XIAO.pdf	1	Oath or Declaration filed	175 KB
US11799131 Statement of Assignee - NINGDE AMPEREX TECHNOLOGY	1	Oath or Declaration filed	289 KB

LIMITED.pdf			
Petition for Correction of Inventorship.pdf	1	Petition for review by the Office of Petitions	20 KB

Digest

DOCUMENT	MESSAGE DIGEST(SHA-512)
US11799131 Statement by Remaining Inventor - WU.pdf	6845B96901658BA49D0A2BCE422BA02A731A86A4A1AD45AD9F322975890B1FEEDA336C2095F14F928C675363CF9A09BA01B8674F826D82513CAEB20F1115CD29
US11799131 Statement by Remaining Inventor - WANG.pdf	198CACF905B133F995F909690D1930F236206A824F7CA30358FAA5E495DED82BAFDF7711E209367DA2BEF53A4DC6D5BFDC80483ADCB6D04EC8C20637B54DD829
US11799131 Statement by Removed Inventor - ZENG.pdf	CD70512AEF05C00DF61BEF5BAABC8DB07ABF5F931AF1668D1EB2EC258E3F287C507A4B84A24D18578CFA3F45A455B63EBCA1ACBF730D965A220D2A8D04B76736
US11799131 Statement by Remaining Inventor - XIAO.pdf	22C68CFD71B48F7262E9A1D438B032AD4124301CB49BED5F412D4011BFA88ABC5F78B3AB5D11F389FE15B20133016366EAE5F8117CD92F9BB09B26B830D9C5B8
US11799131 Statement of Assignee - NINGDE AMPEREX TECHNOLOGY LIMITED.pdf	937EA5C782A643EFFCBA646BC7AB7698144689979D1CB04404B71429BC4B14D4627975E8B89BAE2751959D2831A99DDDD8AEF24534DD06AE8E2FE9B02B28A1AF
Petition for Correction of Inventorship.pdf	5F41F67D4737F195199828227562DBD742560C9E47C6A2EF4F0CB6014B7B09DAFA9651B4CC03E532A9D92CD5D0D44CD9E16F30CCAE15127001A2F403C47E4A4A

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 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.

Attorney Docket No. 14850089COB

PATENT

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re: Kefei WANG et. al.
Patent No. 11,799,131 Group Art Unit: 1725
Issued: October 24, 2023
For: ELECTROLYTE AND ELECTROCHEMICAL DEVICE

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

STATEMENT OF ASSIGNEE AGREEING TO CHANGE OF INVENTORSHIP UNDER 37 C.F.R. § 1.324(b)(2)

I, Liangxin Yang, hereby certify the following:

1. NINGDE AMPEREX TECHNOLOGY LIMITED, with a principal place of business at No. 1, Xingang Road, Zhangwan Town, Jiaocheng District, Ningde City, Fujian Province, China, 352100, is a full owner (100%) of the entire right, title, and interest of U.S. Patent No. 11,799,131 by way of assignment from the inventors to NINGDE AMPEREX TECHNOLOGY LIMITED recorded in the U.S. Patent and Trademark Office on August 11, 2022 at Reel 060786, Frame 0449.
2. I am empowered and authorized to sign this document on behalf of NINGDE AMPEREX TECHNOLOGY LIMITED.
3. NINGDE AMPEREX TECHNOLOGY LIMITED consents to the change of inventorship of the above-identified patent application by the removal of Qiao ZENG.
4. As required by 37 CFR 3.73(c)(1)(i), the documentary evidence of the chain of title from the inventors to NINGDE AMPEREX TECHNOLOGY LIMITED was, or concurrently is being, submitted for recordation pursuant to 37 CFR 3.11.

By: _____
Liangxin Yang
IP Director
NINGDE AMPEREX TECHNOLOGY LIMITED

Date: Sept. 12, 2024

LEGAL02/44388481v1

Attorney Docket No. 14850089COB

PATENT

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re: Kefei WANG et. al.
Patent No. 11,799,131 Group Art Unit: 1725
Issued: October 24, 2023
For: ELECTROLYTE AND ELECTROCHEMICAL DEVICE

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

STATEMENT OF REMOVED INVENTOR AGREEING TO CHANGE IN INVENTORSHIP UNDER 37 CFR 1.324(b)(1)

I, Qiao ZENG, declare that:

1. I have reviewed Claims 1-17 of Patent No. 11,799,131.
2. In view of my review of Claims 1-17 of Patent No. 11,799,131, I confirm I no longer should be listed as an inventor of Patent No. 11,799,131.
3. I agree to the change in inventorship to remove me as an inventor.

Signature: Qiao ZENG Date: 2024.09.12
Qiao ZENG

UNITED STATES
PATENT AND TRADEMARK OFFICE

P.O. Box 1450
Alexandria, VA 22313 - 1450
www.uspto.gov

ELECTRONIC PAYMENT RECEIPT

APPLICATION #	RECEIPT DATE / TIME	ATTORNEY DOCKET #
17/885,920	**10/08/2024 02:15:04 PM Z ET**	**14850089COB**

Title of Invention

ELECTROLYTE AND ELECTROCHEMICAL DEVICE

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APPLICATION TYPE	Utility - Nonprovisional Application under 35 USC 111(a)	PATENT #	11799131
CONFIRMATION #	7924	FILED BY	Nathan Lord
PATENT CENTER #	67466934	AUTHORIZED BY	Timothy Maier
CUSTOMER #	62008	FILING DATE	08/11/2022
CORRESPONDENCE ADDRESS	-	FIRST NAMED INVENTOR	Kefei WANG

Payment Information

PAYMENT METHOD	PAYMENT TRANSACTION ID	PAYMENT AUTHORIZED BY
CARD / 8716	**E202408E16226904**	**Nathan Lord**

FEE CODE	DESCRIPTION	ITEM PRICE($)	QUANTITY	ITEM TOTAL($)
1816	PROCESSING FEE FOR CORRECTING INVENTORSHIP IN A PATENT	160.00	1	160.00
			TOTAL AMOUNT:	**$160.00**

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 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.

Attorney Docket No. 14850089COB

PATENT

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re: Kefei WANG et. al.
Patent No. 11,799,131 Group Art Unit: 1725
Issued: October 24, 2023
For: ELECTROLYTE AND ELECTROCHEMICAL DEVICE

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

STATEMENT OF CURRENTLY NAMED INVENTOR AGREEING TO CHANGE IN INVENTORSHIP UNDER 37 CFR 1.324(b)(1)

I, Liangzhen XIAO, declare that:

1. I have reviewed Claims 1-17 of Patent No. 11,799,131.
2. I confirm that I am an inventor of the invention claimed in 11,799,131.
3. I agree to the change in inventorship to remove Qiao ZENG as an inventor.
4. I agree that Kefei WANG and Fei WU should also be listed as inventors of Patent No. 11,799,131.

Signature: Liangzhen XIAO Date: 2024.9.12
Liangzhen XIAO

Attorney's Docket No. 14850089COB

PATENT

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re: Kefei WANG et. al.
Patent No. 11,799,131 Group Art Unit: 1725
Issued: October 24, 2023
For: ELECTROLYTE AND ELECTROCHEMICAL DEVICE

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

STATEMENT OF CURRENTLY NAMED INVENTOR AGREEING TO CHANGE IN INVENTORSHIP UNDER 37 CFR 1.324(b)(1)

I, Kefei WANG, declare that:

1. I have reviewed Claims 1-17 of Patent No. 11,799,131.
2. I confirm that I am an inventor of the invention claimed in 11,799,131.
3. I agree to the change in inventorship to remove Qiao ZENG as an inventor.
4. I agree that Fei WU and Liangzhen XIAO should also be listed as inventors of Patent No. 11,799,131.

Signature: Kefei WANG Date: Sep. 12th 2024
Kefei WANG

IN THE UNITED STATES PATENT & TRADEMARK OFFICE

Patentee: NINGDE AMPEREX TECHNOLOGY LIMITED U.S. Patent Application No.: 17/885,920 Filed: August 11, 2022 U.S. Patent No.: 11,799,131 B2 Issued: October 24, 2023 Title: ELECTROLYTE AND ELECTROCHEMICAL DEVICE	Confirmation No.: 7924 Art Unit: 1725 Examiner: KENNETH J DOUYETTE Attorney Docket No.: 14850089COB

PETITION FOR CORRECTION OF INVENTORSHIP UNDER 37 CFR 1.324

Commissioner for Patents
ATTN: Office of Petitions
P.O. Box 1450
Alexandria, VA 22313-1450

October 8, 2024

Dear Commissioner:

Patentee hereby petitions under 37 CFR § 1.324 that the designation of inventorship in the above-identified patent be amended to remove the named inventor Qiao ZENG.

This petition is accompanied by:

(1) a statement, in accordance with 37 C.F.R. § 1.324(b)(1) by Qiao ZENG, agreeing to the change of inventorship,

(2) statements, in accordance with 37 C.F.R. § 1.324(b)(1), from each person who is currently named as an inventor either agreeing to the change of inventorship or stating that he or she has no disagreement in regard to the requested change, executed by the currently named inventors, Kefei WANG, Liangzhen XIAO, and Fei WU,

(3) a statement of the assignee of the above-identified patent, NINGDE AMPEREX TECHNOLOGY LIMITED, agreeing to the change of inventorship in the patent pursuant to 37 CFR § 1.324(b)(2), and

(4) a processing fee in the amount of $160.00 for the petition fee as required by 37 CFR § 1.20(b). Any additional fee or refund associated with this Petition may be charged to our Deposit Account No. 50-5976.

Upon approval of the Petition, Patentee will file a Certificate of Correction to reflect the change in inventorship.

MAIER & MAIER, PLLC
345 South Patrick Street
Alexandria, VA 22314
(703) 740-8322
Customer No. 62008

Respectfully submitted,

/Timothy J. Maier/
Timothy J. Maier
Attorney of Record
Reg. No. 51986

TJM/npl

Attorney's Docket No. 14850089COB

PATENT

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re: Kefei WANG et. al.
Patent No. 11,799,131 Group Art Unit: 1725
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For: ELECTROLYTE AND ELECTROCHEMICAL DEVICE

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

STATEMENT OF CURRENTLY NAMED INVENTOR AGREEING TO CHANGE IN INVENTORSHIP UNDER 37 CFR 1.324(b)(1)

I, Fei WU, declare that:

1. I have reviewed Claims 1-17 of Patent No. 11,799,131.
2. I confirm that I am an inventor of the invention claimed in 11,799,131.
3. I agree to the change in inventorship to remove Qiao ZENG as an inventor.
4. I agree that Kefei WANG and Liangzhen XIAO should also be listed as inventors of Patent No. 11,799,131.

Signature: Fei Wu Date: 2024. 9. 14.
Fei WU

UNITED STATES PATENT AND TRADEMARK OFFICE

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

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
17/885,920	08/11/2022	Kefei WANG	14850089COB	7924

62008 7590 10/24/2023

MAIER & MAIER, PLLC
345 SOUTH PATRICK STREET
ALEXANDRIA, VA 22314

EXAMINER	
DOUYETTE, KENNETH J	

ART UNIT	PAPER NUMBER
1725	

NOTIFICATION DATE	DELIVERY MODE
10/24/2023	ELECTRONIC

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

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

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

docket@maierandmaier.com
maierandmaier_PAIR@firsttofile.com

PTOL-90A (Rev. 04/07)

UNITED STATES PATENT AND TRADEMARK OFFICE

UNITED STATES DEPARTMENT OF COMMERCE
United States Patent and Trademark Office
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APPLICATION NO.	ISSUE DATE	PATENT NO.
17/885,920	24-Oct-2023	11799131

MAIER & MAIER, PLLC
345 SOUTH PATRICK STREET
ALEXANDRIA, VA 22314

EGRANT NOTIFICATION

Your electronic patent grant (eGrant) is now available, which can be accessed via Patent Center at https://patentcenter.uspto.gov

The electronic patent grant is the official patent grant under 35 U.S.C. 153. For more information, please visit https://www.uspto.gov/electronicgrants

UNITED STATES PATENT AND TRADEMARK OFFICE

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APPLICATION NO.	ISSUE DATE	PATENT NO.	ATTORNEY DOCKET NO.	CONFIRMATION NO.
17/885,920	10/24/2023	11799131	14850089COB	7924

62008 7590 10/04/2023

MAIER & MAIER, PLLC
345 SOUTH PATRICK STREET
ALEXANDRIA, VA 22314

ISSUE NOTIFICATION

The projected patent number and issue date are specified above. The patent will issue electronically. The electronically issued patent is the official patent grant pursuant to 35 U.S.C. § 153. The patent may be accessed on or after the issue date through Patent Center at https://patentcenter.uspto.gov/. The patent will be available in both the public and the private sides of Patent Center. Further assistance in electronically accessing the patent, or about Patent Center, is available by calling the Patent Electronic Business Center at 1-888-217-9197.

The USPTO is implementing electronic patent issuance with a transition period, during which period the USPTO will mail a ceremonial paper copy of the electronic patent grant to the correspondence address of record. Additional copies of the patent (i.e., certified and presentation copies) may be ordered for a fee from the USPTO's Certified Copy Center at https://certifiedcopycenter.uspto.gov/index.html. The Certified Copy Center may be reached at (800)972-6382.

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

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

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

Applicant will be able to obtain more detailed information by accessing the Patent Center (https://patentcenter.uspto.gov).

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

IR103 (Rev. 10/09)

INVENTOR(s) (Please see PATENT CENTER site https://patentcenter.uspto.gov for additional inventors):

Kefei WANG, Ningde City, CHINA;
Qiao ZENG, Ningde City, CHINA;
Liangzhen XIAO, Ningde City, CHINA;
Fei WU, Ningde City, CHINA;

APPLICANT(s) (Please see PATENT CENTER site https://patentcenter.uspto.gov for additional applicants):

NINGDE AMPEREX TECHNOLOGY LIMITED, 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.

INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)		
	Application Number	
	Filing Date	2022-08-11
	First Named Inventor	Kefei WANG
	Art Unit	TBD
	Examiner Name	TBD
	Attorney Docket Number	14850089COB

/K.J.D/ Change(s) applied to document, /CLY 9/20/2023	17	20170317385	A1	2017-11-02	Zhang et al. ~~BASF CORPORATION~~	

If you wish to add additional U.S. Published Application citation information please click the Add button. Add

FOREIGN PATENT DOCUMENTS Remove

Examiner Initial*	Cite No	Foreign Document Number[3]	Country Code[2] i	Kind Code[4]	Publication Date	Name of Patentee or Applicant of cited Document	Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear	T[5]
/K.J.D/	1	107210486	CN	A	2017-09-26	Mitsubishi Chem Corp.	Corresponds to US Publication 20170324116A1	
/K.J.D/	2	108232300	CN	A	2018-06-29	Ningde Amperex Technology Ltd.	Corresponds to US Publication 20190214680A1	
/K.J.D/	3	105845984	CN	A	2016-08-10	Dongguan Shanshan Battery Mat. Co., Ltd.	English abstract	
/K.J.D/	4	106602131	CN	A	2017-04-26	Ningde Amperex Technology Ltd.	English abstract	
/K.J.D/	5	105047992	CN	A	2015-11-11	Ningde Amperex Technology Ltd.	English abstract	
/K.J.D/	6	105552439	CN	A	2016-05-04	Dongguan Shanshan Battery Mat. Co., Ltd.	English abstract	
/K.J.D/	7	106099187	CN	A	2016-11-09	Dongguan Kaixin Battery Mat. Co., Ltd.	English abstract	
/K.J.D/	8	106816633	CN	A	2017-06-09	University of Jiliang, China	English abstract	

INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)		
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	First Named Inventor	Kefei WANG
	Art Unit	TBD
	Examiner Name	TBD
	Attorney Docket Number	14850089COB

Change(s) Applied to document, /C.L./ 9/7/2023	6	20170324116	A1	2017-11-09	Ohashi MITSUBISHI CHEMICAL CORPORATION	
/K.J.D/	7	20190214680	A1	2019-07-11	Bo et al. NINGDE AMPEREX TECHNOLOGY LIMITED	
/K.J.D/	8	20170288268	A1	2017-10-05	Kim et al. SAMSUNG SDI CO., LTD.	
/K.J.D/	9	20170018803	A1	2017-01-19	Wang et al. NingDe Contemporary Amperex Technology Limited	
/K.J.D/	10	20190245245	A1	2019-08-08	Ningde Amperex Technology Limited Zhang et al.	
/K.J.D/	11	20180233778	A1	2018-08-16	Park et al. SK Innovation Co., Ltd.	
/K.J.D/	12	20180108947	A9	2018-04-19	Zhuang Ningde Amperex Technology Ltd.	
/K.J.D/	13	20160301103	A1	2016-10-13	Kim et al. SK INNOVATION CO., LTD.	
/K.J.D/	14	20140322596	A1	2014-10-30	Shaturnov et al. Samsung SDI Co., Ltd.	
/K.J.D/	15	20170125845	A1	2017-05-04	Yu et al. LG Chem, Ltd.	
/K.J.D/	16	20170069934	A1	2017-03-09	Kim et al. SAMSUNG SDI CO., LTD.	

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

PTO/SB/08a (01-22)
Approved for use through 05/31/2024. OMB 0651-0031
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE
Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it contains a valid OMB control number.

INFORMATION DISCLOSURE STATEMENT BY APPLICANT
(Not for submission under 37 CFR 1.99)

Application Number	
Filing Date	2022-08-11
First Named Inventor	Kefei WANG
Art Unit	TBD
Examiner Name	TBD
Attorney Docket Number	14850089COB

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
/K.J.D/	1	9812739	B2	2017-11-07	KEFEI	

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U.S.PATENT APPLICATION PUBLICATIONS Remove

Examiner Initial*	Cite No	Publication Number	Kind Code[1]	Publication Date	Name of Patentee or Applicant of cited Document	Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear
/K.J.D/	1	20110311864	A1	2011-12-22	Yamada et al. ~~SONY CORPORATION~~	
/K.J.D/	2	20120313570	A1	2012-12-13	Ohtaniuchi et al. ~~SONY CORPORATION~~	
/K.J.D/	3	20170346127	A1	2017-11-30	Zhang et al. ~~MITSUI CHEMICALS, INC.~~	
/K.J.D/	4	20170346136	A1	2017-11-30	~~Ningde Amperex Technology Limited~~ Wang	
/K.J.D/	5	20090061325	A1	2009-03-05	Odani et al. ~~Sony Corporation~~	

Change(s) applied to document,
/C.L./
/K.J.D/
9/20/2023

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 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. **Because electronic patent issuance may occur shortly after issue fee payment, any desired continuing application should preferably be filed prior to payment of this issue fee in order not to jeopardize copendency.**

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

62008 7590 09/07/2023
MAIER & MAIER, PLLC
345 SOUTH PATRICK STREET
ALEXANDRIA, VA 22314

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.
17/885,920	08/11/2022	Kefei WANG	14850089COB	7924

TITLE OF INVENTION: ELECTROLYTE AND ELECTROCHEMICAL DEVICE

APPLN. TYPE	ENTITY STATUS	ISSUE FEE DUE	PUBLICATION FEE DUE	PREV. PAID ISSUE FEE	TOTAL FEE(S) DUE	DATE DUE
nonprovisional	UNDISCOUNTED	$1200	$0.00	$0.00	$1200	12/07/2023

EXAMINER	ART UNIT	CLASS-SUBCLASS
DOUYETTE, KENNETH J	1725	429-188000

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

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

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

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

1 Maier & Maier, PLLC
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: NINGDE AMPEREX TECHNOLOGY LIMITED

(B) RESIDENCE: (CITY and STATE OR COUNTRY): Ningde City, CHINA

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

4a. Fees submitted: ☒ Issue Fee ❑ Publication Fee (if required)

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

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

☒ The Director is hereby authorized to charge ~~the required fee(s)~~, any deficiency, or credit any overpayment to Deposit Account No. 50-5976

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

❑ Applicant certifying micro entity status. See 37 CFR 1.29

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.

❑ 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 signed in accordance with 37 CFR 1.31 and 1.33. See 37 CFR 1.4 for signature requirements and certifications.

Authorized Signature /Timothy J. Maier/ Date September 18, 2023

Typed or printed name Timothy J. Maier Registration No. 51986

PTOL-85 Part B (08-18) Approved for use through 01/31/2020 OMB 0651-0033 U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE

UNITED STATES
PATENT AND TRADEMARK OFFICE

P.O. Box 1450
Alexandria, VA 22313 - 1450
www.uspto.gov

ELECTRONIC ACKNOWLEDGEMENT RECEIPT

APPLICATION #	RECEIPT DATE / TIME	ATTORNEY DOCKET #
17/885,920	**09/18/2023 10:18:05 AM ET**	**14850089COB**

Title of Invention

ELECTROLYTE AND ELECTROCHEMICAL DEVICE

Application Information

APPLICATION TYPE	Utility - Nonprovisional Application under 35 USC 111(a)	PATENT #	-
CONFIRMATION #	7924	FILED BY	Beatriz Sanchez
PATENT CENTER #	62812177	FILING DATE	08/11/2022
CUSTOMER #	62008	FIRST NAMED INVENTOR	Kefei WANG
CORRESPONDENCE ADDRESS	-	AUTHORIZED BY	Timothy Maier

Documents **TOTAL DOCUMENTS: 1**

DOCUMENT	PAGES	DESCRIPTION	SIZE (KB)
Issue Fee Transmittal.pdf	1	Issue Fee Payment (PTO-85B)	181 KB

Digest

DOCUMENT	MESSAGE DIGEST(SHA-512)
Issue Fee Transmittal.pdf	A47E23EA17510795C78370CAE3BF8E3280A9EC739A28C2AB26C80298F087BCCBF8C991619FDA49A2676449B015A1EEFC8C77F6A0A9A746C70AEC494723CA10E5

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 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
P.O. Box 1450
Alexandria, VA 22313 - 1450
www.uspto.gov

ELECTRONIC PAYMENT RECEIPT

APPLICATION #	RECEIPT DATE / TIME	ATTORNEY DOCKET #
17/885,920	09/18/2023 10:18:05 AM ET	14850089COB

Title of Invention

ELECTROLYTE AND ELECTROCHEMICAL DEVICE

Application Information

APPLICATION TYPE	Utility - Nonprovisional Application under 35 USC 111(a)	PATENT #	-
CONFIRMATION #	7924	FILED BY	Beatriz Sanchez
PATENT CENTER #	62812177	AUTHORIZED BY	Timothy Maier
CUSTOMER #	62008	FILING DATE	08/11/2022
CORRESPONDENCE ADDRESS	-	FIRST NAMED INVENTOR	Kefei WANG

Payment Information

PAYMENT METHOD	PAYMENT TRANSACTION ID	PAYMENT AUTHORIZED BY
CARD / 8716	E20239HA18529119	Beatriz Sanchez

FEE CODE	DESCRIPTION	ITEM PRICE($)	QUANTITY	ITEM TOTAL($)
1501	UTILITY ISSUE FEE	1200.00	1	1200.00
			TOTAL AMOUNT:	$1,200.00

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

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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

62008 7590 09/07/2023

MAIER & MAIER, PLLC
345 SOUTH PATRICK STREET
ALEXANDRIA, VA 22314

EXAMINER	
DOUYETTE, KENNETH J	
ART UNIT	PAPER NUMBER
1725	

DATE MAILED: 09/07/2023

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
17/885,920	08/11/2022	Kefei WANG	14850089COB	7924

TITLE OF INVENTION: ELECTROLYTE AND ELECTROCHEMICAL DEVICE

APPLN. TYPE	ENTITY STATUS	ISSUE FEE DUE	PUBLICATION FEE DUE	PREV. PAID ISSUE FEE	TOTAL FEE(S) DUE	DATE DUE
nonprovisional	UNDISCOUNTED	$1200	$0.00	$0.00	$1200	12/07/2023

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

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

HOW TO REPLY TO THIS NOTICE:

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

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

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

For purposes of this notice, small entity fees are 40% the amount of undiscounted fees, and micro entity fees are 20% the amount of undiscounted fees.

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

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

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

PTOL-85 (Rev. 02/11)

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 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. **Because electronic patent issuance may occur shortly after issue fee payment, any desired continuing application should preferably be filed prior to payment of this issue fee in order not to jeopardize copendency.**

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

62008 7590 09/07/2023
MAIER & MAIER, PLLC
345 SOUTH PATRICK STREET
ALEXANDRIA, VA 22314

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.
17/885,920	08/11/2022	Kefei WANG	14850089COB	7924

TITLE OF INVENTION: ELECTROLYTE AND ELECTROCHEMICAL DEVICE

APPLN. TYPE	ENTITY STATUS	ISSUE FEE DUE	PUBLICATION FEE DUE	PREV. PAID ISSUE FEE	TOTAL FEE(S) DUE	DATE DUE
nonprovisional	UNDISCOUNTED	$1200	$0.00	$0.00	$1200	12/07/2023

EXAMINER	ART UNIT	CLASS-SUBCLASS
DOUYETTE, KENNETH J	1725	429-188000

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

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

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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)

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

❑ Electronic Payment via Patent Center or 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

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.

❑ Applicant asserting small entity status. See 37 CFR 1.27

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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. _____

PTOL-85 Part B (08-18) Approved for use through 01/31/2020 OMB 0651-0033 U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE

Zhuhai CosMX Battery Co. - EX1002
Zhuhai CosMX Battery Co. v. Ningde Amperex Tech. Ltd.
IPR2025-00722
Page 24 of 273

UNITED STATES PATENT AND TRADEMARK OFFICE

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

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
17/885,920	08/11/2022	Kefei WANG	14850089COB	7924

62008 7590 09/07/2023

MAIER & MAIER, PLLC
345 SOUTH PATRICK STREET
ALEXANDRIA, VA 22314

EXAMINER	
DOUYETTE, KENNETH J	

ART UNIT	PAPER NUMBER
1725	

DATE MAILED: 09/07/2023

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

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

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

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

PTOL-85 (Rev. 02/11)

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

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

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

Privacy Act Statement

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

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

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

Notice of Allowability	Application No. 17/885,920	Applicant(s) WANG et al.	
	Examiner KENNETH J DOUYETTE	Art Unit 1725	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 7/20/2023.
   ☐ 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 1-3,5-7,9-18 and 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. 16/211,853 .
   3. ☐ Copies of the certified copies of the priority documents have been received in this national stage application from the International Bureau (PCT Rule 17.2(a)).

   * Certified copies not received: _____ .

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

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

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

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

Attachment(s)

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

/KENNETH J DOUYETTE/
Primary Examiner, Art Unit 1725

Zhuhai CosMX Battery Co. - EX1002
Zhuhai CosMX Battery Co. v. Ningde Amperex Tech. Ltd.
IPR2025-00722
Page 27 of 273

DETAILED ACTION

Response to Amendment

1. Claims 1-3, 5-7, 9-18 and 20 are pending in the application. Previous grounds of rejection and claim objections have been withdrawn as a result of the amendment to the claims submitted 7/20/2023.

EXAMINER'S AMENDMENT

2. An examiner's amendment to the record appears below. Should the changes and/or additions be unacceptable to applicant, an amendment may be filed as provided by 37 CFR 1.312. To ensure consideration of such an amendment, it MUST be submitted no later than the payment of the issue fee.

The application has been amended as follows:

TO THE SPECIFICATION

- **P1/L4** has been amended to recite: "~~17/0649591~~7/064,782, now U.S. Patent No. 11,522,222, which is a continuation application of US Application"

- **P1/L5** has been amended to recite: "16/211,853, now ~~US Patent 10/833,363,~~ U.S. Patent No. 10,833,363, where 16/211,853 claims the"

Terminal Disclaimer

3. The terminal disclaimer filed on 7/20/2023 disclaiming the terminal portion of any patent granted on this application which would extend beyond the expiration date of:

- U.S. Patent No. 11,522,222;
- U.S. Patent No 10,833,363;
- any U.S. patent granted on US 17/990,641;
- any U.S. patent granted on US 17/990,626;
- any U.S. patent granted on US 17/885,915;
- any U.S. patent granted on US 18/076,882

...has been reviewed and is accepted. The terminal disclaimer has been recorded.

Allowable Subject Matter

4. Claims 1-3, 5-7, 9-18 and 20 are allowed.

5. The following is an examiner's statement of reasons for allowance: Applicant's arguments submitted 7/20/2023 with respect to amended instant independent claims 1 and 16 have been found persuasive. Instant independent claims 1 and 16 each disclose electrochemical devices, each comprising an electrolyte having the specific compounds at the explicit amounts and ratios as set forth in the claims and the explicit electrode structure as set forth in the claims.

Hong, Ohashi, and Zhang are considered to be the prior art references of record closest to the aforementioned claim limitations. However, as persuasively argued by the Applicants, the aforementioned references, neither alone or in any combination, disclose or render obvious all of the aforementioned claim limitations. Namely, while the applied references disclose a battery electrolyte having a number of organic compound constituents at various combinations and ratios with the electrode structure as set forth in the claims, none disclose nor render obvious the electrolyte having the specific organic compounds at the explicit amounts and ratios as set forth in the claims and electrode structure as set forth in the claim.

A further search did not reveal any additional references that alleviate the previously cited prior art references. Therefore, instant independent claims 1 and 16 are found allowable over the cited prior art references of record.

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

6. Any inquiry concerning this communication or earlier communications from the examiner should be directed to KENNETH J DOUYETTE whose telephone number is (571)270-1212. The examiner can normally be reached Monday - Friday 8A - 4P EST.

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

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

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Basia Ridley can be reached on 571-272-1453. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

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

/KENNETH J DOUYETTE/
Primary Examiner, Art Unit 1725

Search Notes	Application/Control No.	Applicant(s)/Patent Under Reexamination
	17/885,920	WANG et al.
	Examiner	Art Unit
	KENNETH J DOUYETTE	1725

CPC - Searched*		
Symbol	Date	Examiner
H01M 10/04, 10/04, 10/0566, 10/0525, 10/0566	04/14/2023	KD
updated above CPC search	08/11/2023	KD

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
PDP inventor / assignee database search	04/14/2023	KD
global dossier search for pertinent documents	04/14/2023	KD
google.com search for battery electrolytes	04/14/2023	KD
reviewed filewrapper of parent apps 16211853, 17064782	04/14/2023	KD
SEARCH, see text search history	04/14/2023	KD
updated above PDP and SEARCH, see text search history	08/11/2023	KD

Zhuhai CosMX Battery Co. - EX1002
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IPR2025-00722
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Search Notes	Application/Control No.	Applicant(s)/Patent Under Reexamination
	17/885,920	WANG et al.
	Examiner	Art Unit
	KENNETH J DOUYETTE	1725

Interference Search			
US Class/CPC Symbol	US Subclass/CPC Group	Date	Examiner
H01M	10/04, 10/04, 10/0566, 10/0525, 10/0566	08/11/2023	KD

Zhuhai CosMX Battery Co. - EX1002
Zhuhai CosMX Battery Co. v. Ningde Amperex Tech. Ltd.
IPR2025-00722
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Issue Classification	Application/Control No.	Applicant(s)/Patent Under Reexamination
	17/885,920	WANG et al.
	Examiner	**Art Unit**
	KENNETH J DOUYETTE	1725

CPC						
Symbol					**Type**	**Version**
H01M	/	10	/	0566	F	2013-01-01
H01M	/	10	/	0525	I	2013-01-01
H01M	/	10	/	0567	I	2013-01-01
H01M	/	10	/	0569	I	2013-01-01
H01M	/	4	/	64	I	2013-01-01
H01M	/	4	/	13	I	2013-01-01
H01M	/	2300	/	0025	A	2013-01-01
H01M	/	2300	/	0034	A	2013-01-01
H01M	/	2300	/	0037	A	2013-01-01

CPC Combination Sets							
Symbol					**Type**	**Set**	**Ranking**	**Version**
	/		/					

NONE		**Total Claims Allowed:**	
(Assistant Examiner)	(Date)	17	
/KENNETH J DOUYETTE/ Primary Examiner, Art Unit 1725	11 August 2023	O.G. Print Claim(s)	O.G. Print Figure
(Primary Examiner)	(Date)	1	1C

U.S. Patent and Trademark Office — Part of Paper No.: 20230721

Zhuhai CosMX Battery Co. - EX1002
Zhuhai CosMX Battery Co. v. Ningde Amperex Tech. Ltd.
IPR2025-00722
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Issue Classification	Application/Control No.	Applicant(s)/Patent Under Reexamination
	17/885,920	WANG et al.
	Examiner	Art Unit
	KENNETH J DOUYETTE	1725

INTERNATIONAL CLASSIFICATION				
CLAIMED				
H01M	/	4	/	64
H01M	/	4	/	13
H01M	/	10	/	0566
H01M	/	10	/	0525

NON-CLAIMED				
	/		/	

US ORIGINAL CLASSIFICATION	
CLASS	SUBCLASS
429	188

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

NONE		Total Claims Allowed:	
(Assistant Examiner)	(Date)	17	
/KENNETH J DOUYETTE/ Primary Examiner, Art Unit 1725	11 August 2023	O.G. Print Claim(s)	O.G. Print Figure
(Primary Examiner)	(Date)	1	1C

U.S. Patent and Trademark Office — Part of Paper No.: 20230721

Zhuhai CosMX Battery Co. - EX1002
Zhuhai CosMX Battery Co. v. Ningde Amperex Tech. Ltd.
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Issue Classification	Application/Control No.	Applicant(s)/Patent Under Reexamination
	17/885,920	WANG et al.
	Examiner	Art Unit
	KENNETH J DOUYETTE	1725

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

CLAIMS

Final	Original	Final	Original	Final	Original	Final	Original	Final	Original	Final	Original	Final	Original	Final	Original
1	1	8	10		19										
2	2	9	11	17	20										
3	3	10	12												
	4	11	13												
4	5	12	14												
5	6	13	15												
6	7	14	16												
	8	15	17												
7	9	16	18												

NONE		Total Claims Allowed:	
(Assistant Examiner)	(Date)	17	
/KENNETH J DOUYETTE/ Primary Examiner, Art Unit 1725	11 August 2023	O.G. Print Claim(s)	O.G. Print Figure
(Primary Examiner)	(Date)	1	1C

U.S. Patent and Trademark Office — Part of Paper No.: 20230721

Zhuhai CosMX Battery Co. - EX1002
Zhuhai CosMX Battery Co. v. Ningde Amperex Tech. Ltd.
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PE2E SEARCH - Search History (Prior Art)

Ref #	Hits	Search Query	DBs	Default Operator	Plurals	British Equivalents	Time Stamp
L1	8	"20150140446"	(US-PGPUB; USPAT)	OR	ON	ON	2023/03/14 04:55 PM
L2	20	("2015/0140446").urpn. AND (PGPB | USPT | USOC).dbnm.	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2023/03/14 04:55 PM
L3	40	(Artificial Intelligence) More like doc: US-20150140446-A1 Text: (WO-2015073419-A1 OR EP-3072178-A1 OR US-9698447-B2 OR EP-3072178-B1 OR KR-102298774-B1 OR KR-20160086838-A OR JP-2017504145-A OR CN-105745780-A OR CN-105745780-B OR US-20170207486-A1 OR WO-2016011613-A1 OR KR-101586139-B1 OR CN-104781975-A OR CN-104781975-B OR US-20140349198-A1 OR CN-109994775-B OR WO-2020079819-A1 OR KR-102050964-B1 OR JP-2015522210-A OR KR-20150114460-A).did.	(US-PGPUB; USPAT; USOCR; FIT (AU, AP, AT, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, OA, RU, SU, WO, MC, MD, MY, NL, NO, NZ, PH, PL, PT, RO, RS, SE, SG, SI, SK, TH, TN, TR, TW, UA, VN); FPRS; EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2023/03/14 04:56 PM
L4	0	"170317385"	(US-PGPUB; USPAT)	OR	ON	ON	2023/03/14 04:58 PM
L5	4	"20170317385"	(US-PGPUB; USPAT)	OR	ON	ON	2023/03/14 04:58 PM
L6	4	"20170069934"	(US-PGPUB; USPAT)	OR	ON	ON	2023/03/14 04:58 PM
L7	4	"20170125845"	(US-PGPUB; USPAT)	OR	ON	ON	2023/03/14 04:58 PM
L8	4	"20140322596"	(US-PGPUB; USPAT)	OR	ON	ON	2023/03/14 04:58 PM
L9	4	"20160301103"	(US-PGPUB; USPAT)	OR	ON	ON	2023/03/14 04:58 PM
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L13	4	"20170018803"	(US-PGPUB; USPAT)	OR	ON	ON	2023/03/14

							04:59 PM
L14	5	"20170288268"	(US-PGPUB; USPAT)	OR	ON	ON	2023/03/14 04:59 PM
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L18	4	"20170346136"	(US-PGPUB; USPAT)	OR	ON	ON	2023/03/14 05:00 PM
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L20	3	"20120313570"	(US-PGPUB; USPAT)	OR	ON	ON	2023/03/14 05:00 PM
L21	5	"20110311864"	(US-PGPUB; USPAT)	OR	ON	ON	2023/03/14 05:00 PM
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L24	10	h01m$.cpc. AND battery AND electrolyte AND dinitrile SAME trinitrile SAME propyl ADJ propionate	(US-PGPUB; USPAT)	OR	ON	ON	2023/03/14 05:01 PM
L25	10	h01m$.cpc. AND battery AND electrolyte AND dinitrile SAME trinitrile SAME propionate	(US-PGPUB; USPAT)	OR	ON	ON	2023/03/14 05:02 PM
L26	32	h01m$.cpc. AND battery AND electrolyte AND dinitrile SAME trinitrile AND propyl ADJ propionate	(US-PGPUB; USPAT)	OR	ON	ON	2023/03/14 05:02 PM
L27	15	h01m$.cpc. AND battery AND electrolyte AND dinitrile SAME trinitrile SAME glycol AND propyl ADJ propionate	(US-PGPUB; USPAT)	OR	ON	ON	2023/03/14 05:02 PM
L28	1	("2016/0294007").urpn. AND (PGPB | USPT | USOC).dbnm.	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2023/03/14 05:02 PM
L29	7	("20120009487" | "20140072865" | "20140134461").pn. OR ("9812739").urpn. AND	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2023/03/14 05:03 PM

		(PGPB | USPT | USOC).dbnm.					
L30	32	battery AND electrolyte AND dinitrile SAME trinitrile AND propyl ADJ propionate	(US-PGPUB; USPAT)	OR	ON	ON	2023/03/14 05:03 PM
L31	32	battery AND electrolyte AND dinitrile SAME trinitrile AND propyl ADJ propionate	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2023/03/14 05:03 PM
L32	200	battery AND electrolyte AND dinitrile SAME trinitrile AND propyl ADJ propionate	(FIT (AU, AP, AT, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, OA, RU, SU, WO, MC, MD, MY, NL, NO, NZ, PH, PL, PT, RO, RS, SE, SG, SI, SK, TH, TN, TR, TW, UA, VN); FPRS; EPO; JPO; DERWENT)	OR	ON	ON	2023/03/14 05:03 PM
L33	11	battery AND electrolyte AND dinitrile SAME trinitrile AND propyl ADJ propionate	(FPRS; EPO; JPO; DERWENT)	OR	ON	ON	2023/03/14 05:03 PM
L34	11	battery AND electrolyte AND dinitrile SAME trinitrile AND propyl near3 propionate	(FPRS; EPO; JPO; DERWENT)	OR	ON	ON	2023/03/14 05:03 PM
L35	14	battery AND electrolyte AND dinitrile SAME trinitrile AND propyl ADJ propionate SAME (amount ratio)	(US-PGPUB; USPAT)	OR	ON	ON	2023/03/14 05:04 PM
L36	32	h01m$.cpc. AND battery AND electrolyte AND dinitrile AND trinitrile AND propyl ADJ propionate	(US-PGPUB; USPAT)	OR	ON	ON	2023/03/14 05:05 PM
L37	33	h01m$.cpc. AND battery AND electrolyte AND (glutaronitrile adiponitrile dinitrile) AND trinitrile AND propyl ADJ propionate	(US-PGPUB; USPAT)	OR	ON	ON	2023/03/14 05:06 PM
L38	681	h01m$.cpc. AND battery AND electrolyte AND (glutaronitrile adiponitrile dinitrile) AND propyl ADJ propionate	(US-PGPUB; USPAT)	OR	ON	ON	2023/03/14 05:07 PM
L39	110	h01m$.cpc. AND	(US-PGPUB; USPAT)	OR	ON	ON	2023/03/14

		battery AND electrolyte AND (glutaronitrile adiponitrile dinitrile) SAME propyl ADJ propionate					05:07 PM
L40	10	h01m$.cpc. AND battery AND electrolyte AND (glutaronitrile adiponitrile dinitrile) SAME propyl ADJ propionate SAME (amount ratio)	(US-PGPUB; USPAT)	OR	ON	ON	2023/03/14 05:07 PM
L41	547	h01m$.cpc. AND battery AND electrolyte AND (glutaronitrile adiponitrile dinitrile) SAME propyl ADJ propionate	(FIT (AU, AP, AT, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, OA, RU, SU, WO, MC, MD, MY, NL, NO, NZ, PH, PL, PT, RO, RS, SE, SG, SI, SK, TH, TN, TR, TW, UA, VN); FPRS; EPO; JPO; DERWENT)	OR	ON	ON	2023/03/14 05:07 PM
L42	95	h01m$.cpc. AND battery AND electrolyte AND (glutaronitrile adiponitrile dinitrile) SAME propyl ADJ propionate	(FPRS; EPO; JPO; DERWENT)	OR	ON	ON	2023/03/14 05:07 PM
L43	22	h01m$.cpc. AND battery AND electrolyte AND (glutaronitrile adiponitrile dinitrile) SAME propyl ADJ propionate SAME (amount ratio)	(FPRS; EPO; JPO; DERWENT)	OR	ON	ON	2023/03/14 05:07 PM
L44	52	battery AND electrolyte AND (glutaronitrile adiponitrile dinitrile) SAME propyl ADJ propionate SAME (amount ratio)	(FPRS; EPO; JPO; DERWENT)	OR	ON	ON	2023/03/14 05:07 PM
L45	33	h01m$.cpc. AND battery AND electrolyte AND (glutaronitrile adiponitrile dinitrile) AND trinitrile AND propyl ADJ propionate AND (amount ratio)	(US-PGPUB; USPAT)	OR	ON	ON	2023/03/14 05:08 PM
L46	6	("20100216035" | "20110229772" | "20130093392" | "20130230768" |	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2023/03/15 10:43 AM

		"20150236382" | "20160226103").pn. OR ("10424813").urpn. AND (PGPB | USPT | USOC).dbnm.					
L47	46	(Artificial Intelligence) More like doc: US-20180034105-A1 Text: (EP-3273520-A1 OR US-10424813-B2 OR EP-3273520-B1 OR JP-WO2016148128-A1 OR WO-2016148128-A1 OR JP-6627860-B2 OR CN-107408734-B OR CN-107408734-A OR JP-2012038716-A OR JP-2020102451-A OR JP-2006059797-A OR JP-5978796-B2 OR JP-6713452-B2 OR JP-2010198922-A OR JP-2014002976-A OR JP-4894157-B2 OR JP-5391938-B2 OR US-20200274199-A1 OR JP-2011054490-A OR JP-2002158035-A).did.	(US-PGPUB; USPAT; USOCR; FIT (AU, AP, AT, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, OA, RU, SU, WO, MC, MD, MY, NL, NO, NZ, PH, PL, PT, RO, RS, SE, SG, SI, SK, TH, TN, TR, TW, UA, VN); FPRS; EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2023/03/15 10:43 AM
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L49	153	h01m$.cpc. AND battery AND electrolyte AND (glutaronitrile adiponitrile dinitrile) AND propyl ADJ propionate SAME (amount ratio)	(US-PGPUB; USPAT)	OR	ON	ON	2023/03/15 10:44 AM
L50	11	h01m$.cpc. AND battery AND electrolyte AND (glutaronitrile adiponitrile dinitrile) AND propyl ADJ propionate near2 (amount ratio)	(US-PGPUB; USPAT)	OR	ON	ON	2023/03/15 10:44 AM
L51	3	"20170324116"	(US-PGPUB; USPAT)	OR	ON	ON	2023/03/15 08:54 PM
L52	1	"106848381"	(DERWENT)	OR	ON	ON	2023/03/15 09:24 PM
L53	23	h01m$.cpc. AND	(US-PGPUB; USPAT;	OR	ON	ON	2023/03/18

		battery AND electrolyte SAME butanedinitrile	USOCR)				10:10 AM
L54	16	h01m$.cpc. AND battery AND electrolyte SAME butanedinitrile AND fec	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2023/03/18 10:15 AM
L55	0	h01m$.cpc. AND battery AND electrolyte SAME butanedinitrile AND cabonate SAME ester	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2023/04/13 12:17 PM
L57	25	h01m$.cpc. AND battery AND electrolyte SAME butanedinitrile AND carbonate	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2023/04/13 12:17 PM
L58	25	battery AND electrolyte SAME butanedinitrile AND carbonate	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2023/04/13 12:17 PM
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L61	37	(Artificial Intelligence) More like doc: US-20150140446-A1 Text: (EP-3072178-A1 OR WO-2015073419-A1 OR US-9698447-B2 OR EP-3072178-B1 OR KR-102298774-B1 OR KR-20160086838-A OR JP-2017504145-A OR CN-105745780-A OR CN-105745780-B OR US-20170207486-A1 OR WO-2016011613-A1 OR WO-2020079819-A1 OR KR-102050964-B1 OR KR-20150114460-A OR JP-6177339-B2 OR EP-2917957-B1 OR JP-2015534254-A OR WO-2014074118-A1 OR EP-2917957-A1 OR EP-3072178-A4).did.	(US-PGPUB; USPAT; USOCR; FIT (AU, AP, AT, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, OA, RU, SU, WO, MC, MD, MY, NL, NO, NZ, PH, PL, PT, RO, RS, SE, SG, SI, SK, TH, TN, TR, TW, UA, VN); FPRS; EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2023/07/17 12:38 PM
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L79	5	"20110311864"	(US-PGPUB; USPAT)	OR	ON	ON	2023/07/17 12:38 PM
L80	1	"9812739".pn.	(US-PGPUB; USPAT)	OR	ON	ON	2023/07/17 12:38 PM
L81	7	("20120009487" | "20140072865" | "20140134461").pn. OR ("9812739").urpn. AND (PGPB | USPT | USOC).dbnm.	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2023/07/17 12:38 PM
L82	12	h01m$.cpc. AND battery AND electrolyte AND dinitrile SAME trinitrile SAME propyl ADJ propionate	(US-PGPUB; USPAT)	OR	ON	ON	2023/07/17 12:38 PM
L83	12	h01m$.cpc. AND battery AND electrolyte AND dinitrile SAME trinitrile SAME propionate	(US-PGPUB; USPAT)	OR	ON	ON	2023/07/17 12:38 PM
L84	35	h01m$.cpc. AND battery AND electrolyte AND dinitrile SAME trinitrile AND propyl	(US-PGPUB; USPAT)	OR	ON	ON	2023/07/17 12:38 PM

		ADJ propionate					
L85	17	h01m$.cpc. AND battery AND electrolyte AND dinitrile SAME trinitrile SAME glycol AND propyl ADJ propionate	(US-PGPUB; USPAT)	OR	ON	ON	2023/07/17 12:38 PM
L86	1	("2016/0294007").urpn. AND (PGPB | USPT | USOC).dbnm.	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2023/07/17 12:38 PM
L87	7	("20120009487" | "20140072865" | "20140134461").pn. OR ("9812739").urpn. AND (PGPB | USPT | USOC).dbnm.	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2023/07/17 12:38 PM
L88	35	battery AND electrolyte AND dinitrile SAME trinitrile AND propyl ADJ propionate	(US-PGPUB; USPAT)	OR	ON	ON	2023/07/17 12:38 PM
L89	35	battery AND electrolyte AND dinitrile SAME trinitrile AND propyl ADJ propionate	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2023/07/17 12:38 PM
L90	216	battery AND electrolyte AND dinitrile SAME trinitrile AND propyl ADJ propionate	(FIT (AU, AP, AT, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, OA, RU, SU, WO, MC, MD, MY, NL, NO, NZ, PH, PL, PT, RO, RS, SE, SG, SI, SK, TH, TN, TR, TW, UA, VN); FPRS; EPO; JPO; DERWENT)	OR	ON	ON	2023/07/17 12:38 PM
L91	11	battery AND electrolyte AND dinitrile SAME trinitrile AND propyl ADJ propionate	(FPRS; EPO; JPO; DERWENT)	OR	ON	ON	2023/07/17 12:38 PM
L92	11	battery AND electrolyte AND dinitrile SAME trinitrile AND propyl near3 propionate	(FPRS; EPO; JPO; DERWENT)	OR	ON	ON	2023/07/17 12:38 PM
L93	16	battery AND electrolyte AND dinitrile SAME trinitrile AND propyl ADJ propionate SAME (amount ratio)	(US-PGPUB; USPAT)	OR	ON	ON	2023/07/17 12:38 PM
L94	35	h01m$.cpc. AND battery AND electrolyte AND dinitrile AND trinitrile AND propyl	(US-PGPUB; USPAT)	OR	ON	ON	2023/07/17 12:38 PM

		ADJ propionate					
L95	37	h01m$.cpc. AND battery AND electrolyte AND (glutaronitrile adiponitrile dinitrile) AND trinitrile AND propyl ADJ propionate	(US-PGPUB; USPAT)	OR	ON	ON	2023/07/17 12:38 PM
L96	745	h01m$.cpc. AND battery AND electrolyte AND (glutaronitrile adiponitrile dinitrile) AND propyl ADJ propionate	(US-PGPUB; USPAT)	OR	ON	ON	2023/07/17 12:38 PM
L97	117	h01m$.cpc. AND battery AND electrolyte AND (glutaronitrile adiponitrile dinitrile) SAME propyl ADJ propionate	(US-PGPUB; USPAT)	OR	ON	ON	2023/07/17 12:38 PM
L98	10	h01m$.cpc. AND battery AND electrolyte AND (glutaronitrile adiponitrile dinitrile) SAME propyl ADJ propionate SAME (amount ratio)	(US-PGPUB; USPAT)	OR	ON	ON	2023/07/17 12:38 PM
L99	580	h01m$.cpc. AND battery AND electrolyte AND (glutaronitrile adiponitrile dinitrile) SAME propyl ADJ propionate	(FIT (AU, AP, AT, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, OA, RU, SU, WO, MC, MD, MY, NL, NO, NZ, PH, PL, PT, RO, RS, SE, SG, SI, SK, TH, TN, TR, TW, UA, VN); FPRS; EPO; JPO; DERWENT)	OR	ON	ON	2023/07/17 12:38 PM
L100	98	h01m$.cpc. AND battery AND electrolyte AND (glutaronitrile adiponitrile dinitrile) SAME propyl ADJ propionate	(FPRS; EPO; JPO; DERWENT)	OR	ON	ON	2023/07/17 12:38 PM
L101	23	h01m$.cpc. AND battery AND electrolyte AND (glutaronitrile adiponitrile dinitrile) SAME propyl ADJ propionate SAME (amount ratio)	(FPRS; EPO; JPO; DERWENT)	OR	ON	ON	2023/07/17 12:38 PM
L102	56	battery AND electrolyte AND (glutaronitrile	(FPRS; EPO; JPO; DERWENT)	OR	ON	ON	2023/07/17 12:38 PM

		adiponitrile dinitrile) SAME propyl ADJ propionate SAME (amount ratio)					
L103	37	h01m$.cpc. AND battery AND electrolyte AND (glutaronitrile adiponitrile dinitrile) AND trinitrile AND propyl ADJ propionate AND (amount ratio)	(US-PGPUB; USPAT)	OR	ON	ON	2023/07/17 12:38 PM
L104	6	("20100216035" | "20110229772" | "20130093392" | "20130230768" | "20150236382" | "20160226103").pn. OR ("10424813").urpn. AND (PGPB | USPT | USOC).dbnm.	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2023/07/17 12:38 PM
L105	43	(Artificial Intelligence) More like doc: US-20180034105-A1 Text: (EP-3273520-A1 OR US-10424813-B2 OR EP-3273520-B1 OR JP-WO2016148128-A1 OR WO-2016148128-A1 OR JP-6627860-B2 OR CN-107408734-B OR CN-107408734-A OR JP-2012038716-A OR EP-2120279-A1 OR JP-2020102451-A OR JP-2006059797-A OR JP-5978796-B2 OR JP-2014002976-A OR JP-4894157-B2 OR EP-2120279-B1 OR US-20200274199-A1 OR EP-2768067-A2 OR JP-WO2019039345-A1 OR US-11631895-B2).did.	(US-PGPUB; USPAT; USOCR; FIT (AU, AP, AT, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, OA, RU, SU, WO, MC, MD, MY, NL, NO, NZ, PH, PL, PT, RO, RS, SE, SG, SI, SK, TH, TN, TR, TW, UA, VN); FPRS; EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2023/07/17 12:38 PM
L106	4	("20060035144" | "20140193707" | "20140295288" | "20150349381").pn. OR ("10886565").urpn. AND (PGPB | USPT | USOC).dbnm.	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2023/07/17 12:38 PM
L107	171	h01m$.cpc. AND battery AND electrolyte AND (glutaronitrile adiponitrile dinitrile) AND propyl ADJ	(US-PGPUB; USPAT)	OR	ON	ON	2023/07/17 12:38 PM

		propionate SAME (amount ratio)					
L108	11	h01m$.cpc. AND battery AND electrolyte AND (glutaronitrile adiponitrile dinitrile) AND propyl ADJ propionate near2 (amount ratio)	(US-PGPUB; USPAT)	OR	ON	ON	2023/07/17 12:38 PM
L109	3	"20170324116"	(US-PGPUB; USPAT)	OR	ON	ON	2023/07/17 12:38 PM
L110	1	"106848381"	(DERWENT)	OR	ON	ON	2023/07/17 12:38 PM
L111	29	h01m$.cpc. AND battery AND electrolyte SAME butanedinitrile	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2023/07/17 12:38 PM
L112	21	h01m$.cpc. AND battery AND electrolyte SAME butanedinitrile AND fec	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2023/07/17 12:38 PM
L113	0	h01m$.cpc. AND battery AND electrolyte SAME butanedinitrile AND cabonate SAME ester	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2023/07/17 12:38 PM
L114	28	h01m$.cpc. AND battery AND electrolyte SAME butanedinitrile AND carbonate	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2023/07/17 12:38 PM
L115	28	battery AND electrolyte SAME butanedinitrile AND carbonate	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2023/07/17 12:38 PM
L116	24	h01m$.cpc. AND battery AND electrolyte AND (glutaronitrile adiponitrile dinitrile) AND propyl ADJ propionate near2 (wt weight)	(US-PGPUB; USPAT)	OR	ON	ON	2023/07/17 12:39 PM
L117	10	("9812739" | "20060035144" | "20140322596" | "20160301103" | "20170018803" | "20170125845" | "20170288268" | "20180108947" | "20180233778" | "20190245245").pn. OR ("11024884").urpn. AND (PGPB | USPT | USOC).dbnm.	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2023/07/17 12:39 PM
L118	487	h01m$.cpc. AND battery AND electrolyte	(USOCR; FIT (AU, AP, AT, BE, BG, BR, BY,	OR	ON	ON	2023/07/17 12:40 PM

		AND (glutaronitrile adiponitrile dinitrile) AND trinitrile AND propyl ADJ propionate AND (amount ratio)	CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, OA, RU, SU, WO, MC, MD, MY, NL, NO, NZ, PH, PL, PT, RO, RS, SE, SG, SI, SK, TH, TN, TR, TW, UA, VN); FPRS; EPO; JPO; DERWENT)				
L119	487	h01m$.cpc. AND battery AND electrolyte AND (glutaronitrile adiponitrile dinitrile) AND trinitrile AND propyl ADJ propionate AND (amount ratio)	(FIT (AU, AP, AT, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, OA, RU, SU, WO, MC, MD, MY, NL, NO, NZ, PH, PL, PT, RO, RS, SE, SG, SI, SK, TH, TN, TR, TW, UA, VN); FPRS; EPO; JPO; DERWENT)	OR	ON	ON	2023/07/17 12:40 PM
L120	11	h01m$.cpc. AND battery AND electrolyte AND (glutaronitrile adiponitrile dinitrile) AND trinitrile AND propyl ADJ propionate AND (amount ratio)	(FPRS; EPO; JPO; DERWENT)	OR	ON	ON	2023/07/17 12:40 PM
L121	5	("20100143805" | "20110045361" | "20110159377" | "20180358655" | "20200044287").pn. OR ("11431028").urpn. AND (PGPB | USPT | USOC).dbnm.	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2023/07/17 12:40 PM

PE2E SEARCH - Search History (Interference)

Ref #	Hits	Search Query	DBs	Default Operator	Plurals	British Equivalents	Time Stamp
N1	0	(battery AND electrolyte AND dinitrile SAME trinitrile AND propyl ADJ propionate).clm.	(US-PGPUB; USPAT)	OR	ON	ON	2023/07/17 12:41 PM
N2	0	(battery AND electrolyte AND dinitrile AND trinitrile AND propyl ADJ propionate).clm.	(US-PGPUB; USPAT)	OR	ON	ON	2023/07/17 12:41 PM
N3	4	(battery AND electrolyte AND dinitrile AND	(US-PGPUB; USPAT)	OR	ON	ON	2023/07/17 12:41 PM

		propyl ADJ propionate).clm.					
N4	186	(battery AND electrolyte AND propyl ADJ propionate).clm.	(US-PGPUB; USPAT)	OR	ON	ON	2023/07/17 12:42 PM
N5	11	(battery AND electrolyte AND propyl ADJ propionate near3 (amount ratio wt weight)).clm.	(US-PGPUB; USPAT)	OR	ON	ON	2023/07/17 12:42 PM
N6	15	(battery AND electrolyte AND propyl ADJ propionate SAME (amount ratio wt weight)).clm.	(US-PGPUB; USPAT)	OR	ON	ON	2023/07/17 12:42 PM
N7	9	(battery AND electrolyte SAME butanedinitrile).clm.	(US-PGPUB; USPAT)	OR	ON	ON	2023/07/17 12:43 PM
N8	3	(battery AND electrolyte AND propyl ADJ propionate SAME nitrile).clm.	(US-PGPUB; USPAT)	OR	ON	ON	2023/07/17 12:44 PM
N9	31	(battery AND electrolyte AND propyl ADJ propionate SAME ether).clm.	(US-PGPUB; USPAT)	OR	ON	ON	2023/07/17 12:45 PM

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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
17/885,920	08/11/2022	Kefei WANG	14850089COB	7924

62008 7590 07/24/2023

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EXAMINER	
DOUYETTE, KENNETH J	

ART UNIT	PAPER NUMBER
1725	

NOTIFICATION DATE	DELIVERY MODE
07/24/2023	ELECTRONIC

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

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

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

docket@maierandmaier.com
maierandmaier_PAIR@firsttofile.com

PTOL-90A (Rev. 04/07)

Applicant-Initiated Interview Summary	Application No. 17/885,920	Applicant(s) WANG et al.		
	Examiner KENNETH J DOUYETTE	Art Unit 1725	AIA (First Inventor to File) Status Yes	Page 1 of 1

All Participants (applicant, applicants representative, PTO personnel)	Title	Type
KENNETH J DOUYETTE	Primary Examiner	Telephonic
ROBERT MADSEN, #58,543	Agent	
LIN CHEN, # L1386	Attorney	

Date of Interview: 18 July 2023

Issues Discussed:

35 U.S.C. 103

Applicant argues prior art does not disclose amended ranges of materials & compounds of proposed amendments and compares this to what the prior art reference(s) show, which is different/distinct from the proposed amendments. Examiner stated this appears persuasive. Further search & consideration needed before a final determination of patentability can be made.

Proposed Amendment(s)

Independent claims 1 and 16 amended to X+Y and X/Y ratios and to further define electrode structure

☑ Attachment

/KENNETH J DOUYETTE/ Primary Examiner, Art Unit 1725	

Applicant is reminded that a complete written statement as to the substance of the interview must be made of record in the application file. It is the applicants responsibility to provide the written statement, unless the interview was initiated by the Examiner and the Examiner has indicated that a written summary will be provided. See MPEP 713.04
Please further see:
MPEP 713.04
Title 37 Code of Federal Regulations (CFR) § 1.133 Interviews, paragraph (b)
37 CFR § 1.2 Business to be transacted in writing

Applicant recordation instructions: The formal written reply to the last Office action must include the substance of the interview. (See MPEP section 713.04). If a reply to the last Office action has already been filed, applicant is given a non-extendable period of the longer of one month or thirty days from this interview date, or the mailing date of this interview summary form, whichever is later, to file a statement of the substance of the interview.

Examiner recordation instructions: Examiners must summarize the substance of any interview of record. A complete and proper recordation of the substance of an interview should include the items listed in MPEP 713.04 for complete and proper recordation including the identification of the general thrust of each argument or issue discussed, a general indication of any other pertinent matters discussed regarding patentability and the general results or outcome of the interview, to include an indication as to whether or not agreement was reached on the issues raised.

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PROPOSED AMENDMENTS TO THE CLAIMS/CLAIM LIST

Please **CANCEL** claims 4, 8, and 19 without prejudice or disclaimer.

Please **AMEND** claims 1 and 16 as shown below.

The following list of claims replaces any prior listing of claims:

1. (Currently Amended) An electrochemical device, comprising:

an electrode; and

an electrolyte comprising a dinitrile compound, a trinitrile compound, and propyl propionate; wherein,

based on a total weight of the electrolyte, a weight percentage of the dinitrile compound is X, and a weight percentage of the trinitrile compound is Y; wherein,

about 2 wt% ≤ (X+Y) ≤ about ~~11 wt%~~ 8 wt%, and

about 0.1 ≤ (X/Y) ≤ about [[8]]6; wherein,

the electrode comprises a current collector, a single-sided coating and a double-sided coating;

a first part of the current collector is provided with the single-sided coating and a second part of the current collector is provided with the double-sided coating; and

an electrode compaction density of the electrode corresponding to the first part with the single-sided coating is D1, and, an electrode compaction density of the electrode corresponding to the second part with the double-sided coating is D2, wherein, about 0.8 ≤ D1/D2 ≤ about 1.2;

wherein based on the total weight of the electrolyte, a weight percentage of the propyl propionate is Z; wherein,

about 0.01 ≤ (Y/Z) ≤ about 0.3;

wherein the trinitrile compound is one selected from the group consisting of 1,3,5-pentanetricarbonitrile; 1,2,3-propanetrinitrile; 1,3,6-hexanetricarbonitrile; 1,2,6-hexanetricarbonitrile; 1,2,3-tris(2-cyanoethoxy)propane; 1,2,4-tris(2-cyanoethoxy)butane; 1,1,1-tris(cyanoethoxymethylene)ethane; 1,1,1-tris(cyanoethoxymethylene)propane; 3-methyl-1,3,5-tris(cyanoethoxy)pentane; 1,2,7-tris(cyanoethoxy)heptane; 1,2,6-tris(cyanoethoxy)hexane; 1,2,5-tris(cyanoethoxy)pentane; and any combination thereof.

2. (Original) The electrochemical device according to Claim 1, wherein the electrode is a cathode, and 3.5 g/cm^3 ≤ D2 ≤ 4.3 g/cm^3.

3. (Original) The electrochemical device according to Claim 1, wherein the electrode is an anode, and 1.2 g/cm^3 ≤ D2 ≤ 1.8 g/cm^3.

4. (Canceled)

5. (Original) The electrochemical device according to Claim 1, wherein the dinitrile compound further comprises a compound of Formula (4):

$CN\text{-}R_1\text{-}CN$ (4);

where R_1 selected from an alkylene group having 1-5 carbon atoms or an alkenylene group having 2-5 carbon atoms.

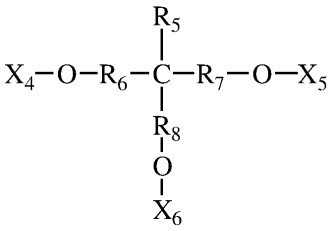
6. (Original) The electrochemical device according to Claim 1, wherein the dinitrile compound is one selected from the group consisting of butanedinitrile, glutaronitrile, adiponitrile, 1,5-dicyanopentane, 1,6-dicyanohexane, 1,7-dicyanoheptane, 1,8-dicyanooctane, 1,9-dicyanononane, 1,10-dicyanodecane, 1,12-dicyanododecane, tetramethylbutanedinitrile, 2-methylglutaronitrile, 2,4-dimethylglutaronitrile, 2,2,4,4-tetramethylglutaronitrile, 1,4-dicyanopentane, 2,6-dicyanoheptane, 2,7-dicyanooctane, 2,8-dicyanononane, 1,6-dicyanodecane, 1,2-dicyanobenzene, 1,3-dicyanobenzene, 1,4-dicyanobenzene, 3,5-dioxa-pimelonitrile, 1,4-bis(cyanoethoxy)butane, ethylene glycol bis(2-cyanoethyl)ether, diethylene glycol bis(2-cyanoethyl)ether, triethylene glycol bis(2-cyanoethyl)ether, tetraethylene glycol bis(2-cyanoethyl)ether, 3,6,9,12,15,18-hexaoxaeicosanoic dinitrile, 1,3-bis(2-cyanoethoxy)propane, 1,4-bis(2-cyanoethoxy)butane, 1,5-bis(2-cyanoethoxy)pentane, ethylene glycol bis(4-cyanobutyl)ether, 1,4-dicyano-2-butene, 1,4-dicyano-2-methyl-2-butene, 1,4-dicyano-2-ethyl-2-butene, 1,4-dicyano-2,3-dimethyl-2-butene, 1,4-dicyano-2,3-diethyl-2-butene, 1,6-dicyano-3-hexene, 1,6-dicyano-2-methyl-3-hexene, 1,6-dicyano-2-methyl-5-methyl-3-hexene, and any combination thereof.

7. (Original) The electrochemical device according to Claim 1, wherein the trinitrile compound comprises a compound of Formula (6)

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$CN\text{-}(CH_2)_x\text{-}CH\{(CH_2)_y\text{-}CN\}\text{-}(CH_2)_z\text{-}CN$ (6);

Formula (7)



(7);

or a combination thereof,

where in Formula (6), x, y, and z represent an integer from 0 to 5, and x, y, and z are not 0 at the same time; and

in Formula (7), R_5 represents hydrogen or an alkyl group having 1-5 carbon atoms, R_6, R_7 and R_8 are each independently an alkylene group having 1-5 carbon atoms, and X_4, X_5 and X_6 are each independently $-R_9-CN$, in which R_9 represents an alkylene group having 1-5 carbon atoms.

8. (Canceled)

9. (Original) The electrochemical device according to Claim 1, wherein X is about 0.01-10 wt%, Y is about 0.01-10 wt%, and a weight percentage Z of the propyl propionate is about 5-50 wt%.

10. (Original) The electrochemical device according to Claim 1, wherein the electrolyte further comprising a fluoroether comprising at least one of the compounds of Formula (8),

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Formula (9), Formula (10) or Formula (11):

$Rf1–O–Rf2$ (8);

$Rf1–O–R$ (9)

$Rf1–O–(R'–O)_n–Rf2$ (10); and

$Rf1–O–(R'–O)_n–R$ (11);

wherein Formulae (8), (9), (10), and (11), Rf1 and Rf2 are each independently a linear or branched C_1 to C_{12} fluoroalkyl group having at least one hydrogen atom substituted with fluoro, R is a linear or branched C_1 to C_{12} alkyl group, and R' is a linear or branched C_1 to C_5 alkylene group, and n is an integer from 1 to 5.

11. (Original) The electrochemical device according to Claim 9, wherein Rf1 or Rf2 is each independently a fluoroalkyl group selected from the group consisting of HCF_2-, CF_3-, HCF_2CF_2-, CH_3CF_2-, CF_3CH_2-, CF_3CF_2-, $(CF_3)_2CH$-, $HCF_2CF_2CH_2$-, $CF_3CH_2CH_2$-, $HCF_2CF_2CF_2CH_2$-, $HCF_2CF_2CF_2CF_2CH_2$-, $CF_3CF_2CH_2$-, $CF_3CFHCF_2CH_2$-, $HCF_2CF(CF_3)CH_2$-, and $CF_3CF_2CH_2CH_2$-.

12. (Original) The electrochemical device according to Claim 9, wherein the fluoroether is one selected from the group consisting of $HCF_2CF_2CH_2OCF_2CF_2H$, $(CF_3)_2CFCF(CF_2CF_3)(OCH_3)$, $CF_3CHFCF_2CH(CH_3)OCF_2CHFCF_3$, $HCF_2CF_2CH_2OCF_2CF_2CF_2CF_2H$, $HCF_2CF_2OCH_2CF_3$, $HCF_2CF_2OCH_2CH_2OCF_2CF_2H$, $HCF_2CF_2OCH_2CH_2CH_2OCF_2CF_2H$, $HCF_2CF_2CH_2OCF_2CF_2CF_2H$, $HCF_2CF_2OCH_2CH_2OCF_2CF_2CF_2H$, $HCF_2CF_2OCH_2CH_2CH_2OCF_2CF_2CF_2H$,

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$CH_3OCH_2CH_2OCH_2CH_2F$, $CH_3OCH_2CH_2OCH_2CF_3$, $CH_3OCH_2CH(CH_3)OCH_2CH_2F$, $CH_3OCH_2CH(CH_3)OCH_2CF_3$, $FCH_2CH_2OCH_2CH_2OCH_2CH_2F$, $FCH_2CH_2OCH_2CH(CH_3)OCH_2CH_2F$, $CF_3CH_2O(CH_2CH_2O)_2CH_2CF_3$, $CF_3CH_2OCH_2CH(CH_3)OCH_2CF_3$, and any combination thereof.

13. (Original) The electrochemical device according to Claim 1, wherein the electrolyte further comprising a cyclic phosphonic anhydride, based on the total weight of the electrolyte, a content of cyclic phosphonic anhydride is about 0.01-10 wt%.

14. (Original) The electrochemical device according to Claim 1, wherein the electrolyte further comprising one selected from a group consisting of: a cyclic carbonate ester having a carbon-carbon double bond, a fluorinated chain carbonate ester, a fluorinated cyclic carbonate ester, a compound having a sulfur-oxygen double bond, and any combination thereof.

15. (Original) The electrochemical device according to Claim 1, wherein the electrolyte further comprising a cyclic carboxylate ester, including γ-butyrolactone or γ-valerolactone or a combination thereof.

16. (Currently Amended) An electrochemical device, comprising:

electrodes; and

an electrolyte comprising a dinitrile compound, a trinitrile compound, and propyl

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propionate; wherein,

based on a total weight of the electrolyte, a weight percentage of the dinitrile compound is X, and a weight percentage of the trinitrile compound is Y; wherein,

about 2 wt% ≤ (X+Y) ≤ about ~~11 wt%~~ 8 wt%, and

about 0.1 ≤ (X/Y) ≤ about [[8]]6; wherein,

the electrodes comprise a first electrode and a second electrode, wherein

the first electrode comprises a first current collector and a single-sided coating;

the second electrode comprises a second current collector and a double-sided coating; and

an electrode compaction density of the first electrode comprising the single-sided coating is D1, and, an electrode compaction density of the second electrode comprising the double-sided coating is D2, wherein, about 0.8 ≤ D1/D2 ≤ about 1.2;

wherein based on the total weight of the electrolyte, a weight percentage of the propyl propionate is Z; wherein,

about 0.01 ≤ (Y/Z) ≤ about 0.3;

wherein the trinitrile compound is one selected from the group consisting of 1,3,5-pentanetricarbonitrile; 1,2,3-propanetrinitrile; 1,3,6-hexanetricarbonitrile; 1,2,6-hexanetricarbonitrile; 1,2,3-tris(2-cyanoethoxy)propane; 1,2,4-tris(2-cyanoethoxy)butane; 1,1,1-tris(cyanoethoxymethylene)ethane; 1,1,1-tris(cyanoethoxymethylene)propane; 3-methyl-1,3,5-tris(cyanoethoxy)pentane; 1,2,7-tris(cyanoethoxy)heptane; 1,2,6-tris(cyanoethoxy)hexane; 1,2,5-

tris(cyanoethoxy)pentane; and any combination thereof.

17. (Original) The electrochemical device according to Claim 16, wherein the first electrode is a cathode, the second electrode is a cathode, and 3.5 g/cm^3 ≤ D2 ≤ 4.3 g/cm^3.

18. (Original) The electrochemical device according to Claim 16, wherein the first electrode is an anode, the second electrode is an anode, and 1.2 g/cm^3 ≤ D2 ≤ 1.8 g/cm^3.

19. (Canceled)

20. (Original) The electrochemical device according to Claim 16, wherein the dinitrile compound is one selected from the group consisting of butanedinitrile, glutaronitrile, adiponitrile, 1,5-dicyanopentane, 1,6-dicyanohexane, 1,7-dicyanoheptane, 1,8-dicyanooctane, 1,9-dicyanononane, 1,10-dicyanodecane, 1,12-dicyanododecane, tetramethylbutanedinitrile, 2-methylglutaronitrile, 2,4-dimethylglutaronitrile, 2,2,4,4-tetramethylglutaronitrile, 1,4-dicyanopentane, 2,6-dicyanoheptane, 2,7-dicyanooctane, 2,8-dicyanononane, 1,6-dicyanodecane, 1,2-dicyanobenzene, 1,3-dicyanobenzene, 1,4-dicyanobenzene, 3,5-dioxa-pimelonitrile, 1,4-bis(cyanoethoxy)butane, ethylene glycol bis(2-cyanoethyl)ether, diethylene glycol bis(2-cyanoethyl)ether, triethylene glycol bis(2-cyanoethyl)ether, tetraethylene glycol bis(2-cyanoethyl)ether, 3,6,9,12,15,18-hexaoxaeicosanoic dinitrile, 1,3-bis(2-cyanoethoxy)propane, 1,4-bis(2-cyanoethoxy)butane, 1,5-bis(2-cyanoethoxy)pentane, ethylene glycol bis(4-

cyanobutyl)ether, 1,4-dicyano-2-butene, 1,4-dicyano-2-methyl-2-butene, 1,4-dicyano-2-ethyl-2-butene, 1,4-dicyano-2,3-dimethyl-2-butene, 1,4-dicyano-2,3-diethyl-2-butene, 1,6-dicyano-3-hexene, 1,6-dicyano-2-methyl-3-hexene, 1,6-dicyano-2-methyl-5-methyl-3-hexene, and any combination thereof.

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BRIEF REMARKS

Amendments

Claims 1 and 16 are amended to specify that "about 2 wt% ≤ (X+Y) ≤ about **8 wt%**, and about 0.1 ≤ (X/Y) ≤ **about 6**", which can find support in paragraph [0038] of the present published specification. Furthermore, claims 1 and 16 now incorporate the features from claims 4 and 8. Accordingly, claims 4, 8, and 19 are canceled to avoid duplication. To further clarify the invention, the definitions of D1 and D2 in claims 1 and 16 have been respectively amended as follows:

> --an electrode compaction density of the electrode corresponding to the first part with the single-sided coating is D1, and, an electrode compaction density of the electrode corresponding to the second part with the double-sided coating is D2 -- (claim 1), and
>
> -- an electrode compaction density of the first electrode comprising the single-sided coating is D1, and, an electrode compaction density of the second electrode comprising the double-sided coating is D2-- (claim 16).

Double Patenting

Applicant will submit a terminal disclaimer to overcome these rejections.

Rejections under 35 U.S.C. §103

In the outstanding Office Action, claims 1-12 and 14-20 stand rejected under 35 U.S.C. § 103 as unpatentable over CN 106848381 to Hong et al. ("Hong") in view of Ohashi, and claim 11 stands rejected under 35 U.S.C. § 103 as unpatentable over Hong in view of Ohashi with Zhang.

Amended claims 1 and 16 overcome these rejections under 35 U.S.C. § 103 as unpatentable over Hong in view of Ohashi, even with Zhangbecause:

(1) *Neither* Hong *nor* Ohashi discloses the following features with respect to the D1 and D2:

- a ***first part*** of the current collector is provided with the ***single-sided coating*** and a ***second part*** of the current collector is provided with the ***double-sided coating***; and an electrode compaction density of ***the electrode corresponding to the first part with the***

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single-sided coating is D1, and, an electrode compaction density of ***the electrode corresponding to the second part with the double-sided coating*** is D2, wherein, about 0.8 ≤ D1/D2 ≤ about 1.2 (claim 1)

- wherein the electrode is a cathode, and 3.5 g/cm^3 ≤ D2 ≤ 4.3 g/cm^3 (claim 2)
- wherein the electrode is an anode, and 1.2 g/cm^3 ≤ D2 ≤ 1.8 g/cm^3 (claim 3)

- the electrodes comprise a first electrode and a second electrode, wherein the first electrode comprises a first current collector and a single-sided coating; the second electrode comprises a second current collector and a double-sided coating; and an electrode compaction density of ***the first electrode comprising the single-sided coating*** is D1, and, an electrode compaction density of ***the second electrode comprising the double-sided coating*** is D2, wherein, about 0.8 ≤ D1/D2 ≤ about 1.2. (Claim 16)
  - wherein the first electrode is a cathode, the second electrode is a cathode, and 3.5 g/cm^3 ≤ D2 ≤ 4.3 g/cm^3 (claim 17)
  - wherein the first electrode is an anode, the second electrode is an anode, and 1.2 g/cm^3 ≤ D2 ≤ 1.8 g/cm^3(claim 18)

Specifically, Applicant respectfully notes that *neither* Hong *nor* Ohashi disclose or suggest the configuration where a *first part* of the current collector is coated on a *single side, while* a *second part* of the current collector is coated on *both sides*. In contrast, Hong discloses electrodes formed by applying active material coating to ***both sides*** of the current collector,[1] while Ohashi discloses electrodes formed by applying active material coating to ***only one side*** of the current collector[2]. Accordingly, and as acknowledged by the outstanding Office Action,[3] Hong fails to teach or suggest the claimed density ranges pertaining to D1 and D2. Furthermore, the electrode density of 1.3 g/cm^3 or 4.2 g/cm^3, as taught by Ohashi, specifically relates to the compaction density of an electrode with a single-sided coating and does *not* correspond to an electrode compaction density of the electrode corresponding to the second part with the double-sided coating or an electrode compaction density of the second electrode comprising the double-sided coating, as would be required to meet Applicant's claimed feature of D2.

[1] See Hong, paragraphs [0027]-[0028].
[2] See Ohashi, paragraphs [0240]-[0241].
[3] See outstanding Office Action at page 3, lines 21-23.

Therefore, *neither* Hong *nor* Ohashi discloses or suggests an electrode compaction density of the first electrode comprising the single-sided coating or an electrode compaction density of the electrode corresponding to the first part with the single-sided coating (D1), and an electrode compaction density of the second electrode comprising the double-sided coating or an electrode compaction density of the electrode corresponding to the second part with the double-sided coating (D2). Accordingly, neither of them provides any information or suggestion regarding the specific ranges: $0.8 \leq D1/D2 \leq$ about 1.2 as recited in claims 1 and 16, $3.5\ g/cm^3 \leq D2 \leq 4.3\ g/cm^3$ as recited in claims 2 and 17, and $1.2\ g/cm^3 \leq D2 \leq 1.8\ g/cm^3$ as recited in claims 3 and 18.

(2) Additionally, *neither* Hong *nor* Ohashi teaches or suggests the following features related to the weight percentages of the trinitrile compound and the propyl propionate.

- a weight percentage of the trinitrile compound is Y, wherein the trinitrile compound is one selected from the group consisting of 1,3,5-pentanetricarbonitrile; 1,2,3-propanetrinitrile; 1,3,6-hexanetricarbonitrile; 1,2,6-hexanetricarbonitrile; 1,2,3-tris(2-cyanoethoxy)propane; 1,2,4-tris(2-cyanoethoxy)butane; 1,1,1-tris(cyanoethoxymethylene)ethane; 1,1,1-tris(cyanoethoxymethylene)propane; 3-methyl-1,3,5-tris(cyanoethoxy)pentane; 1,2,7-tris(cyanoethoxy)heptane; 1,2,6-tris(cyanoethoxy)hexane; 1,2,5-tris(cyanoethoxy)pentane; and any combination thereof (claims 1 and 16)
    - wherein a weight percentage of the propyl propionate in the electrolyte (Z), about $0.01 \leq (Y/Z) \leq$ about 0.3 (claims 1 and 16)
    - wherein, about 2 wt% $\leq (X+Y) \leq$ about 8 wt%, and about $0.1 \leq (X/Y) \leq$ about 6 (claims 1 and 16)
- Y is about 0.01-10 wt%, a weight percentage Z of the propyl propionate is about 5-50 wt% (claim 9)

The outstanding Office Action rejects Applicant's claims 4, 9, and 19 based on the proposition that modified Hong discloses the above feature related to the weight percentages of the trinitrile compound and the propyl propionate (i.e., Y and Z).[4] Applicant respectfully submits, however, that Hong, even in view of Ohashi, fails to disclose the above feature related to the weight

[4] See outstanding Office Action at page 4, lines 12-14, and page 5, lines 1-4.

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percentages Y and Z, as next discussed.

The outstanding Office Action relies on EMB 2, 18, and 25 at paragraphs [0034]-[0035] of Hong. However, in EMB 2, 18, and 25, the electrolytes do *not* include the trinitrile compound selected from the group consisting of 1,3,5-pentanetricarbonitrile; 1,2,3-propanetrinitrile; 1,3,6-hexanetricarbonitrile; 1,2,6-hexanetricarbonitrile; 1,2,3-tris(2-cyanoethoxy)propane; 1,2,4-tris(2-cyanoethoxy)butane; 1,1,1-tris(cyanoethoxymethylene)ethane; 1,1,1-tris(cyanoethoxymethylene)propane; 3-methyl-1,3,5-tris(cyanoethoxy)pentane; 1,2,7-tris(cyanoethoxy)heptane; 1,2,6-tris(cyanoethoxy)hexane; 1,2,5-tris(cyanoethoxy)pentane; and any combination thereof, as would be required to meet Applicant's claimed feature. In contrast, EMB 2, 18, and 25 disclose electrolytes containing ***compound II_1 and II_6*** as the trinitrile compound, [5] which are not included within the Markush group specified in claims 1 and 16. Accordingly, it should be noted that the weight percentage of the trinitrile compound in the electrolytes disclosed in EMB 2, 18, and 25 does *not* correspond to the weight percentage of the trinitrile compound selected from the group consisting of 1,3,5-pentanetricarbonitrile; 1,2,3-propanetrinitrile; 1,3,6-hexanetricarbonitrile; 1,2,6-hexanetricarbonitrile; 1,2,3-tris(2-cyanoethoxy)propane; 1,2,4-tris(2-cyanoethoxy)butane; 1,1,1-tris(cyanoethoxymethylene)ethane; 1,1,1-tris(cyanoethoxymethylene)propane; 3-methyl-1,3,5-tris(cyanoethoxy)pentane; 1,2,7-tris(cyanoethoxy)heptane; 1,2,6-tris(cyanoethoxy)hexane; 1,2,5-tris(cyanoethoxy)pentane; and any combination thereof, as would be required to meet Applicant's claimed feature of Y.

Furthermore, in EMB 2, 18, and 25, Hong discloses propyl propionate (PP) is one of the four components of the organic solvent, and further discloses that the weight percentage of the four components (EC:PP:DEC:PC) ***based on the total weight of the organic solvent***. [6] However, it should be noted that the disclosure of Hong does not provide any specific weight percentage information regarding individual organic solvent (e.g., PP) *based on the total weight of the electrolyte*, nor does it provide the overall weight percentage of the entire organic solvent *based on the total weight of the electrolyte*. Therefore, without such information, it is *not* feasible to determine the exact weight percentage of propyl propionate (PP) as one of the components of the

[5] See Hong, paragraphs [0024] and [0034].
[6] See Hong, paragraph [0034].

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organic solvent ***based on the total weight of the electrolyte,*** as would be required to meet Applicant's claimed feature of Z.

Ohashi does not provide any information regarding the weight percentage of the trinitrile compound (Y) and the mass percentage of the propyl propionate (Z), both based on the total weight of the electrolyte.

Accordingly, neither Hong nor Ohashi teaches or suggests the specific weight percentage Y of the trinitrile compound based on the total weight of the electrolyte, which is within the range of about 0.01-10 wt%, and the specific weight percentage Z of the propyl propionate (PP) based on the total weight of the electrolyte, which is within the range of about 5-50 wt%. Additionally, neither of them discloses or suggests the specific relationship related to the weight percentage of the trinitrile compound and the propyl propionate (Y and Z), as defined by about 2 wt% ≤ (X+Y) ≤ about 8 wt%, about 0.1 ≤ (X/Y) ≤ about 6, and about 0.01 ≤ (Y/Z) ≤ about 0.3.

Therefore, even if the combination of Hong and Ohashi is assumed to be proper, the combination fails to teach every element of the claimed invention. Specifically, the combination fails to teach the claimed:

- a ***first part*** of the current collector is provided with the ***single-sided coating*** and a ***second part*** of the current collector is provided with the ***double-sided coating***; and an electrode compaction density of ***the electrode corresponding to the first part with the single-sided coating*** is D1, and, an electrode compaction density of ***the electrode corresponding to the second part with the double-sided coating*** is D2, wherein, about 0.8 ≤ D1/D2 ≤ about 1.2 (claim 1)
    - wherein the electrode is a cathode, and 3.5 g/cm^3 ≤ D2 ≤ 4.3 g/cm^3 (claim 2)
    - wherein the electrode is an anode, and 1.2 g/cm^3 ≤ D2 ≤ 1.8 g/cm^3 (claim 3)
- the electrodes comprise a first electrode and a second electrode, wherein the first electrode comprises a first current collector and a single-sided coating; the second electrode comprises a second current collector and a double-sided coating; and an electrode compaction density of ***the first electrode comprising the single-sided coating*** is D1, and, an electrode compaction density of ***the second electrode comprising the double-sided coating*** is D2, wherein, about 0.8 ≤ D1/D2 ≤ about 1.2. (Claim 16)

- wherein the first electrode is a cathode, the second electrode is a cathode, and 3.5 g/cm^3 ≤ D2 ≤ 4.3 g/cm^3 (claim 17)
- wherein the first electrode is an anode, the second electrode is an anode, and 1.2 g/cm^3 ≤ D2 ≤ 1.8 g/cm^3(claim 18)

- a weight percentage of the trinitrile compound is Y, wherein the trinitrile compound is one selected from the group consisting of 1,3,5-pentanetricarbonitrile; 1,2,3-propanetrinitrile; 1,3,6-hexanetricarbonitrile; 1,2,6-hexanetricarbonitrile; 1,2,3-tris(2-cyanoethoxy)propane; 1,2,4-tris(2-cyanoethoxy)butane; 1,1,1-tris(cyanoethoxymethylene)ethane; 1,1,1-tris(cyanoethoxymethylene)propane; 3-methyl-1,3,5-tris(cyanoethoxy)pentane; 1,2,7-tris(cyanoethoxy)heptane; 1,2,6-tris(cyanoethoxy)hexane; 1,2,5-tris(cyanoethoxy)pentane; and any combination thereof (claims 1 and 16)
  - wherein a weight percentage of the propyl propionate in the electrolyte (Z), about 0.01 ≤ (Y/Z) ≤ about 0.3 (claims 1 and 16)
  - wherein, about 2 wt% ≤ (X+Y) ≤ about 8 wt%, and about 0.1 ≤ (X/Y) ≤ about 6 (claims 1 and 16)
- Y is about 0.01-10 wt%, a weight percentage Z of the propyl propionate is about 5-50 wt% (claim 9)

Accordingly, Applicant respectfully traverses, and requests reconsideration of, the rejections based on Hong and Ohashi, even in further view of Zhang.[7]

Accordingly, for at least the reasons set forth above, Applicant respectfully requests that the §103 rejections of claims 1-3, 5-7, 9-18, and 20 be withdrawn.

[7] See MPEP 2142 stating, as one of the three "basic criteria [that] must be met" in order to establish a *prima facie* case of obviousness, that "the prior art reference (or references when combined) must teach or suggest all the claim limitations," (emphasis added). See also MPEP 2143.03: "All words in a claim must be considered in judging the patentability of that claim against the prior art."

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Doc Code: DIST.E.FILE **Document Description: Electronic Terminal Disclaimer - Filed**	PTO/SB/25 PTO/SB/26 U.S. Patent and Trademark Office Department of Commerce

Electronic Petition Request	**TERMINAL DISCLAIMER TO OBVIATE A PROVISIONAL DOUBLE PATENTING REJECTION OVER A PENDING "REFERENCE" APPLICATION AND TERMINAL DISCLAIMER TO OBVIATE A DOUBLE PATENTING REJECTION OVER A "PRIOR" PATENT**
Application Number	17885920
Filing Date	11-Aug-2022
First Named Inventor	Kefei WANG
Attorney Docket Number	14850089COB
Title of Invention	ELECTROLYTE AND ELECTROCHEMICAL DEVICE

☒ Filing of terminal disclaimer does not obviate requirement for response under 37 CFR 1.111 to outstanding Office Action

☒ This electronic Terminal Disclaimer is not being used for a Joint Research Agreement.

Owner	Percent Interest
NINGDE AMPEREX TECHNOLOGY LIMITED	100 %

The owner(s) of percent interest listed above in the instant application hereby disclaims, except as provided below, the terminal part of the statutory term of any patent granted on the instant application which would extend beyond the expiration date of the full statutory term of any patent granted on pending reference Application Number(s)

18076882 filed on 12/07/2022

17990641 filed on 11/18/2022

17990626 filed on 11/18/2022

17885915 filed on 08/11/2022

as the term of any patent granted on said reference application may be shortened by any terminal disclaimer filed prior to the grant of any patent on the pending reference application. The owner hereby agrees that any patent so granted on the instant application shall be enforceable only for and during such period that it and any patent granted on the reference application are commonly owned. This agreement runs with any patent granted on the instant application and is binding upon the grantee, its successors or assigns.

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as the term of said prior patent is presently shortened by any terminal disclaimer. The owner hereby agrees that any patent so granted on the instant application shall be enforceable only for and during such period that it and the prior patent are commonly owned. This agreement runs with any patent granted on the instant application and is binding upon the grantee, its successors or assigns.

In making the above disclaimer, the owner does not disclaim the terminal part of the term of any patent granted on the instant application that would extend to the expiration date of the full statutory term of the prior patent, "as the term of said prior patent is presently shortened by any terminal disclaimer," in the event that said prior patent later:
- expires for failure to pay a maintenance fee;
- is held unenforceable;
- is found invalid by a court of competent jurisdiction;
- is statutorily disclaimed in whole or terminally disclaimed under 37 CFR 1.321;
- has all claims canceled by a reexamination certificate;
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◉ Terminal disclaimer fee under 37 CFR 1.20(d) is included with Electronic Terminal Disclaimer request.

○ I certify, in accordance with 37 CFR 1.4(d)(4), that the terminal disclaimer fee under 37 CFR 1.20(d) required for this terminal disclaimer has already been paid in the above-identified application.

Applicants claims the following fee status:

○ Small Entity

○ Micro Entity

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

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I certify, in accordance with 37 CFR 1.4(d)(4) that I am:

◉ An attorney or agent registered to practice before the Patent and Trademark Office who is of record in this application

Registration Number 51986

○ A sole inventor

○ A joint inventor; I certify that I am authorized to sign this submission on behalf of all of the inventors as evidenced by the power of attorney in the application

○ A joint inventor; all of whom are signing this request

Signature	/Timothy J. Maier/
Name	Timothy J. Maier

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

Electronic Patent Application Fee Transmittal					
Application Number:	17885920				
Filing Date:	11-Aug-2022				
Title of Invention:	ELECTROLYTE AND ELECTROCHEMICAL DEVICE				
First Named Inventor/Applicant Name:	Kefei WANG				
Filer:	Timothy Joseph Maier/Karina Fernandez				
Attorney Docket Number:	14850089COB				
Filed as Large Entity					
Filing Fees for Utility under 35 USC 111(a)					
Description		**Fee Code**	**Quantity**	**Amount**	**Sub-Total in USD($)**
Basic Filing:					
STATUTORY OR TERMINAL DISCLAIMER		1814	1	170	170
Pages:					
Claims:					
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Petition:					
Patent-Appeals-and-Interference:					
Post-Allowance-and-Post-Issuance:					

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		Total in USD ($)		**170**

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Applicant/Patent under Reexamination: WANG

Electronic Terminal Disclaimer filed on July 20, 2023

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This patent is subject to a terminal disclaimer

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Electronic Acknowledgement Receipt	
EFS ID:	48321370
Application Number:	17885920
International Application Number:	
Confirmation Number:	7924
Title of Invention:	ELECTROLYTE AND ELECTROCHEMICAL DEVICE
First Named Inventor/Applicant Name:	Kefei WANG
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Filer:	Timothy Joseph Maier/Karina Fernandez
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Payment was successfully received in RAM	$170
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Deposit Account	
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The Director of the USPTO is hereby authorized to charge indicated fees and credit any overpayment as follows:	

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1	Terminal Disclaimer-Filed (Electronic)	eTerminal-Disclaimer.pdf	49392 00238ef2d2776dfbb4f369afeb8c3e236538c3ba	no	3
Warnings:					
Information:					
2	Fee Worksheet (SB06)	fee-info.pdf	38041 4549f4b047117303fcba25af06d12c20fce814dc	no	2
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National Stage of an International Application under 35 U.S.C. 371
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ELECTRONIC ACKNOWLEDGEMENT RECEIPT

APPLICATION #	RECEIPT DATE / TIME	ATTORNEY DOCKET #
17/885,920	**07/20/2023 03:20:40 PM ET**	**14850089COB**

Title of Invention

ELECTROLYTE AND ELECTROCHEMICAL DEVICE

Application Information

APPLICATION TYPE	Utility - Nonprovisional Application under 35 USC 111(a)	PATENT #	-
CONFIRMATION #	7924	FILED BY	Karina Fernandez
PATENT CENTER #	62475670	FILING DATE	08/11/2022
CUSTOMER #	62008	FIRST NAMED INVENTOR	Kefei WANG
CORRESPONDENCE ADDRESS	-	AUTHORIZED BY	Timothy Maier

Documents **TOTAL DOCUMENTS: 3**

DOCUMENT		PAGES	DESCRIPTION	SIZE (KB)
Response_PDF.pdf		19	-	103 KB
Response_PDF-A....pdf	(1-1)	1	Amendment/Request for Reconsideration-After Non-Final Rejection	22 KB
Response_PDF-CLM.pdf	(2-10)	9	Claims	50 KB
Response_PDF-REM.pdf	(11-19)	9	Applicant Arguments/Remarks Made in an Amendment	72 KB

Digest

DOCUMENT	MESSAGE DIGEST(SHA-512)
Response_PDF.pdf	22946650F2B9B6AA3004852A551C50E7C50CB98ADE5A2A089F78DC6084C50A45AFC06835E90C1E547F9BBEDF78CAB2D39C7233FE277D8AE418DB8BD2BA48F4AB
Response_PDF-A....pdf	F91F9D09F7F6BD6AFA8A379EE17356DE49C4A0D63B70D96E6B15D2497B2030FC8D25FC5E5D495EBFEA5BCB3940F58AFBA1DAD974F29BE647E4E5165070582A23
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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 & TRADEMARK OFFICE

In re Patent Application of: NINGDE AMPEREX TECHNOLOGY LIMITED U.S. Patent Application No.: 17/885,920 Filed: August 11, 2022 Title: ELECTROLYTE AND ELECTROCHEMICAL DEVICE	Confirmation No.: 7924 Art Unit: 1725 Examiner: KENNETH J DOUYETTE Attorney Docket No.: 14850089COB

AMENDMENT AND RESPONSE

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

July 20, 2023

Dear Commissioner:

In response to the Office Action mailed April 20, 2023, Applicant respectfully requests reconsideration of the Application in view of the following Amendments and Remarks.

Amendments to the Claims begin on page 2.

Remarks follow the above-mentioned amendments.

AMENDMENTS TO THE CLAIMS/CLAIM LIST

Please **CANCEL** claims 4, 8, and 19 without prejudice or disclaimer.

Please **AMEND** claims 1 and 16 as shown below.

The following list of claims replaces any prior listing of claims:

1. (Currently Amended) An electrochemical device, comprising:

an electrode; and

an electrolyte comprising a dinitrile compound, a trinitrile compound, and propyl propionate; wherein,

based on a total weight of the electrolyte, a weight percentage of the dinitrile compound is X, and a weight percentage of the trinitrile compound is Y; wherein,

about 2 wt% ≤ (X+Y) ≤ about ~~11 wt%~~ 8 wt%, and

about 0.1 ≤ (X/Y) ≤ about [[8]]6; wherein,

the electrode comprises a current collector, a single-sided coating and a double-sided coating;

a first part of the current collector is provided with the single-sided coating and a second part of the current collector is provided with the double-sided coating; and

an electrode compaction density of the electrode corresponding to the first part with the single-sided coating is D1, and, an electrode compaction density of the electrode corresponding to the second part with

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the double-sided coating is D2, wherein, about 0.8 ≤ D1/D2 ≤ about 1.2;

wherein based on the total weight of the electrolyte, a weight percentage of the propyl propionate is Z; wherein,

about 0.01 ≤ (Y/Z) ≤ about 0.3;

wherein the trinitrile compound is one selected from the group consisting of 1,3,5-pentanetricarbonitrile; 1,2,3-propanetrinitrile; 1,3,6-hexanetricarbonitrile; 1,2,6-hexanetricarbonitrile; 1,2,3-tris(2-cyanoethoxy)propane; 1,2,4-tris(2-cyanoethoxy)butane; 1,1,1-tris(cyanoethoxymethylene)ethane; 1,1,1-tris(cyanoethoxymethylene)propane; 3-methyl-1,3,5-tris(cyanoethoxy)pentane; 1,2,7-tris(cyanoethoxy)heptane; 1,2,6-tris(cyanoethoxy)hexane; 1,2,5-tris(cyanoethoxy)pentane; and any combination thereof.

2. (Original) The electrochemical device according to Claim 1, wherein the electrode is a cathode, and 3.5 g/cm^3 ≤ D2 ≤ 4.3 g/cm^3.

3. (Original) The electrochemical device according to Claim 1, wherein the electrode is an anode, and 1.2 g/cm^3 ≤ D2 ≤ 1.8 g/cm^3.

4. (Canceled)

5. (Original) The electrochemical device according to Claim 1, wherein the dinitrile compound further comprises a compound of Formula (4):

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$CN\text{-}R_1\text{-}CN$ (4);

where R_1 selected from an alkylene group having 1-5 carbon atoms or an alkenylene group having 2-5 carbon atoms.

6. (Original) The electrochemical device according to Claim 1, wherein the dinitrile compound is one selected from the group consisting of butanedinitrile, glutaronitrile, adiponitrile, 1,5-dicyanopentane, 1,6-dicyanohexane, 1,7-dicyanoheptane, 1,8-dicyanooctane, 1,9-dicyanononane, 1,10-dicyanodecane, 1,12-dicyanododecane, tetramethylbutanedinitrile, 2-methylglutaronitrile, 2,4-dimethylglutaronitrile, 2,2,4,4-tetramethylglutaronitrile, 1,4-dicyanopentane, 2,6-dicyanoheptane, 2,7-dicyanooctane, 2,8-dicyanononane, 1,6-dicyanodecane, 1,2-dicyanobenzene, 1,3-dicyanobenzene, 1,4-dicyanobenzene, 3,5-dioxa-pimelonitrile, 1,4-bis(cyanoethoxy)butane, ethylene glycol bis(2-cyanoethyl)ether, diethylene glycol bis(2-cyanoethyl)ether, triethylene glycol bis(2-cyanoethyl)ether, tetraethylene glycol bis(2-cyanoethyl)ether, 3,6,9,12,15,18-hexaoxaeicosanoic dinitrile, 1,3-bis(2-cyanoethoxy)propane, 1,4-bis(2-cyanoethoxy)butane, 1,5-bis(2-cyanoethoxy)pentane, ethylene glycol bis(4-cyanobutyl)ether, 1,4-dicyano-2-butene, 1,4-dicyano-2-methyl-2-butene, 1,4-dicyano-2-ethyl-2-butene, 1,4-dicyano-2,3-dimethyl-2-butene, 1,4-dicyano-2,3-diethyl-2-butene, 1,6-dicyano-3-hexene, 1,6-dicyano-2-methyl-3-hexene, 1,6-dicyano-2-methyl-5-methyl-3-hexene, and any combination thereof.

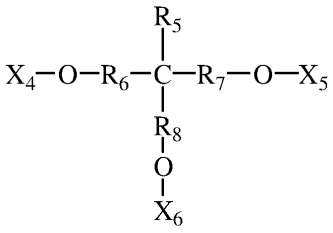
7. (Original) The electrochemical device according to Claim 1, wherein the trinitrile

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compound comprises a compound of Formula (6)

$$CN\text{-}(CH_2)_x\text{-}CH\{(CH_2)_y\text{-}CN\}\text{-}(CH_2)_z\text{-}CN \quad (6);$$

Formula (7)



(7);

or a combination thereof,

where in Formula (6), x, y, and z represent an integer from 0 to 5, and x, y, and z are not 0 at the same time; and

in Formula (7), R_5 represents hydrogen or an alkyl group having 1-5 carbon atoms, R_6, R_7 and R_8 are each independently an alkylene group having 1-5 carbon atoms, and X_4, X_5 and X_6 are each independently $-R_9-CN$, in which R_9 represents an alkylene group having 1-5 carbon atoms.

8. (Canceled)

9. (Original) The electrochemical device according to Claim 1, wherein X is about 0.01-10 wt%, Y is about 0.01-10 wt%, and a weight percentage Z of the propyl propionate is about 5-50 wt%.

10. (Original) The electrochemical device according to Claim 1, wherein the electrolyte further

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comprising a fluoroether comprising at least one of the compounds of Formula (8), Formula (9), Formula (10) or Formula (11):

Rf1–O – Rf2 (8);

Rf1–O – R (9)

Rf1–O –(R' –O)$_n$– Rf2 (10); and

Rf1–O –(R' –O)$_n$– R (11);

wherein Formulae (8), (9), (10), and (11), Rf1 and Rf2 are each independently a linear or branched C_1 to C_{12} fluoroalkyl group having at least one hydrogen atom substituted with fluoro, R is a linear or branched C_1 to C_{12} alkyl group, and R' is a linear or branched C_1 to C_5 alkylene group, and n is an integer from 1 to 5.

11. (Original) The electrochemical device according to Claim 9, wherein Rf1 or Rf2 is each independently a fluoroalkyl group selected from the group consisting of HCF_2-, CF_3-, HCF_2CF_2-, CH_3CF_2-, CF_3CH_2-, CF_3CF_2-, $(CF_3)_2CH$-, $HCF_2CF_2CH_2$-, $CF_3CH_2CH_2$-, $HCF_2CF_2CF_2CH_2$-, $HCF_2CF_2CF_2CF_2CH_2$-, $CF_3CF_2CH_2$-, $CF_3CFHCF_2CH_2$-, $HCF_2CF(CF_3)CH_2$-, and $CF_3CF_2CH_2CH_2$-.

12. (Original) The electrochemical device according to Claim 9, wherein the fluoroether is one selected from the group consisting of $HCF_2CF_2CH_2OCF_2CF_2H$, $(CF_3)_2CFCF(CF_2CF_3)(OCH_3)$, $CF_3CHFCF_2CH(CH_3)OCF_2CHFCF_3$, $HCF_2CF_2CH_2OCF_2CF_2CF_2CF_2H$, $HCF_2CF_2OCH_2CF_3$, $HCF_2CF_2OCH_2CH_2OCF_2CF_2H$, $HCF_2CF_2OCH_2CH_2CH_2OCF_2CF_2H$, $HCF_2CF_2CH_2OCF_2CF_2CF_2H$,

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$HCF_2CF_2OCH_2CH_2OCF_2CF_2CF_2H$, $HCF_2CF_2OCH_2CH_2CH_2OCF_2CF_2CF_2H$, $CH_3OCH_2CH_2OCH_2CH_2F$, $CH_3OCH_2CH_2OCH_2CF_3$, $CH_3OCH_2CH(CH_3)OCH_2CH_2F$, $CH_3OCH_2CH(CH_3)OCH_2CF_3$, $FCH_2CH_2OCH_2CH_2OCH_2CH_2F$, $FCH_2CH_2OCH_2CH(CH_3)OCH_2CH_2F$, $CF_3CH_2O(CH_2CH_2O)_2CH_2CF_3$, $CF_3CH_2OCH_2CH(CH_3)OCH_2CF_3$, and any combination thereof.

13. (Original) The electrochemical device according to Claim 1, wherein the electrolyte further comprising a cyclic phosphonic anhydride, based on the total weight of the electrolyte, a content of cyclic phosphonic anhydride is about 0.01-10 wt%.

14. (Original) The electrochemical device according to Claim 1, wherein the electrolyte further comprising one selected from a group consisting of: a cyclic carbonate ester having a carbon-carbon double bond, a fluorinated chain carbonate ester, a fluorinated cyclic carbonate ester, a compound having a sulfur-oxygen double bond, and any combination thereof.

15. (Original) The electrochemical device according to Claim 1, wherein the electrolyte further comprising a cyclic carboxylate ester, including γ-butyrolactone or γ-valerolactone or a combination thereof.

16. (Currently Amended) An electrochemical device, comprising:

electrodes; and

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an electrolyte comprising a dinitrile compound, a trinitrile compound, and propyl propionate; wherein,

based on a total weight of the electrolyte, a weight percentage of the dinitrile compound is X, and a weight percentage of the trinitrile compound is Y; wherein,

about 2 wt% ≤ (X+Y) ≤ about ~~11 wt%~~ 8 wt%, and

about 0.1 ≤ (X/Y) ≤ about [[8]]6; wherein,

the electrodes comprise a first electrode and a second electrode, wherein

the first electrode comprises a first current collector and a single-sided coating;

the second electrode comprises a second current collector and a double-sided coating; and

an electrode compaction density of the first electrode comprising the single-sided coating is D1, and, an electrode compaction density of the second electrode comprising the double-sided coating is D2, wherein, about 0.8 ≤ D1/D2 ≤ about 1.2;

wherein based on the total weight of the electrolyte, a weight percentage of the propyl propionate is Z; wherein,

about 0.01 ≤ (Y/Z) ≤ about 0.3;

wherein the trinitrile compound is one selected from the group consisting of 1,3,5-pentanetricarbonitrile; 1,2,3-propanetrinitrile; 1,3,6-hexanetricarbonitrile; 1,2,6-hexanetricarbonitrile; 1,2,3-tris(2-cyanoethoxy)propane; 1,2,4-tris(2-cyanoethoxy)butane; 1,1,1-tris(cyanoethoxymethylene)ethane; 1,1,1-tris(cyanoethoxymethylene)propane; 3-methyl-1,3,5-tris(cyanoethoxy)pentane;

1,2,7-tris(cyanoethoxy)heptane; 1,2,6-tris(cyanoethoxy)hexane; 1,2,5-tris(cyanoethoxy)pentane; and any combination thereof.

17. (Original) The electrochemical device according to Claim 16, wherein the first electrode is a cathode, the second electrode is a cathode, and 3.5 g/cm^3 ≤ D2 ≤ 4.3 g/cm^3.

18. (Original) The electrochemical device according to Claim 16, wherein the first electrode is an anode, the second electrode is an anode, and 1.2 g/cm^3 ≤ D2 ≤ 1.8 g/cm^3.

19. (Canceled)

20. (Original) The electrochemical device according to Claim 16, wherein the dinitrile compound is one selected from the group consisting of butanedinitrile, glutaronitrile, adiponitrile, 1,5-dicyanopentane, 1,6-dicyanohexane, 1,7-dicyanoheptane, 1,8-dicyanooctane, 1,9-dicyanononane, 1,10-dicyanodecane, 1,12-dicyanododecane, tetramethylbutanedinitrile, 2-methylglutaronitrile, 2,4-dimethylglutaronitrile, 2,2,4,4-tetramethylglutaronitrile, 1,4-dicyanopentane, 2,6-dicyanoheptane, 2,7-dicyanooctane, 2,8-dicyanononane, 1,6-dicyanodecane, 1,2-dicyanobenzene, 1,3-dicyanobenzene, 1,4-dicyanobenzene, 3,5-dioxa-pimelonitrile, 1,4-bis(cyanoethoxy)butane, ethylene glycol bis(2-cyanoethyl)ether, diethylene glycol bis(2-cyanoethyl)ether, triethylene glycol bis(2-cyanoethyl)ether, tetraethylene glycol bis(2-cyanoethyl)ether, 3,6,9,12,15,18-hexaoxaeicosanoic dinitrile, 1,3-bis(2-cyanoethoxy)propane, 1,4-bis(2-

cyanoethoxy)butane, 1,5-bis(2-cyanoethoxy)pentane, ethylene glycol bis(4-cyanobutyl)ether, 1,4-dicyano-2-butene, 1,4-dicyano-2-methyl-2-butene, 1,4-dicyano-2-ethyl-2-butene, 1,4-dicyano-2,3-dimethyl-2-butene, 1,4-dicyano-2,3-diethyl-2-butene, 1,6-dicyano-3-hexene, 1,6-dicyano-2-methyl-3-hexene, 1,6-dicyano-2-methyl-5-methyl-3-hexene, and any combination thereof.

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REMARKS

Favorable reconsideration of this Application, in light of the following discussion, is respectfully requested. Claims 1-20 were originally presented. Claims 1 and 16 have been amended, and no new claims have been added. Claims 4, 8, and 19 have been canceled without prejudice or disclaimer. Accordingly, claims 1-3, 5-7, 9-18, and 20 are pending in the present Application. Applicant submits that upon entry of the present Response, claims 1-3, 5-7, 9-18, and 20 are in condition for allowance. Moreover, the Applicant submits that no new matter has been introduced by the foregoing amendments.

Examiner Interview

First, Applicant wishes to thank the Examiner for the courtesy of an interview granted to Applicant's representatives on July 18, 2023, at which time the outstanding issues in this case were discussed. Amendments similar to those attached and arguments similar to the ones developed hereinafter were presented and the Examiner indicated that in light of the amendments, he would reconsider the outstanding grounds for rejection upon formal submission of a response.

Double Patenting

In the outstanding Office Action, claims 1-4 and 16-18 stand rejected under the judicially created doctrine of non-statutory double patenting as being unpatentable over claims 13-16 of U.S. Patent No. 10,833,363.

In the outstanding Office Action, claims 1-4 and 16-19 stand rejected under the judicially created doctrine of non-statutory double patenting as being unpatentable over claims 12-15 of U.S. Patent No. 11,522,222.

In the outstanding Office Action, claims 1-20 stand rejected under the judicially created doctrine of non-statutory double patenting as being unpatentable over claims 1-30 of copending Application No. 18/076,882.

In the outstanding Office Action, claims 1-20 stand rejected under the judicially created doctrine of non-statutory double patenting as being unpatentable over claims 1-19 of copending Application No. 17/885,915.

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In the outstanding Office Action, claims 1-20 stand rejected under the judicially created doctrine of non-statutory double patenting as being unpatentable over claims 1-44 of copending Application No. 17/990,626.

In the outstanding Office Action, claims 1-20 stand rejected under the judicially created doctrine of non-statutory double patenting as being unpatentable over claims 1-4 of copending Application No. 17/990,641.

With this correspondence, Applicant has submitted a terminal disclaimer to overcome these rejections. Accordingly, Applicant respectfully requests the withdrawal of this double patenting rejection of claims 1-3, 5-7, 9-18, and 20.

Applicant notes that "[t]he filing of a terminal disclaimer to obviate a rejection based on nonstatutory double patenting is not an admission of the propriety of the rejection [because] the filing of a terminal disclaimer simply serves the statutory function of removing the rejection of double patenting, and raises neither a presumption nor estoppels on the merits of the rejection" (MPEP §804.02.II, citations omitted). Hence, the terminal disclaimer included with this reply serves the statutory function of removing the double patenting rejection without raising a presumption or estoppels on the merits of the rejection.

Rejections under 35 U.S.C. §103

In the outstanding Office Action, claims 1-12 and 14-20 stand rejected under 35 U.S.C. § 103 as unpatentable over CN 106848381 to Hong et al. ("Hong") in view of U.S. Patent Application Publication No. 2017/0324116, applied for by Ohashi.

In the outstanding Office Action, claim 11 stands rejected under 35 U.S.C. § 103 as unpatentable over Hong in view of Ohashi as applied to claim 1, and further in view of U.S. Patent Application Publication No. 2017/0317385, applied for by Zhang et al. ("Zhang").

Addressing now the rejection of claims 1 and 16 under 35 U.S.C. § 103 as unpatentable over Hong in view of Ohashi, this rejection is respectfully traversed. Claims 1 and 16 have been amended to overcome the rejection under 35 U.S.C. § 103. Specifically, claims 1 and 16 are amended to specify that "about 2 wt% ≤ (X+Y) ≤ about **8 wt%**, and about 0.1 ≤ (X/Y) ≤ **about 6**", which can find support in paragraph [0038] of the present published specification. Furthermore, claims 1 and 16 now incorporate the features from claims 4 and 8. Accordingly, claims 4, 8, and

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19 are canceled to avoid duplication. To further clarify the invention, the definitions of D1 and D2 in claims 1 and 16 have been respectively amended as follows:

--an electrode compaction density of the electrode corresponding to the first part with the single-sided coating is D1, and, an electrode compaction density of the electrode corresponding to the second part with the double-sided coating is D2 -- (claim 1), and

-- an electrode compaction density of the first electrode comprising the single-sided coating is D1, and, an electrode compaction density of the second electrode comprising the double-sided coating is D2-- (claim 16).

The combination of Hong and Ohashi, however, fails to teach or suggest Applicant's claimed electrochemical device, as next discussed.

(1) *Neither* Hong *nor* Ohashi discloses the following features with respect to the D1 and D2:

- a ***first part*** of the current collector is provided with the ***single-sided coating*** and a ***second part*** of the current collector is provided with the ***double-sided coating***; and an electrode compaction density of ***the electrode corresponding to the first part with the single-sided coating*** is D1, and, an electrode compaction density of ***the electrode corresponding to the second part with the double-sided coating*** is D2, wherein, about $0.8 \leq D1/D2 \leq$ about 1.2 (claim 1)
    - wherein the electrode is a cathode, and 3.5 g/cm$^3 \leq D2 \leq$ 4.3 g/cm^3 (claim 2)
    - wherein the electrode is an anode, and 1.2 g/cm$^3 \leq D2 \leq$ 1.8 g/cm^3 (claim 3)
- the electrodes comprise a first electrode and a second electrode, wherein the first electrode comprises a first current collector and a single-sided coating; the second electrode comprises a second current collector and a double-sided coating; and an electrode compaction density of ***the first electrode comprising the single-sided coating*** is D1, and, an electrode compaction density of ***the second electrode comprising the double-sided coating*** is D2, wherein, about $0.8 \leq D1/D2 \leq$ about 1.2. (Claim 16)
    - wherein the first electrode is a cathode, the second electrode is a cathode, and 3.5 g/cm$^3 \leq D2 \leq$ 4.3 g/cm^3 (claim 17)

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- wherein the first electrode is an anode, the second electrode is an anode, and 1.2 g/cm^3 ≤ D2 ≤ 1.8 g/cm^3(claim 18)

Specifically, Applicant respectfully notes that *neither* Hong *nor* Ohashi disclose or suggest the configuration where a *first part* of the current collector is coated on a *single side, while* a *second part* of the current collector is coated on *both sides*. In contrast, Hong discloses electrodes formed by applying active material coating to ***both sides*** of the current collector,[1] while Ohashi discloses electrodes formed by applying active material coating to ***only one side*** of the current collector[2]. Accordingly, and as acknowledged by the outstanding Office Action,[3] Hong fails to teach or suggest the claimed density ranges pertaining to D1 and D2. Furthermore, the electrode density of 1.3 g/cm^3 or 4.2 g/cm^3, as taught by Ohashi, specifically relates to the compaction density of an electrode with a single-sided coating and does *not* correspond to an electrode compaction density of the electrode corresponding to the second part with the double-sided coating or an electrode compaction density of the second electrode comprising the double-sided coating, as would be required to meet Applicant's claimed feature of D2.

Therefore, *neither* Hong *nor* Ohashi discloses or suggests an electrode compaction density of the first electrode comprising the single-sided coating or an electrode compaction density of the electrode corresponding to the first part with the single-sided coating (D1), and an electrode compaction density of the second electrode comprising the double-sided coating or an electrode compaction density of the electrode corresponding to the second part with the double-sided coating (D2). Accordingly, neither of them provides any information or suggestion regarding the specific ranges: 0.8 ≤ D1/D2 ≤ about 1.2 as recited in claims 1 and 16, 3.5 g/cm^3 ≤ D2 ≤ 4.3 g/cm^3 as recited in claims 2 and 17, and 1.2 g/cm^3 ≤ D2 ≤ 1.8 g/cm^3 as recited in claims 3 and 18.

(2) Additionally, *neither* Hong *nor* Ohashi teaches or suggests the following features related to the weight percentages of the trinitrile compound and the propyl propionate.

- a weight percentage of the trinitrile compound is Y, wherein the trinitrile compound is one selected from the group consisting of 1,3,5-pentanetricarbonitrile; 1,2,3-propanetrinitrile; 1,3,6-hexanetricarbonitrile; 1,2,6-hexanetricarbonitrile; 1,2,3-tris(2-

[1] See Hong, paragraphs [0027]-[0028].
[2] See Ohashi, paragraphs [0240]-[0241].
[3] See outstanding Office Action at page 3, lines 21-23.

cyanoethoxy)propane; 1,2,4-tris(2-cyanoethoxy)butane; 1,1,1-tris(cyanoethoxymethylene)ethane; 1,1,1-tris(cyanoethoxymethylene)propane; 3-methyl-1,3,5-tris(cyanoethoxy)pentane; 1,2,7-tris(cyanoethoxy)heptane; 1,2,6-tris(cyanoethoxy)hexane; 1,2,5-tris(cyanoethoxy)pentane; and any combination thereof (claims 1 and 16)

- wherein a weight percentage of the propyl propionate in the electrolyte (Z), about 0.01 ≤ (Y/Z) ≤ about 0.3 (claims 1 and 16)
- wherein, about 2 wt% ≤ (X+Y) ≤ about 8 wt%, and about 0.1 ≤ (X/Y) ≤ about 6 (claims 1 and 16)

- Y is about 0.01-10 wt%, a weight percentage Z of the propyl propionate is about 5-50 wt% (claim 9)

The outstanding Office Action rejects Applicant's claims 4, 9, and 19 based on the proposition that modified Hong discloses the above feature related to the weight percentages of the trinitrile compound and the propyl propionate (i.e., Y and Z).[4] Applicant respectfully submits, however, that Hong, even in view of Ohashi, fails to disclose the above feature related to the weight percentages Y and Z, as next discussed.

The outstanding Office Action relies on EMB 2, 18, and 25 at paragraphs [0034]-[0035] of Hong. However, in EMB 2, 18, and 25, the electrolytes do *not* include the trinitrile compound selected from the group consisting of 1,3,5-pentanetricarbonitrile; 1,2,3-propanetrinitrile; 1,3,6-hexanetricarbonitrile; 1,2,6-hexanetricarbonitrile; 1,2,3-tris(2-cyanoethoxy)propane; 1,2,4-tris(2-cyanoethoxy)butane; 1,1,1-tris(cyanoethoxymethylene)ethane; 1,1,1-tris(cyanoethoxymethylene)propane; 3-methyl-1,3,5-tris(cyanoethoxy)pentane; 1,2,7-tris(cyanoethoxy)heptane; 1,2,6-tris(cyanoethoxy)hexane; 1,2,5-tris(cyanoethoxy)pentane; and any combination thereof, as would be required to meet Applicant's claimed feature. In contrast, EMB 2, 18, and 25 disclose electrolytes containing ***compound II$_1$ and II$_6$*** as the trinitrile compound,[5] which are not included within the Markush group specified in claims 1 and 16. Accordingly, it should be noted that the weight percentage of the trinitrile compound in the

[4] See outstanding Office Action at page 4, lines 12-14, and page 5, lines 1-4.
[5] See Hong, paragraphs [0024] and [0034].

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electrolytes disclosed in EMB 2, 18, and 25 does *not* correspond to the weight percentage of the trinitrile compound selected from the group consisting of 1,3,5-pentanetricarbonitrile; 1,2,3-propanetrinitrile; 1,3,6-hexanetricarbonitrile; 1,2,6-hexanetricarbonitrile; 1,2,3-tris(2-cyanoethoxy)propane; 1,2,4-tris(2-cyanoethoxy)butane; 1,1,1-tris(cyanoethoxymethylene)ethane; 1,1,1-tris(cyanoethoxymethylene)propane; 3-methyl-1,3,5-tris(cyanoethoxy)pentane; 1,2,7-tris(cyanoethoxy)heptane; 1,2,6-tris(cyanoethoxy)hexane; 1,2,5-tris(cyanoethoxy)pentane; and any combination thereof, as would be required to meet Applicant's claimed feature of Y.

Furthermore, in EMB 2, 18, and 25, Hong discloses propyl propionate (PP) is one of the four components of the organic solvent, and further discloses that the weight percentage of the four components (EC:PP:DEC:PC) ***based on the total weight of the organic solvent***.[6] However, it should be noted that the disclosure of Hong does not provide any specific weight percentage information regarding individual organic solvent (e.g., PP) *based on the total weight of the electrolyte*, nor does it provide the overall weight percentage of the entire organic solvent *based on the total weight of the electrolyte*. Therefore, without such information, it is *not* feasible to determine the exact weight percentage of propyl propionate (PP) as one of the components of the organic solvent ***based on the total weight of the electrolyte*****,** as would be required to meet Applicant's claimed feature of Z.

Ohashi does not provide any information regarding the weight percentage of the trinitrile compound (Y) and the mass percentage of the propyl propionate (Z), both based on the total weight of the electrolyte.

Accordingly, neither Hong nor Ohashi teaches or suggests the specific weight percentage Y of the trinitrile compound based on the total weight of the electrolyte, which is within the range of about 0.01-10 wt%, and the specific weight percentage Z of the propyl propionate (PP) based on the total weight of the electrolyte, which is within the range of about 5-50 wt%. Additionally, neither of them discloses or suggests the specific relationship related to the weight percentage of the trinitrile compound and the propyl propionate (Y and Z), as defined by about 2 wt% $\leq$ (X+Y) $\leq$ about 8 wt%, about 0.1 $\leq$ (X/Y) $\leq$ about 6, and about 0.01 $\leq$ (Y/Z) $\leq$ about 0.3.

[6] See Hong, paragraph [0034].

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Therefore, even if the combination of Hong and Ohashi is assumed to be proper, the combination fails to teach every element of the claimed invention. Specifically, the combination fails to teach the claimed:

- a ***first part*** of the current collector is provided with the ***single-sided coating*** and a ***second part*** of the current collector is provided with the ***double-sided coating***; and an electrode compaction density of ***the electrode corresponding to the first part with the single-sided coating*** is D1, and, an electrode compaction density of ***the electrode corresponding to the second part with the double-sided coating*** is D2, wherein, about $0.8 \leq D1/D2 \leq$ about 1.2 (claim 1)
    - wherein the electrode is a cathode, and 3.5 g/cm$^3 \leq D2 \leq 4.3$ g/cm^3 (claim 2)
    - wherein the electrode is an anode, and 1.2 g/cm$^3 \leq D2 \leq 1.8$ g/cm^3 (claim 3)
- the electrodes comprise a first electrode and a second electrode, wherein the first electrode comprises a first current collector and a single-sided coating; the second electrode comprises a second current collector and a double-sided coating; and an electrode compaction density of ***the first electrode comprising the single-sided coating*** is D1, and, an electrode compaction density of ***the second electrode comprising the double-sided coating*** is D2, wherein, about $0.8 \leq D1/D2 \leq$ about 1.2. (Claim 16)
    - wherein the first electrode is a cathode, the second electrode is a cathode, and 3.5 g/cm$^3 \leq D2 \leq 4.3$ g/cm^3 (claim 17)
    - wherein the first electrode is an anode, the second electrode is an anode, and 1.2 g/cm$^3 \leq D2 \leq 1.8$ g/cm^3(claim 18)
- a weight percentage of the trinitrile compound is Y, wherein the trinitrile compound is one selected from the group consisting of 1,3,5-pentanetricarbonitrile; 1,2,3-propanetrinitrile; 1,3,6-hexanetricarbonitrile; 1,2,6-hexanetricarbonitrile; 1,2,3-tris(2-cyanoethoxy)propane; 1,2,4-tris(2-cyanoethoxy)butane; 1,1,1-tris(cyanoethoxymethylene)ethane; 1,1,1-tris(cyanoethoxymethylene)propane; 3-methyl-1,3,5-tris(cyanoethoxy)pentane; 1,2,7-tris(cyanoethoxy)heptane; 1,2,6-tris(cyanoethoxy)hexane; 1,2,5-tris(cyanoethoxy)pentane; and any combination thereof (claims 1 and 16)

- wherein a weight percentage of the propyl propionate in the electrolyte (Z), about 0.01 ≤ (Y/Z) ≤ about 0.3 (claims 1 and 16)
- wherein, about 2 wt% ≤ (X+Y) ≤ about 8 wt%, and about 0.1 ≤ (X/Y) ≤ about 6 (claims 1 and 16)

- Y is about 0.01-10 wt%, a weight percentage Z of the propyl propionate is about 5-50 wt% (claim 9)

Accordingly, Applicant respectfully traverses, and requests reconsideration of, this rejection based on these patents.[7]

As a result, Applicant respectfully submits that independent claims 1 and 16 and dependent claims 2-3, 9, and 17-18 are patentable over the combination of Hong and Ohashi. As claims 5-7 and 10-15 depend from independent claim 1, claim 20 depends from independent claim 16, Applicant respectfully submits that claims 5-7, 10-15, and 20 are likewise patentable over Hong and Ohashi, even in further view of Zhang.

Accordingly, for at least the reasons set forth above, Applicant respectfully requests that the §103 rejections of claims 1-3, 5-7, 9-18, and 20 be withdrawn.

[7] See MPEP 2142 stating, as one of the three "basic criteria [that] must be met" in order to establish a *prima facie* case of obviousness, that "the prior art reference (or references when combined) must teach or suggest all the claim limitations," (emphasis added). See also MPEP 2143.03: "All words in a claim must be considered in judging the patentability of that claim against the prior art."

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CONCLUSION

Consequently, in view of the present amendment and in light of the above discussion, the outstanding grounds of rejection are believed to have been overcome. The Application, as amended, is believed to be in condition of allowance. An early and favorable action to that effect is respectfully requested.

Respectfully submitted,

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TJM/mae/LC/kcf

Attachment:
e-Terminal Disclaimer

July 20, 2023

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PTO/SB/06 (09-11)
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PATENT APPLICATION FEE DETERMINATION RECORD Substitute for Form PTO-875	Application or Docket Number 17/885,920	Filing Date 08/11/2022	☐ To be Mailed

ENTITY: ☑ LARGE ☐ SMALL ☐ MICRO

APPLICATION AS FILED - PART I

	(Column 1)	(Column 2)			
FOR	NUMBER FILED	NUMBER EXTRA		RATE ($)	FEE ($)
☐ BASIC FEE (37 CFR 1.16(a), (b), or (c))	N/A	N/A		N/A	
☐ SEARCH FEE (37 CFR 1.16(k), (i), or (m))	N/A	N/A		N/A	
☐ EXAMINATION FEE (37 CFR 1.16(o), (p), or (q))	N/A	N/A		N/A	
TOTAL CLAIMS (37 CFR 1.16(i))	minus 20 =	*		x $100 =	
INDEPENDENT CLAIMS (37 CFR 1.16(h))	minus 3 =	*		x $480 =	
☐ APPLICATION SIZE FEE (37 CFR 1.16(s))	If the specification and drawings exceed 100 sheets of paper, the application size fee due is $310 ($155 for small entity) for each additional 50 sheets or fraction thereof. See 35 U.S.C. 41(a)(1)(G) and 37 CFR 1.16(s).				
☐ MULTIPLE DEPENDENT CLAIM PRESENT (37 CFR 1.16(j))					
* If the difference in column 1 is less than zero, enter "0" in column 2.				TOTAL	

APPLICATION AS AMENDED - PART II

		(Column 1)		(Column 2)	(Column 3)			
AMENDMENT	07/20/2023	CLAIMS REMAINING AFTER AMENDMENT		HIGHEST NUMBER PREVIOUSLY PAID FOR	PRESENT EXTRA		RATE ($)	ADDITIONAL FEE ($)
	Total (37 CFR 1.16(i))	* 17	Minus	** 20	= 0		x $100 =	0
	Independent (37 CFR 1.16(h))	* 2	Minus	*** 3	= 0		x $480 =	0
	☐ Application Size Fee (37 CFR 1.16(s))							
	☐ FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j))							
							TOTAL ADD'L FEE	0

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

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

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

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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
17/885,920	08/11/2022	Kefei WANG	14850089COB	7924

62008 7590 04/20/2023

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EXAMINER	
DOUYETTE, KENNETH J	

ART UNIT	PAPER NUMBER
1725	

NOTIFICATION DATE	DELIVERY MODE
04/20/2023	ELECTRONIC

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

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

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

docket@maierandmaier.com
maierandmaier_PAIR@firsttofile.com

PTOL-90A (Rev. 04/07)

Office Action Summary	Application No. 17/885,920	Applicant(s) WANG et al.	
	Examiner KENNETH J DOUYETTE	Art Unit 1725	AIA (FITF) Status Yes

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

Period for Reply

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

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

Status

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

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

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

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

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

Disposition of Claims*

5) ☑ Claim(s) 1-20 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) 1-20 is/are rejected.

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

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

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

Application Papers

10)☐ The specification is objected to by the Examiner.

11)☑ The drawing(s) filed on 8/11/2022 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. 16/211,853.

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 8/11/2022.

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

4) ☐ Other: _____.

DETAILED ACTION

Notice of Pre-AIA or AIA Status

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

Claim Rejections - 35 USC § 103

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

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

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

4. The factual inquiries 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.

5. 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.

6. Claims 1-12 and 14-20 are rejected under 35 U.S.C. 103 as being unpatentable over Hong et al. (CN 106848381, see English Translation) in view of Ohashi (US 2017/0324116).

Regarding claims 1-3 and 16-18, Hong et al. discloses an electrochemical device ([0001], [0029]), comprising an electrodes ([0029]), and an electrolyte ([0007]), comprising a dinitrile compound ([0015]), a trinitrile compound ([0015]), and propyl propionate ([0013]), wherein based on a weight of the electrolyte, a weight percentage of the dinitrile compound is X, a weight percentage of the trinitrile compound is Y; wherein about 2 wt% ≤(X+Y) ≤ about 11 wt% ([0035], P8-9, EMB 2, 18, 25), about 0.1 ≤ (X/Y) ≤ about 8 ([0035], P8-9, EMB 2, 18, 25), the electrode comprises a current collector ([0027], [0028]) that is coated on two surfaces ([0027], [0028]) but does not explicitly disclose one side is coated only and the cathode electrode has a density of 4.2 g/cm3 and an anode electrode has a density of 1.3 g/cm3.

Ohashi discloses a battery having cathode and anode electrodes formed on current collectors coating one side ([0181], [0217], [0214], [0218]), the cathode having a density of 4.2 g/cm3 ([0217]) and the anode having a density of 1.3 g/cm3 ([0181]). This configuration enhances battery capacity and overall performance ([0027], [0214]-[0218]).

Ohashi and Hong et al. are analogous since both deal in the same field of endeavor, namely, battery electrolytes.

It would have been obvious to one of ordinary skill in the art at the time of filing to incorporate the cathode and anode of Hong et al. as having the coating and density disclosed by Ohashi to enhance battery capacity and overall performance.

Regarding claims 4 and 19, modified Hong et al. discloses all of the claim limitations as set forth above and also discloses a weight percentage of the propyl propionate is Z, and about 0.1 ≤ (Y/Z) ≤ about 0.3 ([0035], P8-9, EMB 2, 18, 25).

Regarding claims 5, 6 and 20, modified Hong et al. discloses all of the claim limitations as set forth above and also discloses the dinitrile compound is adiponitrile ([0015]).

Regarding claims 7 and 8, modified Hong et al. discloses all of the claim limitations as set forth above and also discloses the trinitrile compound is 1,3,6-hexane tricarbonitrile ([0015]).

Regarding claim 9, modified Hong et al. discloses all of the claim limitations as set forth above and also discloses X is about 0.01 – 10 wt% ([0034]-[0035], P8-9), Y is about 0.01 – 10 wt% ([0034]-[0035], P8-9), and a weight percentage Z of the propyl propionate is about 5-50 wt% ([0034]-[0035], P8-9).

Regarding claims 10-12, modified Hong et al. discloses all of the claim limitations as set forth above but does not explicitly disclose the electrolyte further comprises 1,1,2,2-tetrafluoroethyl-2,2,3,3-tetrafluoropropyl ether.

Ohashi discloses an electrolyte ([0002]) a dinitrile compound ([0070]-[0071]), a trinitrile compound ([0070]-[0071]), and propyl propionate ([0134]) and a fluoroether comprising 1,1,2,2-tetrafluoroethyl-2,2,3,3-tetrafluoropropyl ether ([0136]). This configuration enhances battery performance at high temperatures and enhances cycle characteristics ([0027]).

It would have been obvious to one of ordinary skill in the art at the time of filing to incorporate the 1,1,2,2-tetrafluoroethyl-2,2,3,3-tetrafluoropropyl ether disclosed by Ohashi into the electrolyte of Hong et al. to enhance high temperature performance and cycle characteristics of the battery.

Regarding claim 14, modified Hong et al. discloses all of the claim limitations as set forth above and also discloses FEC ([0034]-[0035], P8-9).

Regarding claim 15, modified Hong et al. discloses all of the claim limitations as set forth above and also discloses y-butyrolacetone ([0013]).

7. Claim 11 is rejected under 35 U.S.C. 103 as being unpatentable over Hong et al. (CN 106848381, see English Translation) in view of Ohashi (US 2017/0324116) as applied to claim 1 above, and further in view of Zhang et al. (US 2017/0317385).

Regarding claim 11, Hong et al. discloses all of the claim limitations as set forth above but does not explicitly disclose a cyclic phosphonic anhydride at 0.01 – 10 wt%.

Zhang et al. discloses a battery ([0008]) including an electrolyte ([0008]) comprising a cyclic phosphonic anhydride ([0043]) at 0.05 – 10 wt% ([0089]). Adding these compounds enhances battery stability and cycle life ([0090], [0101], [0103], [0114], [0115]).

Zhang et al. and Hong et al. are analogous since both deal in the same field of endeavor, namely, battery electrolytes.

It would have been obvious to one of ordinary skill in the art at the time of filing to incorporate the amount of cyclic phosphonic anhydride disclosed by Zhang et al. into the electrolyte of Ohashi to enhance battery stability and cycle life, thereby enhancing overall battery performance.

Double Patenting

8. The nonstatutory double patenting rejection is based on a judicially created doctrine grounded in public policy (a policy reflected in the statute) so as to prevent the unjustified or improper timewise extension of the “right to exclude” granted by a patent and to prevent possible harassment by multiple assignees. A nonstatutory double patenting rejection is appropriate where the conflicting claims are not identical, but at

least one examined application claim is not patentably distinct from the reference claim(s) because the examined application claim is either anticipated by, or would have been obvious over, the reference claim(s). See, e.g., *In re Berg*, 140 F.3d 1428, 46 USPQ2d 1226 (Fed. Cir. 1998); *In re Goodman*, 11 F.3d 1046, 29 USPQ2d 2010 (Fed. Cir. 1993); *In re Longi*, 759 F.2d 887, 225 USPQ 645 (Fed. Cir. 1985); *In re Van Ornum*, 686 F.2d 937, 214 USPQ 761 (CCPA 1982); *In re Vogel*, 422 F.2d 438, 164 USPQ 619 (CCPA 1970); *In re Thorington*, 418 F.2d 528, 163 USPQ 644 (CCPA 1969).

A timely filed terminal disclaimer in compliance with 37 CFR 1.321(c) or 1.321(d) may be used to overcome an actual or provisional rejection based on nonstatutory double patenting provided the reference application or patent either is shown to be commonly owned with the examined application, or claims an invention made as a result of activities undertaken within the scope of a joint research agreement. See MPEP § 717.02 for applications subject to examination under the first inventor to file provisions of the AIA as explained in MPEP § 2159. See MPEP § 2146 *et seq.* for applications not subject to examination under the first inventor to file provisions of the AIA. A terminal disclaimer must be signed in compliance with 37 CFR 1.321(b).

The USPTO Internet website contains terminal disclaimer forms which may be used. Please visit www.uspto.gov/patent/patents-forms. The filing date of the application in which the form is filed determines what form (e.g., PTO/SB/25, PTO/SB/26, PTO/AIA/25, or PTO/AIA/26) should be used. A web-based eTerminal Disclaimer may be filled out completely online using web-screens. An eTerminal Disclaimer that meets all requirements is auto-processed and approved immediately upon submission. For

more information about eTerminal Disclaimers, refer to

www.uspto.gov/patents/process/file/efs/guidance/eTD-info-I.jsp.

9. Claims 1-4 and 16-18 are rejected on the ground of nonstatutory double patenting as being unpatentable over claims 13-16 of U.S. Patent No. US 10,833,363. Although the claims at issue are not identical, they are not patentably distinct from each other because the claims of the '363 patent anticipate the instant claims. Further regarding the ranges / ratios of the individual compounds relative to each other, it would have been obvious to one of ordinary skill in the art at the time of invention to have selected the overlapping portion of the ranges disclosed by the reference because selection of overlapping portion of ranges has been held to be a prima facie case of obviousness. *In re Malagari*, 182 USPQ 549.

10. Claims 1-4 and 16-19 are rejected on the ground of nonstatutory double patenting as being unpatentable over claims 12-15 of U.S. Patent No. US 11,522,222. Although the claims at issue are not identical, they are not patentably distinct from each other because the claims of the '222 patent anticipate the instant claims. Further regarding the ranges / ratios of the individual compounds relative to each other, it would have been obvious to one of ordinary skill in the art at the time of invention to have selected the overlapping portion of the ranges disclosed by the reference because selection of overlapping portion of ranges has been held to be a prima facie case of obviousness. *In re Malagari*, 182 USPQ 549.

11. Claims 1-20 are provisionally rejected on the ground of nonstatutory double patenting as being unpatentable over claims 1-30 of copending Application No. 18/076,882 (reference application). Although the claims at issue are not identical, they are not patentably distinct from each other because the claims of the '882 patent application anticipate the instant claims. Further regarding the ranges / ratios of the individual compounds relative to each other, it would have been obvious to one of ordinary skill in the art at the time of invention to have selected the overlapping portion of the ranges disclosed by the reference because selection of overlapping portion of ranges has been held to be a prima facie case of obviousness. *In re Malagari*, 182 USPQ 549.

This is a provisional nonstatutory double patenting rejection because the patentably indistinct claims have not in fact been patented.

12. Claims 1-20 are provisionally rejected on the ground of nonstatutory double patenting as being unpatentable over claims 1-19 of copending Application No. 17/885,915 (reference application). Although the claims at issue are not identical, they are not patentably distinct from each other because the claims of the '915 patent application anticipate the instant claims. Further regarding the ranges / ratios of the individual compounds relative to each other, it would have been obvious to one of ordinary skill in the art at the time of invention to have selected the overlapping portion of the ranges disclosed by the reference because selection of overlapping portion of ranges has been held to be a prima facie case of obviousness. *In re Malagari*, 182 USPQ 549.

This is a provisional nonstatutory double patenting rejection because the patentably indistinct claims have not in fact been patented.

13. Claims 1-20 are provisionally rejected on the ground of nonstatutory double patenting as being unpatentable over claims 1-44 of copending Application No. 17/990,626 (reference application). Although the claims at issue are not identical, they are not patentably distinct from each other because the claims of the '626 patent application anticipate the instant claims. Further regarding the ranges / ratios of the individual compounds relative to each other, it would have been obvious to one of ordinary skill in the art at the time of invention to have selected the overlapping portion of the ranges disclosed by the reference because selection of overlapping portion of ranges has been held to be a prima facie case of obviousness. *In re Malagari*, 182 USPQ 549.

This is a provisional nonstatutory double patenting rejection because the patentably indistinct claims have not in fact been patented.

14. Claims 1-20 are provisionally rejected on the ground of nonstatutory double patenting as being unpatentable over claims 1-4 of copending Application No. 17/990,641 (reference application). Although the claims at issue are not identical, they are not patentably distinct from each other because the claims of the '641 patent application anticipate the instant claims. Further regarding the ranges / ratios of the individual compounds relative to each other, it would have been obvious to one of ordinary skill in the art at the time of invention to have selected the overlapping portion

of the ranges disclosed by the reference because selection of overlapping portion of ranges has been held to be a prima facie case of obviousness. *In re Malagari*, 182 USPQ 549.

This is a provisional nonstatutory double patenting rejection because the patentably indistinct claims have not in fact been patented.

Conclusion

15. The prior art made of record and not relied upon is considered pertinent to applicant's disclosure:

Li (US 2015/0140446) discloses in Fig 1, a battery ([0001]) including an electrolyte comprising a mix of organic compounds including dinitriles and propyl propionate in distinct ratios within the electrolyte ([0025]-[0027]).

16. Any inquiry concerning this communication or earlier communications from the examiner should be directed to KENNETH J DOUYETTE whose telephone number is (571)270-1212. The examiner can normally be reached Monday - Friday 8A - 4P EST.

Examiner interviews are available via telephone, in-person, and video conferencing using a USPTO supplied web-based collaboration tool. To schedule an interview, applicant is encouraged to use the USPTO Automated Interview Request (AIR) at http://www.uspto.gov/interviewpractice.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Basia Ridley can be reached on 571-272-1453. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

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

/KENNETH J DOUYETTE/
Primary Examiner, Art Unit 1725

Notice of References Cited	Application/Control No. 17/885,920	Applicant(s)/Patent Under Reexamination WANG et al.	
	Examiner KENNETH J DOUYETTE	Art Unit 1725	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-20150140446-A1	05-2015	Li; Wentao	H01M10/052	429/199
	B					
	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	CN-106848381-A	06-2017	CN	HONG K	
	O					
	P					
	Q					
	R					
	S					
	T					

NON-PATENT DOCUMENTS

*		Include as applicable: Author, Title Date, Publisher, Edition or Volume, Pertinent Pages)
	U	English Translation of: CN-106848381-A, Hong et al. 6/13/2017
	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
	17/885,920	WANG et al.
	Examiner	Art Unit
	KENNETH J DOUYETTE	1725

✓	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	04/14/2023								
	1	✓								
	2	✓								
	3	✓								
	4	✓								
	5	✓								
	6	✓								
	7	✓								
	8	✓								
	9	✓								
	10	✓								
	11	✓								
	12	✓								
	13	✓								
	14	✓								
	15	✓								
	16	✓								
	17	✓								
	18	✓								
	19	✓								
	20	✓								

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Search Notes	Application/Control No.	Applicant(s)/Patent Under Reexamination
	17/885,920	WANG et al.
	Examiner	Art Unit
	KENNETH J DOUYETTE	1725

CPC - Searched*		
Symbol	Date	Examiner
H01M 10/04, 10/04, 10/0566, 10/0525, 10/0566	04/14/2023	KD

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
PDP inventor / assignee database search	04/14/2023	KD
global dossier search for pertinent documents	04/14/2023	KD
google.com search for battery electrolytes	04/14/2023	KD
reviewed filewrapper of parent apps 16211853, 17064782	04/14/2023	KD
SEARCH, see text search history	04/14/2023	KD

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

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Espacenet

Bibliographic data: CN106848381 (A) — 2017-06-13

Electrolyte solution lithium and secondary battery containing electrolyte solution

Inventor(s):	HONG KUNGUANG; ZHOU SHAOYUN; YU LE ± (洪坤光, ; 周邵云, ; 余乐)
Applicant(s):	GUANGZHOU TINCI MAT TECH CO LTD ± (广州天赐高新材料股份有限公司)
Classification:	- international: ***H01M10/0525; H01M10/056; H01M10/0567; H01M10/0569*** - cooperative: **H01M10/0525 (CN); H01M10/056 (CN); H01M10/0567 (CN); H01M10/0569 (CN);** Y02E60/10 (EP)
Application number:	CN20171029575 20170116 Global Dossier
Priority number(s):	CN20171029575 20170116

Abstract of CN106848381 (A)

The invention belongs to the field of lithium secondary batteries, and discloses an electrolyte solution and a lithium secondary battery containing the electrolyte solution. The electrolyte solution comprises an electrolyte, an organic solvent, additives and a functional compound, wherein the functional compound comprises at least one of tricyanophosphite compounds and tricyanophosphate compounds. The tricyanophosphite compounds or tricyanophosphate compounds contained in the electrolyte solution can form a film on the surface of the positive and negative electrodes, and can be complexed with metal ions to prevent the positive electrode metal ions from dissolving into the electrolyte solution and from depositing on the negative electrode, thereby achieving the effect of stabilizing the positive electrode structure and improving the negative electrode SEI film, and enhancing the cycle performance and high-temperature properties of the lithium secondary battery. The functional compound can lower the film forming resistance in the low-temperature environment and improve the problem of lithium precipitation during low-temperature charging.

(19)中华人民共和国国家知识产权局

(12)发明专利申请

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(21)申请号 201710029575.X

(22)申请日 2017.01.16

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代理人 罗啸秋 裘晖

(51)Int.Cl.
H01M 10/0525(2010.01)
H01M 10/056(2010.01)
H01M 10/0569(2010.01)
H01M 10/0567(2010.01)

权利要求书1页 说明书9页

(54)发明名称

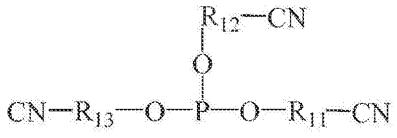
一种电解液及含有该电解液的锂二次电池

(57)摘要

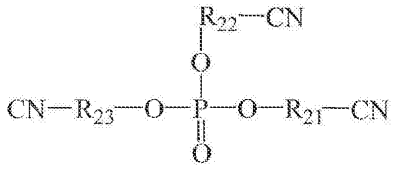
本发明属于锂二次电池领域，公开了一种电解液及含有该电解液的锂二次电池。所述电解液包括电解质、有机溶剂、添加剂和功能化合物，所述功能化合物为三氧基亚磷酸酯化合物和三氧基磷酸酯化合物中的至少一种。本发明的电解液中含有的三氧基亚磷酸酯化合物或三氧基磷酸酯化合物，可以在正负极表面成膜，且能与金属离子络合，防止正极金属离子脱出溶到电解液中和防止其沉积在负极，从而达到稳定正极结构和改善负极SEI膜的作用，提高锂二次电池循环性能和高温性能。同时本发明的功能化合物可降低低温环境下的成膜阻抗，改善低温充电的析锂问题。

CN 106848381 A

1.一种电解液，其特征在于：所述电解液包括电解质、有机溶剂、添加剂和功能化合物，所述功能化合物为三氰基亚磷酸酯化合物和三氰基磷酸酯化合物中的至少一种，所述三氰基亚磷酸酯化合物和三氰基磷酸酯化合物分别具有如下式(I)和式(II)所示的结构式：



式（I），



式（II）；

式中R_{11}、R_{12}、R_{13}、R_{21}、R_{22}、R_{23}各自独立地选自C1～C5的亚烷基或氟代亚烷基。

2.根据权利要求1所述的一种电解液，其特征在于：所述功能化合物在电解液中的质量百分含量为0.05%～10%。

3.根据权利要求2所述的一种电解液，其特征在于：所述功能化合物在电解液中的质量百分含量为0.2%～5%。

4.根据权利要求1所述的一种电解液，其特征在于：所述电解质为$LiPF_6$、$LiBF_4$、$LiSO_3CF_3$、LiBOB、LiDFOB、LiTFSI、LiFSI、$LiPO_2F_2$中的至少一种。

5.根据权利要求1所述的一种电解液，其特征在于：所述有机溶剂包括EC、PC、DMC、DEC、EMC、GBL、MA、EA、PA、BA、MP、EP、PP、BP、MB、EB、PB中的至少两种。

6.根据权利要求5所述的一种电解液，其特征在于：所述有机溶剂为EC、PC、EMC、DEC、PA、MP、EP、PP、EB中的至少两种。

7.根据权利要求1所述的一种电解液，其特征在于：所述添加剂为FEC、VC、VEC、PS、BS、DTD、MMDS、PES、硫酸丙烯酯、亚硫酸乙烯酯、SN、ADN、PN、HTCN、DENE、丁二酸酐、马来酸酐、2-甲基马来酸酐、2,3-二甲基马来酸酐、衣康酸酐中的至少一种。

8.一种锂二次电池，包括含有正极活性材料的正极片、含有负极活性材料的负极片、隔离膜和电解液；正极片包括嵌入或者脱嵌锂离子的正极活性材料、导电剂、集流体及将所述正极活性材料、导电剂、集流体结合的粘结剂；负极片包括可嵌入或者脱嵌锂离子的负极活性材料、导电剂、集流体及将所述负极活性材料、导电剂、集流体结合的粘结剂，其特征在于：所述电解液为权利要求1～7任一项所述的电解液。

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一种电解液及含有该电解液的锂二次电池

技术领域

[0001] 本发明属于锂二次电池领域，具体涉及一种电解液及含有该电解液的锂二次电池。

背景技术

[0002] 锂二次电池具有工作电压高、比能量密度大、循环寿命长、自放电率低、无记忆效应、对环境污染小等优点，已经广泛应用于消费类电子、储能及动力产品。近年来，随着便携式电子产品向轻便化、高性能发展，这对锂二次电池的能量密度提出更高要求。应对电池更高能量密度的不断追求，业内目前普遍采用的策略是提高正负极的压实和提高电池的截止电压。随之而来的是电池性能的劣化，特别是在高压高温下，电池极片表面形成的SEI膜容易被破坏；在低温充电时，由于电池的动力学性能欠佳，低温充放电时容易析锂，电池安全性能受到影响。

[0003] 专利CN201510564696公开了一种含有双氰基化合物NC-R-CN作为锂离子电池电解液添加剂，可以提高电池的高温存储性能以及循环性能。类似的，专利CN201510964662公开了一种同时含有不饱和碳碳键和氰基的化合物作为锂离子电池电解液添加剂，能够在电极表面发生聚合反应形成含有多个氰基的化合物，该化合物能够与正极材料表面的金属离子络合，从而抑制电解液在电极表面发生分解，提高电池的高温储存及循环性能。但本领域的科研人员发现，含不饱和碳碳双键或三键的化合物成膜阻抗会增大，低温充电时更易析锂，降低电池安全性能。

[0004] 因此，开发一种既能改善高温存储及循环性能，同时又能改善低温充电性能的锂二次电池电解液意义重大。

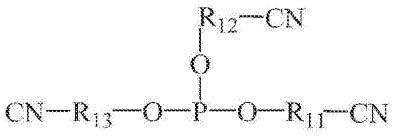
发明内容

[0005] 本发明的目的在于解决上述技术问题，提供一种既能改善高温存储及循环性能，同时又能改善低温充电性能的电解液及含有该电解液的锂二次电池。

[0006] 本发明目的通过以下技术方案实现：

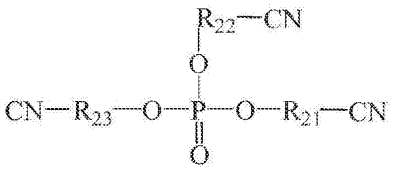
[0007] 一种电解液，包括电解质、有机溶剂、添加剂和功能化合物，所述功能化合物为三氰基亚磷酸酯化合物和三氰基磷酸酯化合物中的至少一种，所述三氰基亚磷酸酯化合物和三氰基磷酸酯化合物分别具有如下式(I)和式(II)所示的结构式：

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式（I），

[0008]



式（II）；

[0009] 式中R_{11}、R_{12}、R_{13}、R_{21}、R_{22}、R_{23}各自独立地选自C1～C5的亚烷基或氟代亚烷基。

[0010] 所述功能化合物在电解液中的质量百分含量优选为0.05%～10%，当低于0.05%时，不能很好的保护正负极，从而难以充分提高电池的高温储存性能及循环性能，而超过10%时，由于其增加电解液的粘度，导致电池性能恶化。更优选地，其在电解液中的质量百分含量为0.2%～5%。

[0011] 所述电解质优选为六氟磷酸锂($LiPF_6$)、四氟硼酸锂($LiBF_4$)、三氟甲基磺酸锂($LiSO_3CF_3$)、双乙二酸硼酸锂(LiBOB)、二氟草酸硼酸锂(LiDFOB)、双三氟甲烷磺酰亚胺锂(LiTFSI)、双氟磺酰亚胺锂(LiFSI)、二氟磷酸锂

[0012] ($LiPO_2F_2$)的至少一种。

[0013] 所述有机溶剂包括碳酸乙烯酯(EC)、碳酸丙烯酯(PC)、碳酸二甲酯(DMC)、碳酸二乙酯(DEC)、碳酸甲乙酯(EMC)、γ-丁内酯(GBL)、乙酸甲酯(MA)、乙酸乙酯(EA)、乙酸丙酯(PA)、乙酸丁酯(BA)、丙酸甲酯(MP)、丙酸乙酯(EP)、丙酸丙酯(PP)、丙酸丁酯(BP)、丁酸甲酯(MB)、丁酸乙酯(EB)、丁酸丙酯(PB)中的至少两种。

[0014] 优选的，所述有机溶剂为EC、PC、EMC、DEC、PA、MP、EP、PP、EB中的至少两种。

[0015] 所述添加剂为本领域常用的添加剂，作为举例，所述添加剂为氟代碳酸乙烯酯(FEC)、碳酸亚乙烯酯(VC)、碳酸乙烯亚乙酯(VEC)、1,3-丙磺酸内酯(PS)、1,4-丁磺酸内酯(BS)、硫酸乙烯酯(DTD)、甲烷二磺酸亚甲酯(MMDS)、丙烯磺酸内酯(PES)、硫酸丙烯酯、亚硫酸乙烯酯、丁二腈(SN)、己二腈(ADN)、庚二腈(PN)、1,3,6-己烷三腈(HTCN)、乙二醇双(丙腈)醚(DENE)、丁二酸酐、马来酸酐、2-甲基马来酸酐、2,3-二甲基马来酸酐、衣康酸酐中的至少一种。

[0016] 本发明还涉及一种含有上述电解液的锂二次电池，包括含有正极活性材料的正极片、含有负极活性材料的负极片、隔离膜和上述电解液；正极片包括嵌入或者脱嵌锂离子的正极活性材料、导电剂、集流体及将所述正极活性材料、导电剂、集流体结合的粘结剂；负极片包括可嵌入或者脱嵌锂离子的负极活性材料、导电剂、集流体及将所述负极活性材料、导电剂、集流体结合的粘结剂。

[0017] 本发明的电解液具有如下优点及有益效果：

[0018] 本发明的电解液中含有的三氰基亚磷酸酯化合物或三氰基磷酸酯化合物，可以在正负极表面成膜，且能与金属离子络合，防止正极金属离子脱出溶到电解液中和防止其沉积在负极，从而达到稳定正极结构和改善负极SEI膜的作用，提高锂二次电池循环性能和高

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温性能。同时本发明的功能化合物可降低低温环境下的成膜阻抗，改善低温充电的析锂问题，从而显著提高电池的安全性能。

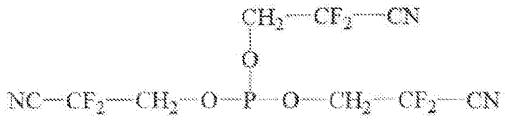
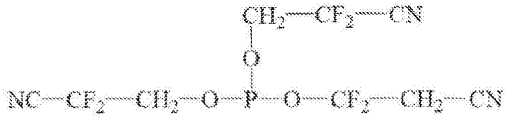
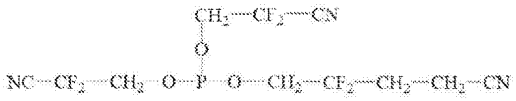
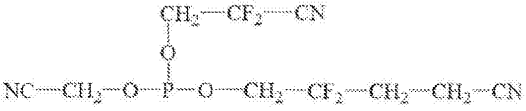
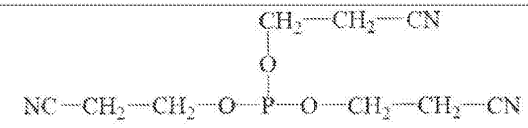
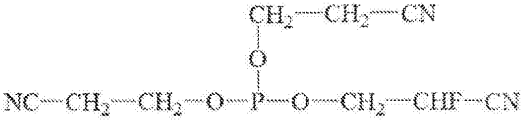
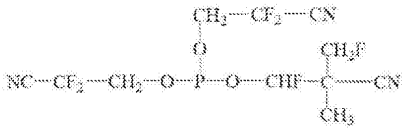
具体实施方式

[0019] 下面结合实施例对本发明作进一步详细的描述，但本发明的实施方式不限于此。

[0020] 本发明实施例所用到的三氰基亚磷酸酯化合物和三氰基磷酸酯化合物的结构分别如表1和表2所示。

[0021] 表1三氰基亚磷酸酯化合物

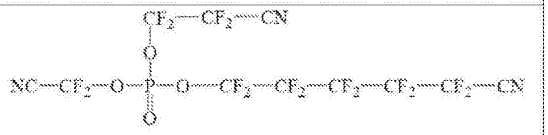
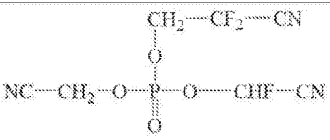
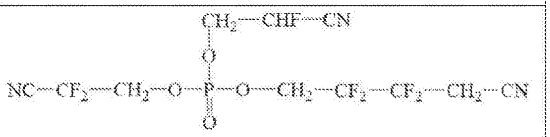
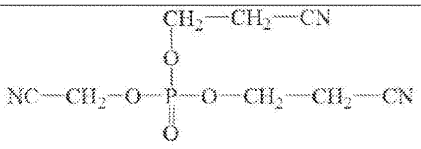
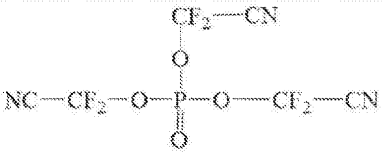
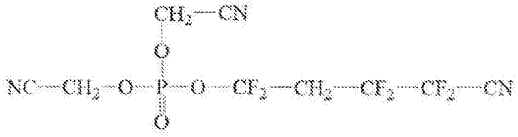
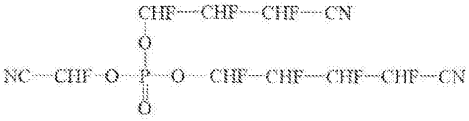
[0022]

	结构式
化合物I_1	
化合物I_2	
化合物I_3	
化合物I_4	
化合物I_5	
化合物I_6	
化合物I_7	

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[0023] 表2三氰基磷酸酯化合物

[0024]

	结构式
化合物II$_1$	
化合物 II$_2$	
化合物 II$_3$	
化合物 II$_4$	
化合物 II$_5$	
化合物 II$_6$	
化合物 II$_7$	

[0025] 本发明实施例中锂二次电池的制备及性能测试步骤如下：

[0026] (1)电解液的制备：在氩气氛围的手套箱中，将有机溶剂按一定质量比混合，再加入添加剂、三氰基亚磷酸酯化合物或三氰基磷酸酯化合物、电解质充分搅拌均匀，即得到本发明所述的电解液。

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[0027] (2)正极极片的制备:将一定质量比的聚偏氟乙烯(PVDF)溶解于1-甲基-2-吡咯烷酮(NMP)溶液中,再将一定质量比的正极活性材料和导电剂加入上述溶液并混合均匀,将混制的浆料涂布在铝箔的两面后,烘干、辊压后得到正极极片。

[0028] (3)负极极片的制备:将质量比的SBR粘结剂和CMC增稠剂溶于水溶液中,再将一定质量比的负极材料和导电剂加入上述溶液并混合均匀,将混制的浆料涂布在铜箔的两面后,烘干、辊压后得到负极极片。

[0029] (4)锂二次电池的制备:将上述制备的正极极片、负极极片和隔离膜制成电芯,注入步骤(1)所得电解液,经化成等工艺后制成锂二次电池。

[0030] (5)电池性能测试

[0031] 高温循环测试:在45℃恒温箱中以0.5/0.5C的倍率对电池进行充放电循环测试。高温储存性能测试:先将电池在常温状态下以0.5/0.5C的倍率对电池进行充放电一次,再以0.5C将电池充满电后进行高温存储,存储一定时间后热态测试电池的厚度,待电池完全冷却后以0.5C进行充放电测试计算容量保持率和容量恢复率。低温充电测试:先将电池在常温状态下以0.5C放电,再在高低温箱中低温0℃搁置4小时后以0.3C将电池充满电,然后在氩气氛围的手套箱中拆解电池观察负极表面是否析锂。

[0032] 本发明实施例1~25及对比例1~6的电解液组成如表3所示。

[0033] 表3实施例和对比例的电解液组分

[0034]

	有机溶剂	添加剂	功能化合物	电解质
实施例1	EC:EMC:DEC:PC=25:25:40:10	5%FEC	3%化合物I_1	1.1 M $LiPF_6$
实施例2	EC:PP:DEC:PC=25:25:40:10	3%PS，5%FEC，2%ADN，1%SN，0.3%VEC，1%DENE	0.8%化合物I_1	1.1 M $LiPF_6$
实施例3	EC:PP:DEC:PC=25:25:40:10	3%PS，5%FEC，2%ADN，1%SN，0.3%VEC，1%DENE	0.8%化合物I_2	1.1 M $LiPF_6$

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[0035]

实施例 4	EC:PP:DEC:PC=25:25:40:10	3%PS，5%FEC，2%ADN，1%SN，0.3%VEC，1%DENE	0.8%化合物 I_5	1.1 M $LiPF_6$
实施例 5	EC:PP:DEC:PC=25:25:40:10	3%PS，5%FEC，2%ADN，1%SN，0.3%VEC，1%DENE	0.8%化合物 I_4	1.1 M $LiPF_6$
实施例 6	EC:PP:DEC:PC=25:25:40:10	3%PS，5%FEC，2%ADN，1%SN，0.3%VEC，1%DENE	0.8%化合物 I_5	1.1 M $LiPF_6$
实施例 7	EC:PP:DEC:PC=25:25:40:10	3%PS，5%FEC，2%ADN，1%SN，0.3%VEC，1%DENE	0.8%化合物 I_6	1.1 M $LiPF_6$
实施例 8	EC:PP:DEC:PC=25:25:40:10	3%PS，5%FEC，2%ADN，1%SN，0.3%VEC，1%DENE	0.8%化合物 I_7	1.1 M $LiPF_6$
实施例 9	EC:PP:DEC:PC=25:25:40:10	3%PS，5%FEC，2%ADN，1%SN，0.3%VEC，1%DENE	0.8%化合物 II_1	1.1 M $LiPF_6$
实施例 10	EC:PP:DEC:PC=25:25:40:10	3%PS，5%FEC，2%ADN，1%SN，0.3%VEC，1%DENE	0.8%化合物 II_2	1.1 M $LiPF_6$
实施例 11	EC:PP:DEC:PC=25:25:40:10	3%PS，5%FEC，2%ADN，1%SN，0.3%VEC，1%DENE	0.8%化合物 II_3	1.1 M $LiPF_6$
实施例 12	EC:PP:DEC:PC=25:25:40:10	3%PS，5%FEC，2%ADN，1%SN，0.3%VEC，1%DENE	0.8%化合物 II_4	1.1 M $LiPF_6$
实施例 13	EC:PP:DEC:PC=25:25:40:10	3%PS，5%FEC，2%ADN，1%SN，0.3%VEC，1%DENE	0.8%化合物 II_5	1.1 M $LiPF_6$
实施例 14	EC:PP:DEC:PC=25:25:40:10	3%PS，5%FEC，2%ADN，1%SN，0.3%VEC，1%DENE	0.8%化合物 II_6	1.1 M $LiPF_6$
实施例 15	EC:PP:DEC:PC=25:25:40:10	3%PS，5%FEC，2%ADN，1%SN，0.3%VEC，1%DENE	0.8%化合物 II_7	1.1 M $LiPF_6$
实施例 16	EC:PP:DEC:PC=25:25:40:10	3%PS，5%FEC，2%ADN，1%SN，0.3%VEC，1%DENE	0.05%化合物 I_1	1.1 M $LiPF_6$
实施例 17	EC:PP:DEC:PC=25:25:40:10	3%PS，5%FEC，2%ADN，1%SN，0.3%VEC，1%DENE	0.2%化合物 I_1	1.1 M $LiPF_6$
实施例 18	EC:PP:DEC:PC=25:25:40:10	3%PS，5%FEC，2%ADN，1%SN，0.3%VEC，1%DENE	5%化合物 I_1	1.1 M $LiPF_6$

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[0036]

实施例19	EC:PP:DEC:PC=25:25:40:10	3%PS，5%FEC，2%ADN，1%SN，0.3%VEC，1%DENE	10%化合物I_1	1.1 M $LiPF_6$
实施例20	EC:PP:DEC:PC=25:25:40:10	3%PS，5%FEC，2%ADN，1%SN，0.3%VEC，1%DENE	0.4%化合物I_1，0.4%化合物II_2	1.1 M $LiPF_6$
实施例21	EC:PP:DEC:PC=25:25:40:10	3%PS，5%FEC，2%ADN，1%SN，0.3%VEC，1%DENE	0.4%化合物I_2，0.4%化合物II_5	1.1 M $LiPF_6$
实施例22	EC:PA:EP:DEC:PC=25:20:20:25:10	3%PS，5%FEC，2%ADN，1%SN，0.5%PES，1%DENE，0.5%衣康酸酐	1.0%化合物II_4	1.0 M $LiPF_6$+0.1 M $LiPO_2F_2$
实施例23	EC:MP:EB:DEC:PC=25:20:20:25:10	4%PS，6%FEC，1%DENE，1%PN，0.3%VEC，1%DENE，0.5%马来酸酐	2.0%化合物I_7	0.9 M LiFSI
实施例24	EC:EA:DEC:PC=25:25:40:10	3%PS，5%FEC，2%ADN，1%SN，0.3%VEC，1%DENE	0.8%化合物I_1	1.1 M $LiPF_6$
实施例25	EC:PP:DEC:PC=25:25:40:10	3%PS，5%FEC，2%ADN，1%SN，0.5%DTD，1%DENE，0.5%HTCN	4.5%化合物II_6	1.0 M $LiPF_6$+0.5 M LiTFSI
对比例1	EC:EMC:DEC:PC=25:25:40:10	5%FEC	--	1.1 M $LiPF_6$
对比例2	EC:PP:DEC:PC=25:25:40:10	3%PS，5%FEC，2%ADN，1%SN，0.3%VEC，1%DENE	--	1.1 M $LiPF_6$
对比例3	EC:PA:EP:DEC:PC=25:20:20:25:10	3%PS，5%FEC，2%ADN，1%SN，0.5%PES，1%DENE，0.5%衣康酸酐	--	1.0 M $LiPF_6$+0.1 M $LiPO_2F_2$
对比例4	EC:MP:EB:DEC:PC=25:20:20:25:10	4%PS，6%FEC，1%DENE，1%PN，0.3%VEC，1%DENE，0.5%马来酸酐	--	0.9 M LiFSI
对比例5	EC:EA:DEC:PC=25	3%PS，5%FEC，2%ADN，	--	1.1 M

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[0037]

	:25:40:10	1%SN，0.3%VEC，1%DENE		$LiPF_6$
对比例 6	EC:PP:DEC:PC=25:25:40:10	3%PS，5%FEC，2%ADN，1%SN，0.5%DTD，1%DENE，0.5%HTCN	--	1.0 M $LiPF_6$+0.5 M LiTFSI

[0038] 表中百分含量是指占最终电解液中的质量百分含量，浓度是指在最终电解液中的浓度。

[0039] 实施例1～25和对比例1～6的电解液得到的锂二次电池的性能测试结果如表4所示。

[0040] 表4实施例和对比例的测试结果

[0041]

	45℃循环 500 周		60℃满电存储 30 天			低温 0℃充电
	容量保持率/%	厚度变化率/%	容量保持率/%	容量恢复率/%	厚度变化率/%	
实施例 1	86.9	4.9	78.2	87.5	8.6	未析锂
实施例 2	85.6	4.5	77.2	86.3	9.2	未析锂
实施例 3	84.5	4.1	78.1	85.2	9.5	未析锂
实施例 4	85.8	4.6	77.1	85.8	8.3	未析锂
实施例 5	83.1	4.9	76.5	86.9	7.6	未析锂
实施例 6	82.9	5.3	78.2	87.1	9.3	未析锂
实施例 7	83.5	4.8	77.5	87.8	7.1	未析锂
实施例 8	83.3	4.2	77.3	87.2	8.2	未析锂
实施例 9	86.2	3.8	76.5	85.3	9.8	未析锂
实施例 10	83.4	4.6	78.5	88.7	6.4	未析锂
实施例 11	82.1	4.6	76.1	85.8	9.2	未析锂
实施例 12	84.6	4.1	76.6	86.5	8.2	未析锂
实施例 13	84.8	4.5	78.1	89.4	6.1	未析锂
实施例 14	85.5	4.0	76.3	86.3	9.1	未析锂
实施例 15	85.2	4.3	76.1	86.8	9.5	未析锂
实施例 16	80.2	6.2	72.1	80.2	12.6	未析锂
实施例 17	83.9	5.3	75.3	84.5	10.5	未析锂

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[0042]

实施例 18	85.6	4.1	77.8	87.9	7.4	未析锂
实施例 19	85.3	4.9	75.5	85.2	8.2	未析锂
实施例 20	86.2	4.2	78.8	89.6	6.3	未析锂
实施例 21	89.3	4.1	77.9	88.2	8.2	未析锂
实施例 22	86.6	3.6	78.3	88.5	8.9	未析锂
实施例 23	88.1	3.8	77.5	89.2	6.5	未析锂
实施例 24	78.9	9.2	69.1	75.2	13.5	未析锂
实施例 25	87.2	3.5	75.1	82.6	8.2	未析锂
对比例 1	75.6	7.6	65.2	75.2	22.3	析锂
对比例 2	73.1	8.5	67.1	77.4	19.3	析锂
对比例 3	74.3	7.3	67.5	77.6	19.5	析锂
对比例 4	75.3	7.2	65.3	76.2	20.2	析锂
对比例 5	61.1	13.9	43.5	45.6	65.4	轻微析锂
对比例 6	74.1	7.1	67.9	77.3	17.2	轻微析锂

[0043] 通过实施例1～25与对比例1～6进行对比，发现加入三氰基亚磷酸酯化合物或三氰基磷酸酯化合物可以有效改善电池的循环性能，能明显提高电池高温存储后的容量保持率，抑制厚度膨胀，而且对低温充电析锂问题也有改善。

[0044] 上述实施例为本发明较佳的实施方式，但本发明的实施方式并不受上述实施例的限制，其它的任何未背离本发明的精神实质与原理下所作的改变、修饰、替代、组合、简化，均应为等效的置换方式，都包含在本发明的保护范围之内。

Zhuhai CosMX Battery Co. - EX1002
Zhuhai CosMX Battery Co. v. Ningde Amperex Tech. Ltd.
IPR2025-00722
Page 124 of 273

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

PTO/SB/08a (01-22)
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INFORMATION DISCLOSURE STATEMENT BY APPLICANT
(Not for submission under 37 CFR 1.99)

Application Number	
Filing Date	2022-08-11
First Named Inventor	Kefei WANG
Art Unit	TBD
Examiner Name	TBD
Attorney Docket Number	14850089COB

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Examiner Initial*	Cite No	Patent Number	Kind Code[1]	Issue Date	Name of Patentee or Applicant of cited Document	Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear
/K.J.D/	1	9812739	B2	2017-11-07	KEFEI	

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/K.J.D/	1	20110311864	A1	2011-12-22	SONY CORPORATION	
/K.J.D/	2	20120313570	A1	2012-12-13	SONY CORPORATION	
/K.J.D/	3	20170346127	A1	2017-11-30	MITSUI CHEMICALS, INC.	
/K.J.D/	4	20170346136	A1	2017-11-30	Ningde Amperex Technology Limited	
/K.J.D/	5	20090061325	A1	2009-03-05	Sony Corporation	

INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)		
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	Filing Date	2022-08-11
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	Art Unit	TBD
	Examiner Name	TBD
	Attorney Docket Number	14850089COB

/K.J.D/	6	20170324116	A1	2017-11-09	MITSUBISHI CHEMICAL CORPORATION	
/K.J.D/	7	20190214680	A1	2019-07-11	NINGDE AMPEREX TECHNOLOGY LIMITED	
/K.J.D/	8	20170288268	A1	2017-10-05	SAMSUNG SDI CO., LTD.	
/K.J.D/	9	20170018803	A1	2017-01-19	NingDe Contemporary Amperex Technology Limited	
/K.J.D/	10	20190245245	A1	2019-08-08	Ningde Amperex Technology Limited	
/K.J.D/	11	20180233778	A1	2018-08-16	SK Innovation Co., Ltd.	
/K.J.D/	12	20180108947	A9	2018-04-19	Ningde Amperex Technology Ltd.	
/K.J.D/	13	20160301103	A1	2016-10-13	SK INNOVATION CO., LTD.	
/K.J.D/	14	20140322596	A1	2014-10-30	Samsung SDI Co., Ltd.	
/K.J.D/	15	20170125845	A1	2017-05-04	LG Chem, Ltd.	
/K.J.D/	16	20170069934	A1	2017-03-09	SAMSUNG SDI CO., LTD.	

INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)		
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	Examiner Name	TBD
	Attorney Docket Number	14850089COB

/K.J.D/	17	20170317385	A1	2017-11-02	BASF CORPORATION	

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Examiner Initial*	Cite No	Foreign Document Number[3]	Country Code[2]	Kind Code[4]	Publication Date	Name of Patentee or Applicant of cited Document	Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear	T[5]
/K.J.D/	1	107210486	CN	A	2017-09-26	Mitsubishi Chem Corp.	Corresponds to US Publication 20170324116A1	
/K.J.D/	2	108232300	CN	A	2018-06-29	Ningde Amperex Technology Ltd.	Corresponds to US Publication 20190214680A1	
/K.J.D/	3	105845984	CN	A	2016-08-10	Dongguan Shanshan Battery Mat. Co., Ltd.	English abstract	
/K.J.D/	4	106602131	CN	A	2017-04-26	Ningde Amperex Technology Ltd.	English abstract	
/K.J.D/	5	105047992	CN	A	2015-11-11	Ningde Amperex Technology Ltd.	English abstract	
/K.J.D/	6	105552439	CN	A	2016-05-04	Dongguan Shanshan Battery Mat. Co., Ltd.	English abstract	
/K.J.D/	7	106099187	CN	A	2016-11-09	Dongguan Kaixin Battery Mat. Co., Ltd.	English abstract	
/K.J.D/	8	106816633	CN	A	2017-06-09	University of Jiliang, China	English abstract	

INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)		
	Application Number	
	Filing Date	2022-08-11
	First Named Inventor	Kefei WANG
	Art Unit	TBD
	Examiner Name	TBD
	Attorney Docket Number	14850089COB

/K.J.D/	9	2017022108	JP	A	2017-01-26	Stella Chemifa Corp.	English abstract	
/K.J.D/	10	105680088	CN	A	2016-06-15	Donguan Kaixin Battery Material Co., Ltd.	English abstract	
/K.J.D/	11	103401020	CN	A	2013-11-20	Dongguan Shanshan Battery Materials Co., Ltd.	English abstract	
/K.J.D/	12	103779607	CN	A	2014-05-07	Central South University	English abstract	
/K.J.D/	13	104752769	CN	A	2015-07-01	Ningde Amperex Technology Ltd.	English abstract	
/K.J.D/	14	106099185	CN	A	2016-11-09	Highpower Tech (Huizhou) Co., Ltd.	English abstract	
/K.J.D/	15	104979589	CN	A	2015-10-14	Donguan Kaixin Battery Material Co., Ltd.	English abstract	
/K.J.D/	16	103956517	CN	A	2014-07-30	South China Normal University	English abstract	
/K.J.D/	17	105098237	CN	A	2015-11-25	Zhejiang Research Inst. of Chemical Industry Ltd.	English abstract	
/K.J.D/	18	105355975	CN	A	2016-02-24	Ningde Amperex Technology Ltd.	English abstract	
/K.J.D/	19	105529498	CN	A	2016-04-27	Donguan Kaixin Battery Material Co., Ltd.	English abstract	

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	Filing Date	2022-08-11
	First Named Inventor	Kefei WANG
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	Examiner Name	TBD
	Attorney Docket Number	14850089COB

/K.J.D/	20	107394269	CN	A	2017-11-24	Ningde Amperex Technology Ltd.	English abstract	
/K.J.D/	21	108242567	CN	A	2018-07-03	Ningde Contemporary Amperex Technology Co., Ltd.	English abstract	
/K.J.D/	22	107275553	CN	A	2017-10-20	Dongguan Liwinon Energy Tech Co., Ltd.	English abstract	
/K.J.D/	23	109301326	CN	A	2019-02-01	Ningde Amperex Technology Ltd.	English abstract	
/K.J.D/	24	101195931	KR	B1	2012-10-30	LG Chemical Ltd.	English abstract	
/K.J.D/	25	103633371	CN	A	2014-03-12	Shenzhen Capchem Technology Co., Ltd.	English abstract	
/K.J.D/	26	104332653	CN	A	2015-02-04	Amperex Technology Ltd.	English abstract	
/K.J.D/	27	102522590	CN	A	2012-06-27	Huawei Tech Co., Ltd.	English abstract	
/K.J.D/	28	105609874	CN	A	2016-05-25	Dongguan Amperex Technology Ltd.	English abstract	
/K.J.D/	29	103682416	CN	B	2018-02-09	Samsung SDI Co., Ltd.	English abstract	
/K.J.D/	30	107408734	CN	A	2017-11-28	Mitsubishi Chem Corp.	English abstract	

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	Filing Date	2022-08-11
	First Named Inventor	Kefei WANG
	Art Unit	TBD
	Examiner Name	TBD
	Attorney Docket Number	14850089COB

/K.J.D/	31	105355968	CN	A	2016-02-24	Ningde Amperex Technology Ltd.	English abstract	
/K.J.D/	32	104766995	CN	A	2015-07-08	Ningde Amperex Technology Ltd.	English abstract	
/K.J.D/	33	105895957	CN	A	2016-08-24	Contemporary Amperex Technology Co., Ltd.	English abstract	
/K.J.D/	34	106784589	CN	A	2017-05-31	Ningde Contemporary Amperex Tech Co., Ltd.	English abstract	
/K.J.D/	35	103348516	CN	A	2013-10-09	Sanyo Electric Co.	English abstract	
/K.J.D/	36	102244294	CN	A	2011-11-16	Mitsubishi Chem Corp.	English abstract	
/K.J.D/	37	106654128	CN	A	2017-05-10	Ningde Amperex Technology Ltd.	English abstract	
/K.J.D/	38	20170051286	KR	A	2017-05-11	LG Chemical Ltd.	English abstract	
/K.J.D/	39	105074993	CN	A	2015-11-18	SK Innovation Co., Ltd.	English abstract	
/K.J.D/	40	101640290	CN	A	2010-02-03	Sanyo Electric Co.	English abstract	
/K.J.D/	41	103928708	CN	A	2014-07-16	Samsung SDI Co., Ltd.	English abstract	

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/K.J.D/	1	Extended European Search Report issued January 14, 2020 in European application 19198416.0; 7 pages in English	☒
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	Application Number	
	Filing Date	2022-08-11
	First Named Inventor	Kefei WANG
	Art Unit	TBD
	Examiner Name	TBD
	Attorney Docket Number	14850089COB

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	/Timothy J. Maier/	Date (YYYY-MM-DD)	2022-08-11
Name/Print	Timothy J. Maier	Registration Number	51986

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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SERIAL NUMBER	FILING or 371(c) DATE RULE	CLASS	GROUP ART UNIT	ATTORNEY DOCKET NO.
17/885,920	08/11/2022	429	1725	14850089COB

APPLICANTS
NINGDE AMPEREX TECHNOLOGY LIMITED, Ningde City, CHINA;

INVENTORS
Kefei WANG, Ningde City, CHINA;
Qiao ZENG, Ningde City, CHINA;
Liangzhen XIAO, Ningde City, CHINA;
Fei WU, Ningde City, CHINA;

**** CONTINUING DATA ***************************
This application is a CON of 17/064,782 10/07/2020 PAT 11522222
which is a CON of 16/211,853 12/06/2018 PAT 10833363

**** FOREIGN APPLICATIONS ***************************
CHINA 201811108529.X 09/21/2018

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Foreign Priority claimed ☑ Yes ☐ No 35 USC 119(a-d) conditions met ☑ Yes ☐ No Verified and Acknowledged /KENNETH J DOUYETTE/ Examiner's Signature	☐ Met after Allowance Initials	STATE OR COUNTRY	SHEETS DRAWINGS	TOTAL CLAIMS	INDEPENDENT CLAIMS
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PE2E SEARCH - Search History (Prior Art)

Ref #	Hits	Search Query	DBs	Default Operator	Plurals	British Equivalents	Time Stamp
L1	8	"20150140446"	(US-PGPUB; USPAT)	OR	ON	ON	2023/03/14 04:55 PM
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L3	40	(Artificial Intelligence) More like doc: US-20150140446-A1 Text: (WO-2015073419-A1 OR EP-3072178-A1 OR US-9698447-B2 OR EP-3072178-B1 OR KR-102298774-B1 OR KR-20160086838-A OR JP-2017504145-A OR CN-105745780-A OR CN-105745780-B OR US-20170207486-A1 OR WO-2016011613-A1 OR KR-101586139-B1 OR CN-104781975-A OR CN-104781975-B OR US-20140349198-A1 OR CN-109994775-B OR WO-2020079819-A1 OR KR-102050964-B1 OR JP-2015522210-A OR KR-20150114460-A).did.	(US-PGPUB; USPAT; USOCR; FIT (AU, AP, AT, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, OA, RU, SU, WO, MC, MD, MY, NL, NO, NZ, PH, PL, PT, RO, RS, SE, SG, SI, SK, TH, TN, TR, TW, UA, VN); FPRS; EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2023/03/14 04:56 PM
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		(PGPB | USPT | USOC).dbnm.					
L30	32	battery AND electrolyte AND dinitrile SAME trinitrile AND propyl ADJ propionate	(US-PGPUB; USPAT)	OR	ON	ON	2023/03/14 05:03 PM
L31	32	battery AND electrolyte AND dinitrile SAME trinitrile AND propyl ADJ propionate	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2023/03/14 05:03 PM
L32	200	battery AND electrolyte AND dinitrile SAME trinitrile AND propyl ADJ propionate	(FIT (AU, AP, AT, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, OA, RU, SU, WO, MC, MD, MY, NL, NO, NZ, PH, PL, PT, RO, RS, SE, SG, SI, SK, TH, TN, TR, TW, UA, VN); FPRS; EPO; JPO; DERWENT)	OR	ON	ON	2023/03/14 05:03 PM
L33	11	battery AND electrolyte AND dinitrile SAME trinitrile AND propyl ADJ propionate	(FPRS; EPO; JPO; DERWENT)	OR	ON	ON	2023/03/14 05:03 PM
L34	11	battery AND electrolyte AND dinitrile SAME trinitrile AND propyl near3 propionate	(FPRS; EPO; JPO; DERWENT)	OR	ON	ON	2023/03/14 05:03 PM
L35	14	battery AND electrolyte AND dinitrile SAME trinitrile AND propyl ADJ propionate SAME (amount ratio)	(US-PGPUB; USPAT)	OR	ON	ON	2023/03/14 05:04 PM
L36	32	h01m$.cpc. AND battery AND electrolyte AND dinitrile AND trinitrile AND propyl ADJ propionate	(US-PGPUB; USPAT)	OR	ON	ON	2023/03/14 05:05 PM
L37	33	h01m$.cpc. AND battery AND electrolyte AND (glutaronitrile adiponitrile dinitrile) AND trinitrile AND propyl ADJ propionate	(US-PGPUB; USPAT)	OR	ON	ON	2023/03/14 05:06 PM
L38	681	h01m$.cpc. AND battery AND electrolyte AND (glutaronitrile adiponitrile dinitrile) AND propyl ADJ propionate	(US-PGPUB; USPAT)	OR	ON	ON	2023/03/14 05:07 PM
L39	110	h01m$.cpc. AND	(US-PGPUB; USPAT)	OR	ON	ON	2023/03/14

		battery AND electrolyte AND (glutaronitrile adiponitrile dinitrile) SAME propyl ADJ propionate					05:07 PM
L40	10	h01m$.cpc. AND battery AND electrolyte AND (glutaronitrile adiponitrile dinitrile) SAME propyl ADJ propionate SAME (amount ratio)	(US-PGPUB; USPAT)	OR	ON	ON	2023/03/14 05:07 PM
L41	547	h01m$.cpc. AND battery AND electrolyte AND (glutaronitrile adiponitrile dinitrile) SAME propyl ADJ propionate	(FIT (AU, AP, AT, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, OA, RU, SU, WO, MC, MD, MY, NL, NO, NZ, PH, PL, PT, RO, RS, SE, SG, SI, SK, TH, TN, TR, TW, UA, VN); FPRS; EPO; JPO; DERWENT)	OR	ON	ON	2023/03/14 05:07 PM
L42	95	h01m$.cpc. AND battery AND electrolyte AND (glutaronitrile adiponitrile dinitrile) SAME propyl ADJ propionate	(FPRS; EPO; JPO; DERWENT)	OR	ON	ON	2023/03/14 05:07 PM
L43	22	h01m$.cpc. AND battery AND electrolyte AND (glutaronitrile adiponitrile dinitrile) SAME propyl ADJ propionate SAME (amount ratio)	(FPRS; EPO; JPO; DERWENT)	OR	ON	ON	2023/03/14 05:07 PM
L44	52	battery AND electrolyte AND (glutaronitrile adiponitrile dinitrile) SAME propyl ADJ propionate SAME (amount ratio)	(FPRS; EPO; JPO; DERWENT)	OR	ON	ON	2023/03/14 05:07 PM
L45	33	h01m$.cpc. AND battery AND electrolyte AND (glutaronitrile adiponitrile dinitrile) AND trinitrile AND propyl ADJ propionate AND (amount ratio)	(US-PGPUB; USPAT)	OR	ON	ON	2023/03/14 05:08 PM
L46	6	("20100216035" | "20110229772" | "20130093392" | "20130230768" |	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2023/03/15 10:43 AM

		"20150236382" | "20160226103").pn. OR ("10424813").urpn. AND (PGPB | USPT | USOC).dbnm.					
L47	46	(Artificial Intelligence) More like doc: US-20180034105-A1 Text: (EP-3273520-A1 OR US-10424813-B2 OR EP-3273520-B1 OR JP-WO2016148128-A1 OR WO-2016148128-A1 OR JP-6627860-B2 OR CN-107408734-B OR CN-107408734-A OR JP-2012038716-A OR JP-2020102451-A OR JP-2006059797-A OR JP-5978796-B2 OR JP-6713452-B2 OR JP-2010198922-A OR JP-2014002976-A OR JP-4894157-B2 OR JP-5391938-B2 OR US-20200274199-A1 OR JP-2011054490-A OR JP-2002158035-A).did.	(US-PGPUB; USPAT; USOCR; FIT (AU, AP, AT, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, OA, RU, SU, WO, MC, MD, MY, NL, NO, NZ, PH, PL, PT, RO, RS, SE, SG, SI, SK, TH, TN, TR, TW, UA, VN); FPRS; EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2023/03/15 10:43 AM
L48	4	("20060035144" | "20140193707" | "20140295288" | "20150349381").pn. OR ("10886565").urpn. AND (PGPB | USPT | USOC).dbnm.	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2023/03/15 10:44 AM
L49	153	h01m$.cpc. AND battery AND electrolyte AND (glutaronitrile adiponitrile dinitrile) AND propyl ADJ propionate SAME (amount ratio)	(US-PGPUB; USPAT)	OR	ON	ON	2023/03/15 10:44 AM
L50	11	h01m$.cpc. AND battery AND electrolyte AND (glutaronitrile adiponitrile dinitrile) AND propyl ADJ propionate near2 (amount ratio)	(US-PGPUB; USPAT)	OR	ON	ON	2023/03/15 10:44 AM
L51	3	"20170324116"	(US-PGPUB; USPAT)	OR	ON	ON	2023/03/15 08:54 PM
L52	1	"106848381"	(DERWENT)	OR	ON	ON	2023/03/15 09:24 PM
L53	23	h01m$.cpc. AND	(US-PGPUB; USPAT;	OR	ON	ON	2023/03/18

		battery AND electrolyte SAME butanedinitrile	USOCR)				10:10 AM
L54	16	h01m$.cpc. AND battery AND electrolyte SAME butanedinitrile AND fec	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2023/03/18 10:15 AM
L55	0	h01m$.cpc. AND battery AND electrolyte SAME butanedinitrile AND cabonate SAME ester	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2023/04/13 12:17 PM
L57	25	h01m$.cpc. AND battery AND electrolyte SAME butanedinitrile AND carbonate	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2023/04/13 12:17 PM
L58	25	battery AND electrolyte SAME butanedinitrile AND carbonate	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2023/04/13 12:17 PM

PE2E SEARCH - Search History (Interference)

There are no Interference searches to show.

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APPLICATION NUMBER	FILING OR 371(C) DATE	FIRST NAMED APPLICANT	ATTY. DOCKET NO./TITLE
17/885,920	08/11/2022	Kefei WANG	14850089COB

CONFIRMATION NO. 7924

62008
MAIER & MAIER, PLLC
345 SOUTH PATRICK STREET
ALEXANDRIA, VA 22314

PUBLICATION NOTICE

OC000000137083216

Title:ELECTROLYTE AND ELECTROCHEMICAL DEVICE

Publication No.US-2022-0407109-A1
Publication Date:12/22/2022

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

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PATENT APPLICATION FEE DETERMINATION RECORD Substitute for Form PTO-875	Application or Docket Number 17/885,920

APPLICATION AS FILED - PART I

FOR	(Column 1) NUMBER FILED	(Column 2) NUMBER EXTRA	SMALL ENTITY RATE($)	SMALL ENTITY FEE($)	OR	OTHER THAN SMALL ENTITY RATE($)	OTHER THAN SMALL ENTITY FEE($)
BASIC FEE (37 CFR 1.16(a), (b), or (c))	N/A	N/A	N/A			N/A	320
SEARCH FEE (37 CFR 1.16(k), (i), or (m))	N/A	N/A	N/A			N/A	700
EXAMINATION FEE (37 CFR 1.16(o), (p), or (q))	N/A	N/A	N/A			N/A	800
TOTAL CLAIMS (37 CFR 1.16(i))	20 minus 20 =	*			OR	x 100 =	0.00
INDEPENDENT CLAIMS (37 CFR 1.16(h))	2 minus 3 =	*				x 480 =	0.00
APPLICATION SIZE FEE (37 CFR 1.16(s))	If the specification and drawings exceed 100 sheets of paper, the application size fee due is $310 ($155 for small entity) for each additional 50 sheets or fraction thereof. See 35 U.S.C. 41(a)(1)(G) and 37 CFR 1.16(s).						0.00
MULTIPLE DEPENDENT CLAIM PRESENT (37 CFR 1.16(j))							0.00
* If the difference in column 1 is less than zero, enter "0" in column 2.			TOTAL			TOTAL	1820

APPLICATION AS AMENDED - PART II

		(Column 1) CLAIMS REMAINING AFTER AMENDMENT		(Column 2) HIGHEST NUMBER PREVIOUSLY PAID FOR	(Column 3) PRESENT EXTRA	SMALL ENTITY RATE($)	SMALL ENTITY ADDITIONAL FEE($)	OR	OTHER THAN SMALL ENTITY RATE($)	OTHER THAN SMALL ENTITY ADDITIONAL FEE($)
AMENDMENT A	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	

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

* 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.

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APPLICATION NUMBER	FILING or 371(c) DATE	GRP ART UNIT	FIL FEE REC'D	ATTY.DOCKET.NO	TOT CLAIMS	IND CLAIMS
17/885,920	08/11/2022	1726	1820	14850089COB	20	2

CONFIRMATION NO. 7924

62008
MAIER & MAIER, PLLC
345 SOUTH PATRICK STREET
ALEXANDRIA, VA 22314

FILING RECEIPT

OC000000136046206

Date Mailed: 08/29/2022

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

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

Inventor(s)

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Assignment For Published Patent Application

NINGDE AMPEREX TECHNOLOGY LIMITED, Ningde City, CHINA

Power of Attorney: The patent practitioners associated with Customer Number 62008

Domestic Priority data as claimed by applicant

This application is a CON of 17/064,782 10/07/2020
which is a CON of 16/211,853 12/06/2018 PAT 10833363

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 201811108529.X 09/21/2018 Access Code Provided

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If Required, Foreign Filing License Granted: 08/24/2022

The country code and number of your priority application, to be used for filing abroad under the Paris Convention, is **US 17/885,920**

Projected Publication Date: 12/08/2022

Non-Publication Request: No

Early Publication Request: No

Title

ELECTROLYTE AND ELECTROCHEMICAL DEVICE

Preliminary Class

429

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

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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.

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Application number: 201811108529X

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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：201811108529.X

申　请　类　型：发明专利

发明 创造 名称：一种电解液及电化学装置

申　　请　　日：2018 年 09 月 21 日

申　　请　　人：宁德新能源科技有限公司

发明人或设计人：王可飞、曾巧、肖良针、吴飞

局长

申长雨

2018 年 09 月 29 日

权 利 要 求 书

1. 一种电解液，所述电解液包括二腈化合物、三腈化合物和丙酸丙酯，其中基于所述电解液总重量，所述二腈化合物的重量百分比是 X 和所述三腈化合物的重量百分比是 Y，X 和 Y 同时满足式(1)和式(2)所表示的条件：

   $2wt\% \leq (X+Y) \leq 11wt\%$ …(1)；和

   $0.1 \leq (X/Y) \leq 8$ …(2)。

2. 根据权利要求 1 所述的电解液，其中基于所述电解液总重量，所述三腈化合物的重量百分比是 Y 和所述丙酸丙酯的重量百分比是 Z，Y 和 Z 满足式(3)所表示的条件：

   $0.01 \leq (Y/Z) \leq 0.3$ …(3)。

3. 根据权利要求 1 所述的电解液，其中所述二腈化合物包括式[4]或[5]的化合物：

   $CN\text{-}R_1\text{-}CN$ [4]，

   $CN\text{-}R_2\text{-}(O\text{-}R_3)_n\text{-}O\text{-}R_4\text{-}CN$ [5]，

   或其组合，

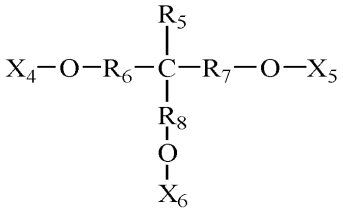
   其中，R_1、R_2、R_3 和 R_4 各自独立地为 1~5 个碳原子的亚烷基或 2~5 个碳原子的亚烯基，且 n 表示 0~5 的整数。

4. 根据权利要求 1 所述的电解液，其中所述二腈化合物选自由以下组成的群组中的一个：丁二腈、戊二腈、己二腈、1,5-二氰基戊烷、1,6-二氰基己烷、1,7-二氰基庚烷、1,8-二氰基辛烷、1,9-二氰基壬烷、1,10-二氰基癸烷、1,12-二氰基十二烷、四甲基丁二腈、2-甲基戊二腈、2,4-二甲基戊二腈、2,2,4,4-四甲基戊二腈、1,4-二氰基戊烷、1,4-二氰基戊烷、2,6-二氰基庚烷、2,7-二氰基辛烷、2,8-二氰基壬烷、1,6-二氰基癸烷、1,2-二氰基苯、1,3-二氰基苯、1,4-二氰基苯、3,5-二氧杂-庚二腈、1,4-二(氰基乙氧基)丁烷、乙二醇二(2-氰基乙基)醚、二乙二醇二(2-氰基乙基)醚、三乙二醇二(2-氰基乙基)醚、四乙二醇二(2-氰基乙基)醚、3,6,9,12,15,18-六氧杂二十烷酸二腈、1,3-二(2-氰基乙氧基)丙烷、1,4-二(2-氰基乙氧基)丁烷、1,5-二(2-氰基乙氧基)戊烷、乙二醇二(4-氰基丁基)醚、1,4-二氰基-2-丁烯、1,4-二氰基-2-甲基-2-丁烯、1,4-二氰基-2-乙基-2-丁烯、1,4-二氰基-2,3-二甲基-2-丁烯、1,4-二氰基-2,3-二乙基-2-丁烯、1,6-二氰基-3-己烯、1,6-二氰基-2-甲基-3-己烯、1,6-二氰基-2-甲基-5-甲基-3-己烯和其任意组合。

5. 根据权利要求 1 所述的电解液，其中所述三腈化合物包括式[6]或[7]的化合物：

   $CN\text{-}(CH_2)_x\text{-}CH\{(CH_2)_y\text{-}CN\}\text{-}(CH_2)_z\text{-}CN$ [6]，

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[7]，

或其组合，

其中在式[6]中，x、y、z 表示 0~5 的整数，且 x、y、z 不同时为 0；

在式[7]中，R_5 表示氢原子或 1~5 个碳原子的烷基，R_6、R_7 和 R_8 各自独立地为 1~5 个碳原子的亚烷基，X_4、X_5 和 X_6 各自独立地为-R_9-CN，且 R_9 表示 1~5 个碳原子的亚烷基。

6. 根据权利要求 1 所述的电解液，其中所述三腈化合物选自由以下组成的群组中的一个：1,3,5-戊三甲腈、1,2,3-丙三甲腈、1,3,6-己烷三腈、1,2,6-己烷三腈、1,2,3-三(2-氰基乙氧基)丙烷、1,2,4-三(2-氰基乙氧基)丁烷、1,1,1-三(氰基乙氧基亚甲基)乙烷、1,1,1-三(氰基乙氧基亚甲基)丙烷、3-甲基-1,3,5-三(氰基乙氧基)戊烷、1,2,7-三(氰基乙氧基)庚烷、 1,2,6-三(氰基乙氧基)已烷、1,2,5-三(氰基乙氧基)戊烷和其任意组合。

7. 根据权利要求 1 所述的电解液，其中 X 为 0.01~10wt%， Y 为 0.01~10wt%，且所述丙酸丙酯的重量百分比 Z 为 5~50wt%。

8. 根据权利要求 1 所述的电解液，其中所述电解液进一步包括氟代醚，所述氟代醚包括式[8]、式[9]、式[10]或式[11]的化合物中的至少一种：

Rf1–O – Rf2 [8]，

Rf1–O – R [9],

Rf1–O –(R' –O)$_n$– Rf2 [10]，

Rf1–O –(R' –O)$_n$– R [11]，

其中在式[8]、[9]、[10]、[11]中，Rf1 和 Rf2 各自独立地为至少一个氢原子被氟基取代的直链或支链的 C_1 至 C_{12} 氟代烷基，R 为直链或支链的 C_1 至 C_{12} 烷基，R'为直链或支链的 C_1 至 C_5 亚烷基，并且 n 为 1 至 5 的整数。

9. 根据权利要求 8 所述的电解液，其中 Rf1 或 Rf2 各自独立地为选自由 HCF_2-、 CF_3-、HCF_2CF_2-、CH_3CF_2-、CF_3CH_2-、CF_3CF_2-、$(CF_3)_2CH$-、$HCF_2CF_2CH_2$-、$CF_3CH_2CH_2$-、$HCF_2CF_2CF_2CH_2$- 、 $HCF_2CF_2CF_2CF_2CH_2$- 、 $CF_3CF_2CH_2$- 、 $CF_3CFHCF_2CH_2$- 、$HCF_2CF(CF_3)CH_2$-和 $CF_3CF_2CH_2CH_2$-组成的组中的氟代烷基。

10. 根据权利要求 8 所述的电解液，其中所述氟代醚选自由以下组成的群组中的一个：

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$HCF_2CF_2CH_2OCF_2CF_2H$、$(CF_3)_2CFCF(CF_2CF_3)(OCH_3)$、$CF_3CHFCF_2CH(CH_3)OCF_2CHFCF_3$、$HCF_2CF_2CH_2OCF_2CF_2CF_2CF_2H$、$HCF_2CF_2OCH_2CF_3$、$HCF_2CF_2OCH_2CH_2OCF_2CF_2H$、$HCF_2CF_2OCH_2CH_2CH_2OCF_2CF_2H$、$HCF_2CF_2CH_2OCF_2CF_2CF_2H$、$HCF_2CF_2OCH_2CH_2OCF_2CF_2CF_2H$、$HCF_2CF_2OCH_2CH_2CH_2OCF_2CF_2CF_2H$、$CH_3OCH_2CH_2OCH_2CH_2F$、$CH_3OCH_2CH_2OCH_2CF_3$、$CH_3OCH_2CH(CH_3)OCH_2CH_2F$、$CH_3OCH_2CH(CH_3)OCH_2CF_3$、$FCH_2CH_2OCH_2CH_2OCH_2CH_2F$、$FCH_2CH_2OCH_2CH(CH_3)OCH_2CH_2F$、$CF_3CH_2O(CH_2CH_2O)_2CH_2CF_3$、$CF_3CH_2OCH_2CH(CH_3)OCH_2CF_3$和其任意组合。

11. 根据权利要求 1 所述的电解液，其中所述电解液进一步包括环状磷酸酐，基于所述电解液总重量，所述环状磷酸酐含量为 0.01~10wt%。

12. 根据权利要求 1 所述的电解液，其中所述电解液进一步包括选自由以下组成的群组中的一个：具有碳-碳双键的环状碳酸酯、氟代链状碳酸酯、氟代环状碳酸酯、含硫氧双键化合物和其任意组合。

13. 根据权利要求 1 所述的电解液，其中所述电解液进一步包括环状羧酸酯，所述环状羧酸酯包括 γ-丁内酯或 γ-戊内酯或其组合。

14. 一种电化学装置，其中所述电化学装置包括极片和如权利要求 1-13 中任一项所述的电解液。

15. 根据权利要求 14 所述的电化学装置，其中所述极片包括集流体和位于所述集流体上的涂层，所述涂层包括单面涂层、双面涂层或其组合；
所述单面涂层是在所述集流体的一个表面涂布浆料形成的涂层，所述双面涂层是在所述集流体相对两个表面涂布浆料形成的涂层；
其中包括所述单面涂层的极片具有极片压实密度 D1，包括所述双面涂层的极片具有极片压实密度 D2，且 D1 和 D2 满足关系式：$0.8 \leq D1/D2 \leq 1.2$。

16. 根据权利要求 15 所述的电化学装置，其中所述极片包括正极极片和负极极片；其中当所述极片为正极极片时，$3.5g/cm^3 \leq D2 \leq 4.3g/cm^3$；或当所述极片为负极极片时，$1.2g/cm^3 \leq D2 \leq 1.8g/cm^3$。

17. 一种电子装置，所述电子装置包括根据权利要求 14-16 中任一项所述的电化学装置。

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说　　明　　书

一种电解液及电化学装置

技术领域

本申请涉及储能技术领域，尤其涉及一种电解液和包含该电解液的电化学装置。

背景技术

随着电子设备、电动汽车的急速发展，对电化学装置的高容量化的要求变高，为了提高电化学装置的容量密度，开发高电压电化学装置是有效方法之一。

目前，工作电压在 4.4V 以上的电化学装置已成为众多科研单位和企业研究的热点。然而在高电压下，正极材料的氧化活性升高、稳定性下降，导致电解液容易在正极表面分解或引起电池材料的劣化，造成电池容量降低。为了解决上述问题，确有必要提供一种改进的电化学装置。

发明内容

本申请实施例提供一种电解液和包括该电解液的电化学装置，所述电解液包括二腈化合物、三腈化合物和丙酸丙酯。二腈化合物能在电化学装置的正极上形成保护膜，从而抑制电化学装置中的溶剂的分解。但在高电位的正极表面，该保护膜自身也分解，因此无法使抑制溶剂分解的效果持续。而本申请发明人意外地发现，通过将二腈化合物、三腈化合物和丙酸丙酯混合使用时，能够在高电位的正极表面形成不易受到分解的牢固的保护膜。本申请实施例的电解液能够有效抑制电化学装置的直流内阻增加。

在一个实施例中，本申请提供了一种电解液，所述电解液包括二腈化合物、三腈化合物和丙酸丙酯，其中基于所述电解液总重量，所述二腈化合物的重量百分比是 X 和所述三腈化合物的重量百分比是 Y，X 和 Y 同时满足式(1)和式(2)所表示的条件：

约 2wt%≤(X+Y)≤约 11wt% …　(1)；和

约 0.1≤(X/Y)≤约 8　(2)。

根据本申请的实施例，基于所述电解液总重量，所述三腈化合物的重量百分比是 Y 和所述丙酸丙酯的重量百分比是 Z，Y 和 Z 满足式(3)所表示的条件：

约 0.01≤(Y/Z)≤约 0.3　(3)。

根据本申请的实施例，　所述二腈化合物的重量百分比是 X，X 为约 0.01~10wt%，所述三

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腈化合物的重量百分比是 Y，Y 为约 0.01~10wt%，且所述丙酸丙酯的重量百分比是 Z，Z 为约 5~50wt%。本申请的实施例的电解液可有效抑制电化学装置的直流内阻增加，从而获得更好的效果。

根据本申请的实施例，所述电解液进一步包括氟代醚，基于所述电解液总重量，所述氟代醚含量为约 0.01~10wt%。氟代醚能够与三腈化合物形成更良好的保护膜，从而改善电化学装置的直流内阻和存储性能。

根据本申请的实施例，所述电解液进一步包括环状磷酸酐，基于所述电解液总重量，所述环状磷酸酐含量为约 0.01~10wt%。加入环状磷酸酐，可以进一步抑制循环过程中直流内阻的增加。

根据本申请的实施例，所述电解液进一步包括选自由以下组成的群组中的一个：具有碳-碳双键的环状碳酸酯、氟代链状碳酸酯、氟代环状碳酸酯、含硫氧双键的化合物和其任意组合。这些化合物能够和二腈化合物、三腈化合物和丙酸丙酯在电极界面形成不易分解的牢固的保护膜，从而进一步抑制电化学装置副反应，降低电化学装置存储中的电压降，提高电化学装置长期存储性能及可靠性。

在另一个实施例中，本申请提供了一种电化学装置以及使用所述电化学装置的电子装置，所述电化学装置包括极片和电解液，所述电解液为如上所述的任意电解液。

根据本申请的实施例，所述极片包括集流体和位于集流体上的涂层，所述涂层包括单面涂层、双面涂层或其组合；所述单面涂层是在集流体的一个表面涂布浆料形成的涂层，所述双面涂层是在集流体相对两个表面涂布浆料形成的涂层；其中包括所述单面涂层的极片具有极片压实密度 D1，包括所述双面涂层的极片具有极片压实密度 D2，且 D1 和 D2 满足下述关系式：约 0.8≤D1/D2≤约 1.2。

根据本申请的实施例，所述极片包括正极极片和负极极片。在一些实施例中，当所述极片为正极极片时，约 3.5g/cm^3≤D2≤约 4.3g/cm^3。在另一些实施例中，当所述极片为负极极片时：约 1.2g/cm^3≤D2≤1.8g/cm^3。

根据本申请实施例的电化学装置，当该电化学装置的电解液包括二腈化合物、三腈化合物和丙酸丙酯，且极片的压实密度满足上述关系式时，可使极片获得良好的导电性能，正负极活性物质得到更好的发挥，而且对控制电化学装置膨胀方面有着重要作用。因此，根据本申请实施例的电化学装置可获得高容量密度，并具有优异的循环性能和存储性能。

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在另一个实施例中，本申请提供了一种电子装置，所述电子装置包括如上所述的电化学装置。

本申请实施例的额外层面及优点将部分地在后续说明中描述、显示、或是经由本申请实施例的实施而阐释。

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 1a 示出了本申请实施例 S1-1 和 S1-2 与对比例 D1-1 的新鲜电池在不同充电状态下（10%SOC、20%SOC、70%SOC）的直流内阻。

图 1b 示出了本申请实施例 S1-1 和 S1-2 与对比例 D1-1 的电池在 200 次充放电后在不同充电状态下（10%SOC、20%SOC、70%SOC）的直流内阻。

图 1c 示出了本申请实施例 S1-1 和 S1-2 与对比例 D1-1 的电池在 400 次充放电后在不同充电状态下（10%SOC、20%SOC、70%SOC）的直流内阻。

图 2 示出本申请具有单面涂层的极片 A 的结构示意图。

图 3 示出本申请具有双面涂层的极片 B 的结构示意图。

图 4 示出本申请同时具有单面涂层和双面涂层的极片 C 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示在下文中。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。除非另外明确指明，本文使用的下述术语具有下文指出的含义。

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、

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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。

如本文所用，“烃基”涵盖烷基、烯基、炔基。例如，烃基预期是具有 1 至 20 个碳原子的直链烃结构。“烃基”还预期是具有 3 至 20 个碳原子的支链或环状烃结构。当指定具有具体碳数的烃基时，预期涵盖具有该碳数的所有几何异构体。本文中烃基还可以为 1~15 个碳原子的烃基、1~10 个碳原子的烃基、1~5 个碳原子的烃基、5~20 个碳原子的烃基、5~15 个碳原子的烃基或 5~10 个碳原子的烃基。另外，烃基可以是任选地被取代的。例如，烃基可被包括氟、氯、溴和碘在内的卤素、烷基、芳基或杂芳基取代。

如本文所用，“烷基”预期是具有 1 至 20 个碳原子的直链饱和烃结构。“烷基”还预期是具有 3 至 20 个碳原子的支链或环状烃结构。例如，烷基可为 1~20 个碳原子的烷基、1~10 个碳原子的烷基、1~5 个碳原子的烷基、5~20 个碳原子的烷基、5~15 个碳原子的烷基或 5~10 个碳原子的烷基。当指定具有具体碳数的烷基时，预期涵盖具有该碳数的所有几何异构体；因此，例如，“丁基”意思是包括正丁基、仲丁基、异丁基、叔丁基和环丁基；“丙基”包括正丙基、异丙基和环丙基。烷基实例包括，但不限于甲基、乙基、正丙基、异丙基、环丙基、正丁基、异丁基、仲丁基、叔丁基、环丁基、正戊基、异戊基、新戊基、环戊基、甲基环戊基、乙基环戊基、正己基、异己基、环己基、正庚基、辛基、环丙基、环丁基、降冰片基等。另外，烷基可以是任选地被取代的。

如本文所用，术语“亚烷基”意指直链或具支链的二价饱和烃基。例如，亚烷基可为 1~20 个碳原子的亚烷基、1~15 个碳原子的亚烷基、1~10 个碳原子的亚烷基、1~5 个碳原子的亚烷基、5~20 个碳原子的亚烷基、5~15 个碳原子的亚烷基或 5~10 个碳原子的亚烷基。代表性亚烷基包括（例如）亚甲基、乙烷-1,2-二基（“亚乙基”）、丙烷-1,2-二基、丙烷-1,3-二基、丁烷-1,4-二基、戊烷-1,5-二基等等。另外，亚烷基可以是任选地被取代的。

如本文所用，术语“亚烯基”涵盖直链和支链亚烯基。当指定具有具体碳数的亚烯基时，预期涵盖具有该碳数的所有几何异构体。例如，亚烯基可为 2~20 个碳原子的亚烯基、2~15 个碳原子的亚烯基、2~10 个碳原子的亚烯基、2~5 个碳原子的亚烯基，5~20 个碳原子的亚烯基、5~15 个碳原子的亚烯基、或 5~10 个碳原子的亚烯基。代表性亚烷基包括（例如）亚乙烯基、亚丙烯基、亚丁烯基等。另外，亚烯基可以是任选地被取代的。

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如本文所用，术语“芳基”涵盖单环系统和多环系统。多环可以具有其中两个碳为两个邻接环(所述环是“稠合的”)共用的两个或更多个环，其中所述环中的至少一者是芳香族的，例如其它环可以是环烷基、环烯基、芳基、杂环和/或杂芳基。例如，芳基可为 C_6~C_{50} 芳基、C_6~C_{40} 芳基、C_6~C_{30} 芳基、C_6~C_{20} 芳基或 C_6~C_{10} 芳基。代表性芳基包括（例如）苯基、甲基苯基、丙基苯基、异丙基苯基、苯甲基和萘-1-基、萘-2-基等等。另外，芳基可以是任选地被取代的。

如本文所用，术语“杂芳基”涵盖可以包括一到三个杂原子的单环杂芳香族基团，例如吡咯、呋喃、噻吩、咪唑、噁唑、噻唑、三唑、吡唑、吡啶、吡嗪和嘧啶等。术语杂芳基还包括具有其中两个原子为两个邻接环(所述环是“稠合的”)共用的两个或更多个环的多环杂芳香族系统，其中所述环中的至少一者是杂芳基，其它环可以是环烷基、环烯基、芳基、杂环和/或杂芳基。杂芳基中的杂原子例如可以为 O、S、N、Se 等。例如杂芳基可为 C_6~C_{50} 杂芳基、C_6~C_{40} 杂芳基、C_6~C_{30} 杂芳基、C_6~C_{20} 杂芳基或 C_6~C_{10} 杂芳基。另外，芳基可以是任选地被取代的。

当上述取代基经取代时，取代基可选自由以下组成的群组：卤素、烷基、环烷基、烯基、芳基和杂芳基。

如本文中所使用，各组分的含量均为基于电解液的总重量得到的。

一、电解液

本申请实施例提供了一种电解液，其包括电解质和溶解该电解质的溶剂。本申请的电解液的一个主要特征在于其包括二腈化合物、三腈化合物和丙酸丙酯，其中基于所述电解液总重量，二腈化合物的重量百分比是 X 和三腈化合物的重量百分比是 Y，X 和 Y 同时满足式(1)和式(2)所表示的条件：

约 2wt%≤(X+Y)≤约 11wt% …(1)；和

约 0.1≤(X/Y)≤约 8 …(2)。

在一些实施例中，X 和 Y 同时满足约 2wt%≤(X+Y)≤约 8wt%，且约 0.1≤(X/Y)≤约 6。在一些实施例中，X 和 Y 同时满足约 3wt%≤(X+Y)≤6wt%，且约 0.2≤(X/Y)≤约 5。在一些实施例中，X 和 Y 同时满足约 4wt%≤(X+Y)≤约 5wt%，且约 0.3≤(X/Y)≤约 4。在一些实施例中，X 和 Y 同时满足约 2wt%≤(X+Y)≤约 5wt%，且约 0.1≤(X/Y)≤约 1。

在一些实施例中，三腈化合物的重量百分比是 Y 和丙酸丙酯的重量百分比是 Z，Y 和 Z 满足式(3)所表示的条件：

约 0.01≤(Y/Z)≤约 0.3 …(3)。

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在一些实施例中，Y 和 Z 同时满足约 0.01≤(Y/Z)≤约 0.2。在一些实施例中，Y 和 Z 同时满足约 0.02≤(Y/Z)≤约 0.1。

在一些实施例中，二腈化合物的重量百分比为约 0.01~10wt%。在一些实施例中，二腈化合物的重量百分比为不小于约 0.01wt%、不小于约 0.1wt%、不小于约 0.3wt%或不小于约 0.5wt%。在一些实施例中，二腈化合物的重量百分比为不大于约 10wt%、不大于约 8wt%、或不大于约 6 wt%。

在一些实施例中，三腈化合物的重量百分比为约 0.01~10 wt%。在一些实施例中，三腈化合物的重量百分比为不小于 0.01 约 wt%、不小于约 0.1 wt%不小于约 0.3 wt%或不小于约 0.5 wt%。在一些实施例中，三腈化合物的重量百分比为不大于约 10 wt%、不大于约 8wt%、不大于约 5 wt%、不大于约 4 wt%、或不大于约 3 wt%。

在一些实施例中，丙酸丙酯的重量百分比为约 5~50wt%。在一些实施例中，丙酸丙酯的重量百分比 Z 为约 5~40 wt%、约 10~40 wt%、约 10~30 wt%、约 20~50wt%、约 20~40wt%、约 20~30 wt%或约 25~30 wt%。

二腈化合物

在一些实施例中，本申请的二腈化合物包括式[4]或[5]化合物：

$CN\text{-}R_1\text{-}CN$ [4]，

$CN\text{-}R_2\text{-}(O\text{-}R_3)_n\text{-}O\text{-}R_4\text{-}CN$ [5]，

或其组合，

其中在式[4]或[5]中，R_1、R_2、R_3 和 R_4 各自独立地可为 1~20 个碳原子的亚烷基，例如为 1~15 个碳原子的亚烷基、1~10 个碳原子的亚烷基、1~5 个碳原子的亚烷基、5~10 个碳原子的亚烷基、5~20 个碳原子的亚烷基、5~15 个碳原子的亚烷基、2~20 个碳原子的亚烯基、2~15 个碳原子的亚烯基、2~10 个碳原子的亚烯基、2~5 个碳原子的亚烯基，5~20 个碳原子的亚烯基、5~15 个碳原子的亚烯基或 5~10 个碳原子的亚烯基，且 n 表示 0~5 的整数。

在一些实施例中，本申请的二腈化合物是上述式[4]或[5]化合物。

在一些实施例中，本申请中的二腈化合物包括、但不限于：丁二腈、戊二腈、己二腈、1,5-二氰基戊烷、1,6-二氰基己烷、1,7-二氰基庚烷、1,8-二氰基辛烷、1,9-二氰基壬烷、1,10-二氰基癸烷、1,12-二氰基十二烷、四甲基丁二腈、2-甲基戊二腈、2,4-二甲基戊二腈、2,2,4,4-四甲基戊二腈、1,4-二氰基戊烷、1,4-二氰基戊烷、2,6-二氰基庚烷、2,7-二氰基辛烷、2,8-二氰基壬烷、1,6-二氰基癸烷、1,2-二氰基苯、1,3-二氰基苯、1,4-二氰基苯、3,5-二氧杂-庚二腈、1,4-

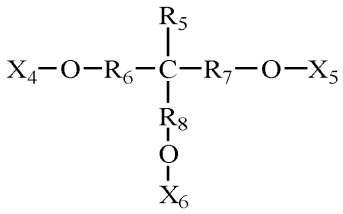
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二(氰基乙氧基)丁烷、乙二醇二(2-氰基乙基)醚、二乙二醇二(2-氰基乙基)醚、三乙二醇二(2-氰基乙基)醚、四乙二醇二(2-氰基乙基)醚、3,6,9,12,15,18-六氧杂二十烷酸二腈、1,3-二(2-氰基乙氧基)丙烷、1,4-二(2-氰基乙氧基)丁烷、1,5-二(2-氰基乙氧基)戊烷、乙二醇二(4-氰基丁基)醚、1,4-二氰基-2-丁烯、1,4-二氰基-2-甲基-2-丁烯、1,4-二氰基-2-乙基-2-丁烯、1,4-二氰基-2,3-二甲基-2-丁烯、1,4-二氰基-2,3-二乙基-2-丁烯、1,6-二氰基-3-已烯、1,6-二氰基-2-甲基-3-已烯或 1,6-二氰基-2-甲基-5-甲基-3-已烯。上述二腈化合物可以单独使用，也可以两种或两种以上同时使用。

三腈化合物

在一些实施例中，本申请的三腈化合物包括式[6]或[7]化合物：

$CN-(CH_2)_x-CH\{(CH_2)_y-CN\}-(CH_2)_z-CN$ [6]，



[7]，

或其组合，

其中在式[6]中，x，y，z 表示 0~5 的整数，且 x，y，z 不同时为 0；

在式[7]中，R_5 可为氢原子或可为 1~20 个碳原子的烷基，例如为 1~10 个碳原子的烷基、1~5 个碳原子的烷基、5~20 个碳原子的烷基、5~15 个碳原子的烷基或 5~10 个碳原子的烷基；R_6、R_7 和 R_8 各自独立地可为 1~20 个碳原子的亚烷基，例如为 1~15 个碳原子的亚烷基、1~10 个碳原子的亚烷基、1~5 个碳原子的亚烷基、5~20 个碳原子的亚烷基、5~15 个碳原子的亚烷基或 5~10 个碳原子的亚烷基，X_4、X_5 和 X_6 各自独立地为-R_9-CN，R_9 可为 1~20 个碳原子的亚烷基，例如为 1~15 个碳原子的亚烷基、1~10 个碳原子的亚烷基、1~5 个碳原子的亚烷基、5~20 个碳原子的亚烷基、5~15 个碳原子的亚烷基或 5~10 个碳原子的亚烷基。

在一些实施例中，本申请的三腈化合物是上述式[6]或[7]化合物。

在一些实施例中，本申请的三腈化合物包括、但不限于：1,3,5-戊三甲腈、1,2,3-丙三甲腈、1,3,6-已烷三腈、1,2,6-已烷三腈、1,2,3-三(2-氰基乙氧基)丙烷、1,2,4-三(2-氰基乙氧基)丁烷、1,1,1-三(氰基乙氧基亚甲基)乙烷、1,1,1-三(氰基乙氧基亚甲基)丙烷、3-甲基-1,3,5-三(氰基乙氧基)戊烷、1,2,7-三(氰基乙氧基)庚烷、1,2,6-三(氰基乙氧基)已烷或 1,2,5-三(氰基乙氧基)戊烷。

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上述三腈化合物可以单独使用，也可以两种或两种以上同时。

氟代醚化合物

在一些实施例中，本申请的氟代醚化合物包括式[8]、式[9]、式[10]或式[11]化合物中的至少一种：

Rf1–O – Rf2 [8]，

Rf1–O – R [9]，

Rf1–O –(R' –O)$_n$– Rf2 [10]，

Rf1–O –(R' –O)$_n$– R [11]，

其中在式[8]、[9]、[10]、[11]中，Rf1 和 Rf2 各自独立地为至少一个氢原子被氟基取代的直链或支链的 C_1 至 C_{12} 氟代烷基，R 为直链或支链的 C_1 至 C_{12} 烷基，R'为直链或支链的 C_1 至 C_5 亚烷基，并且 n 为 1 至 5 的整数。

在一些实施例中，本申请的氟代醚化合物是上述式[8]、式[9]、式[10]或式[11]的化合物。

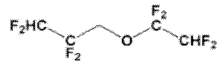
在一些实施例中，其中 Rf1 或 Rf2 各自独立地为选自由 HCF_2-、CF_3-、HCF_2CF_2-、CH_3CF_2-、CF_3CH_2- 、 CF_3CF_2- 、 $(CF_3)_2CH$- 、 $HCF_2CF_2CH_2$- 、 $CF_3CH_2CH_2$- 、 $HCF_2CF_2CF_2CH_2$- 、$HCF_2CF_2CF_2CF_2CH_2$-、$CF_3CF_2CH_2$-、$CF_3CFHCF_2CH_2$-、 $HCF_2CF(CF_3)CH_2$-和 $CF_3CF_2CH_2CH_2$-组成的组中的氟代烷基。

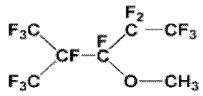
氟代醚与三腈化合物能够形成更好的保护膜，进一步改善电池直流内阻和存储性能。

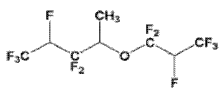
在一些实施例中，本申请的氟代醚包括、但不限于：

$HCF_2CF_2CH_2OCF_2CF_2H$（FEPE）、$(CF_3)_2CFCF(CF_2CF_3)(OCH_3)$ （TMMP）、$CF_3CHFCF_2CH(CH_3)OCF_2CHFCF_3$（TPTP）、$HCF_2CF_2CH_2OCF_2CF_2CF_2CF_2H$、$HCF_2CF_2OCH_2CF_3$、$HCF_2CF_2OCH_2CH_2OCF_2CF_2H$、$HCF_2CF_2OCH_2CH_2CH_2OCF_2CF_2H$、$HCF_2CF_2CH_2OCF_2CF_2CF_2H$、$HCF_2CF_2OCH_2CH_2OCF_2CF_2CF_2H$、$HCF_2CF_2OCH_2CH_2CH_2OCF_2CF_2CF_2H$、$CH_3OCH_2CH_2OCH_2CH_2F$、$CH_3OCH_2CH_2OCH_2CF_3$、$CH_3OCH_2CH(CH_3)OCH_2CH_2F$、$CH_3OCH_2CH(CH_3)OCH_2CF_3$、$FCH_2CH_2OCH_2CH_2OCH_2CH_2F$、$FCH_2CH_2OCH_2CH(CH_3)OCH_2CH_2F$、$CF_3CH_2O(CH_2CH_2O)_2CH_2CF_3$ 或 $CF_3CH_2OCH_2CH(CH_3)OCH_2CF_3$。上述氟代醚可以单独使用，也可以两种或两种以上同时使用。

FEPE 、TMMP 、TPTP 结构式如下：







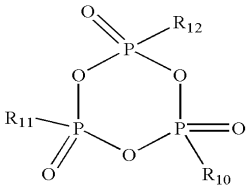
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1,1-二氟-2,2-二氟乙基-2',2'-二氟-3',3'-二氟丙基醚（FEPE）	2-三氟甲基-3-甲氧基全氟戊烷（TMMP）	2-(三氟-2-氟-3-二氟丙氧基)-3-二氟-4-氟-5-三氟戊烷（TPTP）

在一些实施例中，基于所述电解液的总重量，氟代醚的含量为不小于约 0.01wt%、不小于约 0.1wt%或不小于约 0.5wt%。在一些实施例中，氟代醚的含量为不大于约 5wt%、不大于约 4wt%、不大于约 3wt%或不大于约 2%。

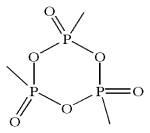
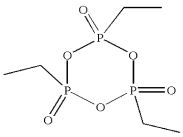
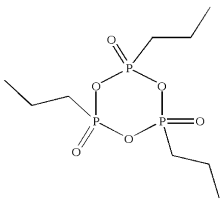
环状磷酸酐化合物

在一些实施例中，本申请的环状磷酸酐包括式[12]化合物中的一种或多种：

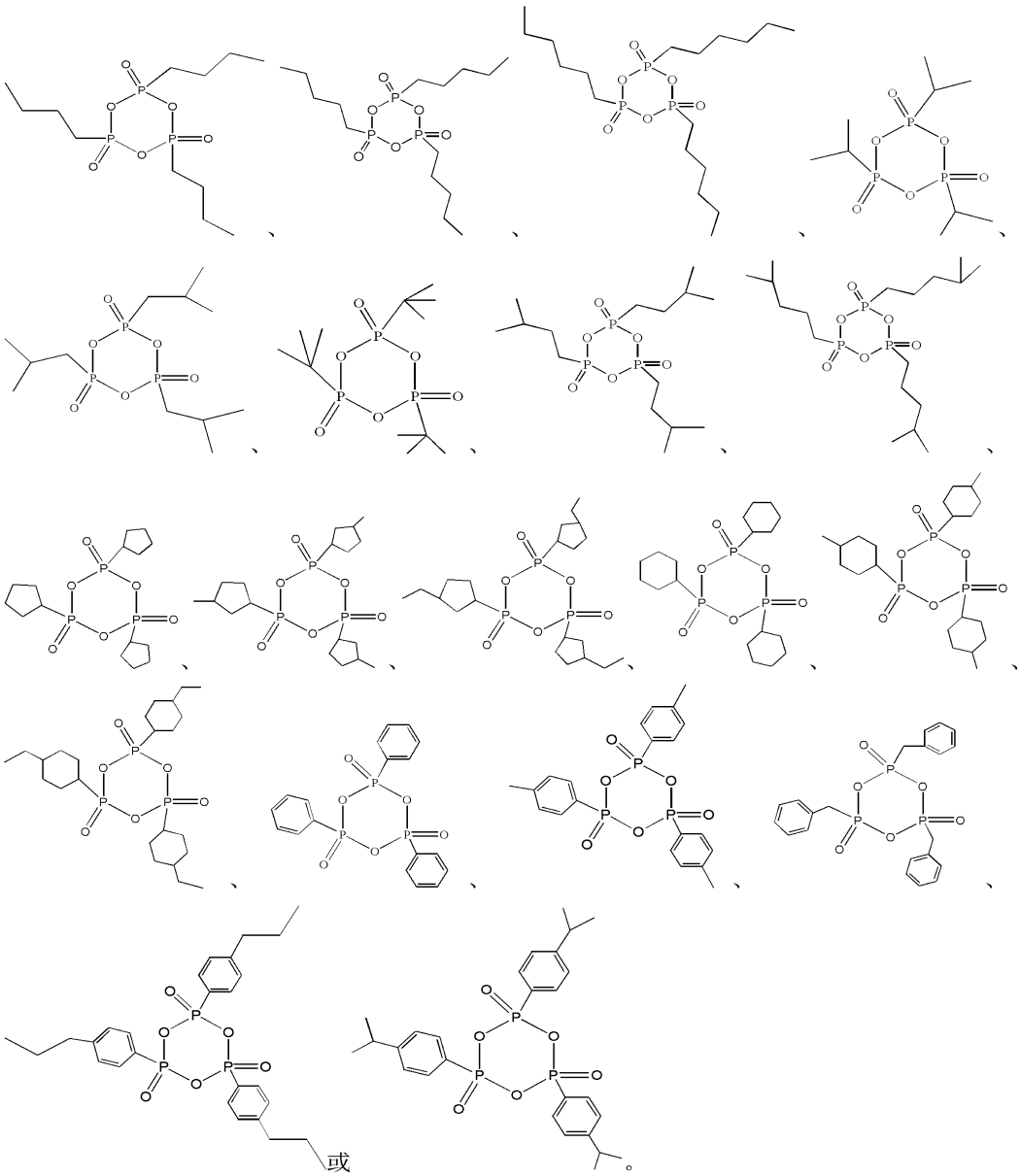

[12]，

其中在式[12]中，R_{10}、R_{11}、R_{12} 各自独立地可为氢原子；各自独立地可为碳原子数为 1~20 的烷基，例如为碳原子数为 1~15 的烷基、碳原子数为 1~10 的烷基、碳原子数为 1~5 的烷基、碳原子数为 5~20 的烷基、碳原子数为 5~15 的烷基、碳原子数为 5~10 的烷基；各自独立地可为碳原子数为 6~50 的芳基，例如为碳原子数为 6~30 的芳基、碳原子数为 6~26 的芳基、碳原子数为 6~20 的芳基、碳原子数为 10~50 的芳基、碳原子数为 10~30 的芳基、碳原子数为 10~26 的芳基或碳原子数为 10~20 的芳基，其中 R_{10}、R_{11}、R_{12} 可以互不相同，也可以彼此相同，又或者是其中任意两者相同。

在一些实施例中，本申请的环状磷酸酐类化合物包括、但不限于如下式所示化合物，它们可以单独使用，也可以两种或两种以上同时使用：


（TM3P）、 
（TE3P）、 
（T3P）、

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或。

在一些实施例中，基于所述电解液的总重量，环状磷酸酐的含量为不小于 0.01 约%或不小于 0.1 约%。在一些实施例中，环状磷酸酐的含量为不小于约 0.3%或不小于约 0.5%。在一

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些实施例中，环状磷酸酐的含量为不大于约 4%或不大于约 3%。

其它添加剂

本申请的电解液还可以进一步包括选自由以下组成的群组中的一种或多种：具有碳-碳双键的环状碳酸酯、氟代链状碳酸酯、氟代环状碳酸酯或含硫氧双键化合物。

在一些实施例中，本申请中的具有碳-碳双键的环状碳酸酯包括、但不限于：碳酸亚乙烯酯、碳酸甲基亚乙烯酯、碳酸乙基亚乙烯酯、碳酸 1,2-二甲基亚乙烯酯、碳酸 1,2-二乙基亚乙烯酯、碳酸氟亚乙烯酯、碳酸三氟甲基亚乙烯酯；碳酸乙烯基亚乙酯、碳酸 1-甲基-2-乙烯基亚乙酯、碳酸 1-乙基-2-乙烯基亚乙酯、碳酸 1-正丙基-2-乙烯基亚乙酯、碳酸 1-甲基-2-乙烯基亚乙酯、碳酸 1,1-二乙烯基亚乙酯、碳酸 1,2-二乙烯基亚乙酯；碳酸 1,1-二甲基-2-亚甲基亚乙酯、碳酸 1,1-二乙基-2-亚甲基亚乙酯。上述具有碳-碳双键的环状碳酸酯可以单独使用，也可以两种或两种以上同时使用。

在一些实施例中，基于所述电解液的总重量，具有碳-碳双键的环状碳酸酯的含量为不小于约 0.01%、不小于约 0.1%或不小于约 0.3%。在一些实施例中，具有碳-碳双键的环状碳酸酯的含量为不小于约 0.5%。在一些实施例中，具有碳-碳双键的环状碳酸酯的含量为不大于约 5%、不大于约 3%或不大于约 1%。

在一些实施例中，本申请的氟代链状碳酸酯包括、但不限于：碳酸氟甲基甲酯、碳酸二氟甲基甲酯、碳酸三氟甲基甲酯、碳酸三氟乙基甲基酯或碳酸双(三氟乙基)酯。上述氟代链状碳酸酯可以单独使用，也可以两种或两种以上同时使用。

在一些实施例中，基于所述电解液的总重量、氟代链状碳酸酯的含量为不小于约 0.01%或不小于约 0.1%。在一些实施例中，氟代链状碳酸酯的含量为不小于约 0.3%。在一些实施例中，氟代链状碳酸酯的含量为不小于约 0.5%。在另一些实施例中，氟代链状碳酸酯的含量为不大于约 3%或不大于约 5%。在另一些实施例中，氟代链状碳酸酯的含量为不大于约 1%。在一些实施例中，本申请的氟代环状碳酸酯包括、但不限于：氟代碳酸亚乙酯、4,4-二氟碳酸亚乙酯、4,5-二氟碳酸亚乙酯、4-氟-4-甲基碳酸亚乙酯、4,5-二氟-4-甲基碳酸亚乙酯、4-氟-5-甲基碳酸亚乙酯、4,4-二氟-5-甲基碳酸亚乙酯、4-(氟甲基)-碳酸亚乙酯、4-(二氟甲基)-碳酸亚乙酯、4-(三氟甲基)-碳酸亚乙酯、4-(氟甲基)-4-氟碳酸亚乙酯、4-(氟甲基)-5-氟碳酸亚乙酯、4-氟-4,5-二甲基碳酸亚乙酯、4,5-二氟-4,5-二甲基碳酸亚乙酯、4,4-二氟-5,5-二甲基碳酸亚乙酯。上述氟代环状碳酸酯可以单独使用，也可以两种或两种以上同时使用。

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在一些实施例中，基于所述电解液总重量，氟代环状碳酸酯的含量为不小于约 0.1wt%。在一些实施例中，氟代环状碳酸酯的含量为不小于约 0.5 wt%。在一些实施例中，氟代环状碳酸酯的含量为不小于约 2 wt%。在一些实施例中，氟代环状碳酸酯的含量为不小于约 4 wt%。在一些实施例中，氟代环状碳酸酯的含量为不大于约 15wt%。在一些实施例中，氟代环状碳酸酯的含量为不大于约 10wt%。在一些实施例中，氟代环状碳酸酯的含量为不大于约 8wt%。

在一些实施例中，本申请的含硫氧双键的化合物包括、但不限于：环状硫酸酯、链状硫酸酯、链状磺酸酯、环状磺酸酯、链状亚硫酸酯、环状亚硫酸酯、链状砜、环状砜等。上述含硫氧双键的化合物可以单独使用，也可以两种或两种以上同时使用。

在一些实施例中，基于电解液的总重量，含硫氧双键的化合物的含量为不小于约 0.01wt%。在一些实施例中，含硫氧双键的化合物的含量为不小于约 0.1wt%。在一些实施例中，含硫氧双键的化合物的含量为不小于约 0.3wt%。在一些实施例中，含硫氧双键的化合物的含量为不小于约 0.5 wt%。在另一些实施例中，含硫氧双键的化合物的含量为不大于约 5wt%。在一些实施例中，含硫氧双键的化合物的含量为不大于约 4wt%。在一些实施例中，含硫氧双键的化合物的含量为不大于约 3wt%。

在一些实施例中，本申请的环状硫酸酯包括、但不限于：1,2-乙二醇硫酸酯、1,2-丙二醇硫酸酯、1,3-丙二醇硫酸酯、1,2-丁二醇硫酸酯、1,3-丁二醇硫酸酯、1,4-丁二醇硫酸酯、1,2-戊二醇硫酸酯、1,3-戊二醇硫酸酯、1,4-戊二醇硫酸酯、1,5-戊二醇硫酸酯。上述环状硫酸酯可以单独使用，也可以两种或两种以上同时使用。

在一些实施例中，本申请的链状硫酸酯包括、但不限于：硫酸二甲酯、硫酸甲乙酯和硫酸二乙酯等硫酸二烷基酯化合物。上述链状硫酸酯可以单独使用，也可以两种或两种以上同时使用。

在一些实施例中，本申请的链状磺酸酯包括、但不限于：氟磺酸甲酯、氟磺酸乙酯、甲磺酸甲酯、甲磺酸乙酯、二甲磺酸丁酯、2-(甲磺酰氧基)丙酸甲酯、2-(甲磺酰氧基)丙酸乙酯、甲磺酰氧基乙酸甲酯、甲磺酰氧基乙酸乙酯、甲磺酸苯酯、甲磺酸五氟苯酯。上述链状磺酸酯可以单独使用，也可以两种或两种以上同时使用。

在一些实施例中，本申请的环状磺酸酯包括、但不限于：1,3-丙磺酸内酯、1-氟-1,3-丙磺酸内酯、2-氟-1,3-丙磺酸内酯、3-氟-1,3-丙磺酸内酯、1-甲基-1,3-丙磺酸内酯、2-甲基-1,3-丙磺酸内酯、3-甲基-1, 3-丙磺酸内酯、1-丙烯-1,3-磺酸内酯、2-丙烯-1,3-磺酸内酯、1-氟-1-丙烯-1,3-

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磺酸内酯、2-氟-1-丙烯-1,3-磺酸内酯、3-氟-1-丙烯-1,3-磺酸内酯、1-氟-2-丙烯-1,3-磺酸内酯、2-氟-2-丙烯-1,3-磺酸内酯、3-氟-2-丙烯-1,3-磺酸内酯、1-甲基-1-丙烯-1,3-磺酸内酯、2-甲基-1-丙烯-1,3-磺酸内酯、3-甲基-1-丙烯-1,3-磺酸内酯、1-甲基-2-丙烯-1,3-磺酸内酯、2-甲基-2-丙烯-1,3-磺酸内酯、3-甲基-2-丙烯-1,3-磺酸内酯、1,4-丁磺酸内酯、1,5-戊磺酸内酯、甲烷二磺酸亚甲酯、甲烷二磺酸亚乙酯。上述环状磺酸酯可以单独使用，也可以两种或两种以上同时使用。

在一些实施例中，本申请链状亚硫酸酯包括、但不限于：亚硫酸二甲酯、亚硫酸甲乙酯、亚硫酸二乙酯。上述链状亚硫酸酯可以单独使用，也可以两种或两种以上同时使用。

在一些实施例中，本申请环状亚硫酸酯包括、但不限于：1,2-乙二醇亚硫酸酯、1,2-丙二醇亚硫酸酯、1,3-丙二醇亚硫酸酯、1,2-丁二醇亚硫酸酯、1,3-丁二醇亚硫酸酯、1,4-丁二醇亚硫酸酯、1,2-戊二醇亚硫酸酯、1,3-戊二醇亚硫酸酯、1,4-戊二醇亚硫酸酯和 1,5-戊二醇亚硫酸酯。上述环状亚硫酸酯可以单独使用，也可以两种或两种以上同时使用。

在一些实施例中，本申请的链状砜包括、但不限于：二甲基砜、二乙基砜等二烷基砜化合物。

在一些实施例中，本申请的环状砜包括、但不限于：环丁砜、甲基环丁砜、4,5-二甲基环丁砜、环丁烯砜。上述环状砜可以单独使用，也可以两种或两种以上同时使用。

电解质

本申请实施例的电解液使用的电解质可以为现有技术中已知的电解质，电解质包括、但不限于：无机锂盐，例如 $LiClO_4$、$LiAsF_6$、$LiPF_6$、$LiBF_4$、$LiSbF_6$、$LiSO_3F$、$LiN(FSO_2)_2$ 等；含氟有机锂盐，例如 $LiCF_3SO_3$、$LiN(FSO_2)(CF_3SO_2)$、$LiN(CF_3SO_2)_2$、$LiN(C_2F_5SO_2)_2$、环状 1,3-六氟丙烷二磺酰亚胺锂、环状 1,2-四氟乙烷二磺酰亚胺锂、$LiN(CF_3SO_2)(C_4F_9SO_2)$、$LiC(CF_3SO_2)_3$、$LiPF_4(CF_3)_2$、$LiPF_4(C_2F_5)_2$、$LiPF_4(CF_3SO_2)_2$、$LiPF_4(C_2F_5SO_2)_2$、$LiBF_2(CF_3)_2$、$LiBF_2(C_2F_5)_2$、$LiBF_2(CF_3SO_2)_2$、$LiBF_2(C_2F_5SO_2)_2$；含二羧酸配合物锂盐，例如双(草酸根合)硼酸锂、二氟草酸根合硼酸锂、三(草酸根合)磷酸锂、二氟双(草酸根合)磷酸锂、四氟(草酸根合)磷酸锂等。另外，上述电解质可以单独使用一种，也可以同时使用两种或两种以上。例如，在一些实施例中，电解质包括 $LiPF_6$ 和 $LiBF_4$ 的组合。在一些实施例中，电解质包括 $LiPF_6$ 或 $LiBF_4$ 等无机锂盐与 $LiCF_3SO_3$、$LiN(CF_3SO_2)_2$、$LiN(C_2F_5SO_2)_2$ 等含氟有机锂盐的组合。在一些实施例中，电解质的浓度在约 0.8-约 3 mol/L 的范围内，例如约 0.8-约 2.5 mol/L 的范围内、约 0.8-约 2 mol/L 的范围内、约 1-约 2 mol/L 的范围内、又例如为 1mol/L、1.15mol/L、1.2mol/L、1.5mol/L、2mol/L

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或 2.5mol/L。

溶剂

本申请实施例的电解液使用的溶剂可为现有技术中已知的任何可作为电解液的溶剂的非水溶剂。

在一些实施例中，本申请的非水溶剂包括、但不限于：环状碳酸酯、链状碳酸酯、环状羧酸酯、链状羧酸酯、环状醚、链状醚、含磷有机溶剂、含硫有机溶剂、芳香族含氟溶剂或其任意组合。

在一些实施例中，本申请的环状碳酸酯的碳原子数通常为 3~6，例如包括、但不限于：碳酸亚乙酯、碳酸亚丙酯、碳酸亚丁酯等环状碳酸酯。

在一些实施例中，本申请的链状碳酸酯包括、但不限于：碳酸二甲酯、碳酸甲乙酯、碳酸二乙酯、碳酸甲基正丙基酯、碳酸乙基正丙基酯和碳酸二正丙酯等链状碳酸酯；作为被氟取代的链状碳酸酯，例如双(氟甲基)碳酸酯、双(二氟甲基)碳酸酯、双(三氟甲基)碳酸酯、双(2-氟乙基)碳酸酯、双(2,2-二氟乙基)碳酸酯、双(2,2,2-三氟乙基)碳酸酯、2-氟乙基甲基碳酸酯、2,2-二氟乙基甲基碳酸酯和 2,2,2-三氟乙基甲基碳酸酯。

在一些实施例中，本申请的环状羧酸酯包括、但不限于：γ-丁内酯和 γ-戊内酯等，以及将这些化合物的一部分氢用氟取代的环状羧酸酯。

在一些实施例中，本申请的链状羧酸酯包括、但不限于：乙酸甲酯、乙酸乙酯、乙酸丙酯、乙酸异丙酯、乙酸丁酯、乙酸仲丁酯、乙酸异丁酯、乙酸叔丁酯、丙酸甲酯、丙酸乙酯、丙酸丙酯、丙酸异丙酯、丁酸甲酯、丁酸乙酯、丁酸丙酯、异丁酸甲酯、异丁酸乙酯、戊酸甲酯、戊酸乙酯、特戊酸甲酯和特戊酸乙酯等，以及将这些化合物的一部分氢用氟取代的链状羧酸酯。氟取代的链状羧酸酯包括、但不限于：三氟乙酸甲酯、三氟乙酸乙酯、三氟乙酸丙酯、三氟乙酸丁酯和三氟乙酸 2,2,2-三氟乙酯。

在一些实施例中，本申请的环状醚包括、但不限于：四氢呋喃、2-甲基四氢呋喃、1,3-二氧戊环、2-甲基-1,3-二氧戊环、4-甲基-1,3-二氧戊环、1,3-二氧六环、1,4-二氧六环和二甲氧基丙烷。在一些实施例中，本申请的链状醚包括、但不限于：二甲氧基甲烷、1,1-二甲氧基乙烷、1,2-二甲氧基乙烷、二乙氧基甲烷、1,1-二乙氧基乙烷、1,2-二乙氧基乙烷、乙氧基甲氧基甲烷、1,1-乙氧基甲氧基乙烷和 1,2-乙氧基甲氧基乙烷。

在一些实施例中，本申请的含磷有机溶剂包括、但不限于：磷酸三甲酯、磷酸三乙酯、磷

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酸二甲基乙酯、磷酸甲基二乙酯、磷酸亚乙基甲酯、磷酸亚乙基乙酯、磷酸三苯酯、亚磷酸三甲酯、亚磷酸三乙酯、亚磷酸三苯酯、磷酸三(2,2,2-三氟乙基)酯和磷酸三(2,2,3,3,3-五氟丙基)酯。

在一些实施例中，本申请的含硫有机溶剂包括、但不限于：环丁砜、2-甲基环丁砜、3-甲基环丁砜、二甲基砜、二乙基砜、乙基甲基砜、甲基丙基砜、二甲基亚砜、甲磺酸甲酯、甲磺酸乙酯、乙磺酸甲酯、乙磺酸乙酯、硫酸二甲酯、硫酸二乙酯和硫酸二丁酯等，以及将上述含硫有机溶剂化合物的一部分氢用氟取代的含硫有机溶剂。

在一些实施例中，本申请的芳香族含氟溶剂包括、但不限于：氟苯、二氟苯、三氟苯、四氟苯、五氟苯、六氟苯和三氟甲基苯。

在一些实施例中，本申请的非水溶剂可以单独使用一种，也可以两种或者两种以上同时使用。

二、电化学装置

本申请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，该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。在一些实施例中，本申请的电化学装置是具备具有能够吸留、放出金属离子的正极活性物质的正极以及具有能够吸留、放出金属离子的负极活性物质的负极的电化学装置，其特征在于，包含本申请的上述任何电解液。

电解液

本申请的电化学装置中使用的电解液为本申请的上述任何电解液。此外，本申请的电化学装置中使用的电解液还可包含不脱离本申请的主旨的范围内的其它电解液。

负极

本申请实施例的电化学装置中使用的负极材料可以使用本领域公知的材料、构造和制造方法制备。例如可以采用 US9812739B 中记载的技术制备本申请的负极，其以全文引用的方式并入本申请中。

在一些实施例中，负极活性物质为任何能够电化学性地吸留、放出锂离子等金属离子的物质。在一些实施例中，负极活性物质包括碳质材料、硅碳材料、合金材料或含锂金属复合氧化物材料等。在一些实施例中，负极活性物质包括如上所述的一种或多种。

在一些实施例中，负极可通过在负极活性物质中加入粘合剂和溶剂，并根据需要加入增稠

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剂、导电材料、填充材料等而制成浆料，将该浆料涂布于集流体上，干燥后进行压制而形成。

在一些实施例中，当负极包括合金系材料时，可使用蒸镀法、溅射法或镀敷法等方法形成为负极活性物质的薄膜层(负极活性物质层)。

在一些实施例中，当负极包括锂金属时，例如用具有球形绞状的导电骨架和分散在导电骨架中的金属颗粒形成负极活性物质层，球形绞状的导电骨架可具有约 5%-约 85%的孔隙率，锂金属负极活性物质层上还可设置保护层。

正极

本申请的电化学装置中使用的正极的材料可以使用本领域公知的材料、构造和制造方法制备。在一些实施例中，可以采用 US9812739B 中记载的技术制备本申请的正极，其以全文引用的方式并入本申请中。

在一些实施例中，正极活性物质包括、但不限于：硫化物、磷酸盐化合物和锂过渡金属复合氧化物。在一些实施例中，正极活性物质包括锂过渡金属系化合物，其具有能够脱离、插入锂离子的结构。在一些实施例中，锂过渡金属系化合物的组成可以参考 US9812739B 中记载的技术内容。

在一些实施例中，正极通过在集流体上使用包括锂过渡金属系化合物粉体和粘结剂的正极活性物质层形成正极材料而制成。

在一些实施例中，正极活性物质层通常可以通过如下操作来制作：将正极材料和粘结剂（根据需要而使用的导电材料和增稠剂等）进行干式混合而制成片状，将得到的片压接于正极集流体，或者使这些材料溶解或分散于液体介质中而制成浆料状，涂布在正极集流体上并进行干燥。在一些实施例中，正极活性物质层的材料包括任何本领域公知的材料。在一些实施例中，正极活性物质层包括 US9812739B 中记载的材料。

极片压实密度

本申请的电化学装置包含正负极极片、隔膜和电解液。极片包括集流体和位于该集流体上的涂层，涂层包括单面涂层、双面涂层或其组合，其中单面涂层是在集流体的一个表面涂布浆料形成的涂层，而双面涂层是在集流体相对两个表面涂布浆料形成的涂层。

在一些实施例中，如图 2 所示，极片 A 包括集流体 1 和位于集流体 1 上的涂层 2。如图 2 所示，涂层 2 仅存在于集流体的一个表面上，此时的涂层为单面涂层。

在一些实施例中，如图 3 所示，极片 B 包括集流体 1 和位于该集流体上的涂层 2。如图 3

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所示，涂层 2 存在于集流体的相对的两个表面上，此时的涂层为双面涂层。

在一些实施例中，如图 4 极片 C 所示，部分集流体 1 的一个表面被涂布浆料以形成涂层 2 且另一部分集流体 1 的相对的两个表面被涂布浆料以形成涂层 2，此时的涂层同时包括单面涂层和双面涂层。

在卷绕式电化学装置中，正极极片和负极极片通常各由一条长条形极片卷绕而成，因此，在长条形极片上会同时存在单面涂层和双面涂层。在叠片式电化学装置中，正极极片和负极极片通常由片状极片叠加而成，在同一片极片上仅有单面涂层或双面涂层。在卷绕和叠片混合装配的电化学装置中，正极极片和负极极片通常包括一条同时存在单面涂层和双面涂层的长条形极片，和仅有单面涂层或双面涂层的片状极片。

电极极片具有极片压实密度。极片压实密度通过如下方式获得：首先使用精确的量具，如万分尺，测试极片厚度；然后取一定面积的极片，精确测量面积和重量；并通过下式计算极片压实密度：

极片压实密度=（极片重量-集流体重量）/极片面积/（极片厚度-集流体厚度）。

较低的压实密度使得孔隙率较高，造成部分颗粒形成绝缘状态，无法参与充放电，从而造成放电比容量低，影响电化学装置的性能。过高的压实密度可能会造成电解液浸润困难，保液量下降，循环和倍率性能无法得到保证。合理控制单面涂层和双面涂层的极片压实密度，对于获得具有高容量密度、优异循环和存储性能的电化学装置非常重要。

在一些实施例中，单面涂层的极片具有极片压实密度 D1，双面涂层的极片具有极片压实密度 D2，且 D1 和 D2 满足关系式：约 0.8≤D1/D2≤约 1.2 时，正负极活性物质得到更好的发挥，可使极片获得良好的导电性能，而且对控制电化学装置膨胀方面有着重要作用。因此，得到的电化学装置具有高容量密度和优异的循环和存储性能。

在一些实施例中，D1 和 D2 满足关系式：约 0.9≤D1/D2≤约 1.1。此时，电化学装置的性能可进一步提高。

在一些实施例中，D1 和 D2 满足关系式：约 0.95≤D1/D2≤约 1.05。此时，单面涂层和双面涂层的孔径和孔隙的分布更加均匀，导电剂和粘结剂分布更加均匀，降低电极的接触电阻和电荷交换阻抗，增大能够参与反应的活性面积，从而显著提高材料的电化学性能，进一步提高电化学装置性能。

在一些实施例中，极片可以是正极极片或负极极片。当极片为正极极片时，约

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3.5g/cm^3≤D2≤约 4.3g/cm^3。当 D2 在这个范围内时，可使正极极片获得良好的导电性能，正极活性物质能够得到更好的发挥。当极片为负极极片时，约 1.2g/cm^3≤D2≤约 1.8g/cm^3。当 D2 在这个范围内时，可使负极极片有更高的断裂强度，从而避免在循环过程中电极颗粒脱落。

隔膜

在一些实施例中，本申请的电化学装置在正极与负极之间设有隔膜以防止短路。本申请的电化学装置中使用的隔膜的材料和形状没有特别限制，其可为任何现有技术中公开的技术。在一些实施例中，隔膜包括由对本申请的电解液稳定的材料形成的聚合物或无机物等。

例如隔膜可包括基材层和表面处理层。基材层为具有多孔结构的无纺布、膜或复合膜，基材层的材料选自聚乙烯、聚丙烯、聚对苯二甲酸乙二醇酯和聚酰亚胺中的至少一种。具体的，可选用聚丙烯多孔膜、聚乙烯多孔膜、聚丙烯无纺布、聚乙烯无纺布或聚丙烯-聚乙烯-聚丙烯多孔复合膜。

基材层的至少一个表面上设置有表面处理层，表面处理层可以是聚合物层或无机物层，也可以是混合聚合物与无机物所形成的层。

无机物层包括无机颗粒和粘结剂，无机颗粒选自氧化铝、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、氧化锆、氧化钇、碳化硅、勃姆石、氢氧化铝、氢氧化镁、氢氧化钙和硫酸钡中的一种或几种的组合。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、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几种的组合。聚合物层中包含聚合物，聚合物的材料包括聚酰胺、聚丙烯腈、丙烯酸酯聚合物、聚丙烯酸、聚丙烯酸盐、聚乙烯吡咯烷酮、聚乙烯醚、聚偏氟乙烯或聚(偏氟乙烯-六氟丙烯)中的至少一种。

三、应用

在高电压下，正极材料的氧化活性升高、稳定性下降，导致电解液容易在正极表面分解或引起电化学装置材料的劣化，造成电化学装置容量降低。在本申请之前，主要的解决方法是向电解液中加入成膜添加剂，但这样做会造成电池的直流内阻增加，导致循环性能衰减、容量保持率降低。

根据本申请实施例的电解液，能够用于制造抑制电化学装置的直流内阻增加，适合使用在包含电化学装置的电子设备中。

本申请的电化学装置的用途没有特别限定，可以用于公知的各种用途。例如笔记本电脑、

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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、家庭用大型蓄电池或锂离子电容器等。

实施例

以下，举出实施例和比较例对本申请进一步具体地进行说明，但只要不脱离其主旨，则本申请并不限定于这些实施例。

1、锂离子电池的制备

（1）负极极片的制备：

将石墨、导电碳(Super-P) 、丁苯橡胶和羧甲基纤维素钠(CMC) 按照约 95: 2:2:1 的质量比例混合在溶剂去离子水中，搅拌均匀，得到负极浆料。将浆料涂布在具有约 12μm 厚度的铜箔上，干燥，冷压，再经过裁片、焊接极耳，得到负极极片。

（2）正极极片的制备：

将钴酸锂($LiCoO_2$)、导电碳(Super-P) 和聚偏氟乙烯(PVDF) 按照约 95: 2:3 的质量比例混合在溶剂 N-甲基吡咯烷酮中，搅拌均匀，得到正极浆料。将浆料涂布在具有约 12μm 厚度的铝箔上，干燥，冷压，再经过裁片、焊接极耳，得到正极极片。

（3）电解液的制备：

在干燥氩气环境下，将 EC、PC 和 DEC（重量比约 1：1：1）混合，加入 $LiPF_6$ 混合均匀，形成基础电解液，其中 $LiPF_6$ 的浓度为 1.15mol/L。在基础电解液中加入如下表 1-1 至表 9 中所示的不同含量的物质得到不同实施例和对比例的电解液，其中如下描述的电解液中各物质的含量均是基于电解液的总重量计算得到。

（4）隔离膜的制备

以 PE 多孔聚合物薄膜作为隔离膜。

（5）锂离子电池的制备

将得到的正极极片、负极极片和隔膜按次序卷绕，置于外包装箔中，留下注液口。从注液口灌注电解液，封装，再经过化成、容量等工序制得锂离子电池。本文中的新鲜电池是指完成前述制作工艺，等待出货的电池。

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2、电池性能测试方法

（1）20%SOC 直流内阻变化的测试方法

在25℃，将电池以1C（标称容量）恒流充电到4.45V，转恒压4.45V充电至电流≤0.05C，搁置5 min，以1C恒流放电至截至电压3V，记录实际放电容量，并以实际容量将电池调节至所需满充容量的50%，以0.3C的电流持续放电10s，以放电前电压及放电终止时电压之差，除以电流，得到首次循环、循环200次和400次后的直流内阻(DCIR)（测15支电池，取其平均值）。

（2）60℃高温存储性能的测试方法

在25℃，将电池静置30分钟，之后以0.5C倍率恒流充电至4.45V，再在4.45V下恒压充电至0.05C，并静置5分钟，然后在60℃下储存21天后，测得电池的厚度膨胀率，通过下式计算得到：

厚度膨胀率=[（存储后厚度-存储前厚度）/存储前厚度]×100%。

（3）电池容量保持率的测试方法

在45℃，将电池以1 C恒流充电至4.45 V，然后恒压充电至电流为0.05 C，再用1 C恒流放电至3.0 V，此时为首次循环，按照上述条件电池进行多次循环，分别计算得出新鲜电池、循环200次和400次后的容量保持率，其中，循环后的容量保持率按照下式进行计算。

循环后的容量保持率=（对应循环的放电容量/首次循环的放电容量）×100%。

（4）电压降的测试方法

在25℃，将电池以1C恒流充电至4.45 V，然后恒压充电至电流为0.05 C，再用1 C恒流放电至3.2 V，并静置5分钟，然后测试电压，在85℃下存储24小时后，复测电压。电压降=存储前电压-存储后电压。

（5）间歇循环的测试方法

在50℃，将锂离子电池在0.5C恒压充电至4.45V，再转恒流充电截至电流为0.05C，静置20小时，然后0.5C恒电流放电至3.0V，如此充电/放电，分别计算新鲜电池、循环30次、50次、100次后的容量保持率。循环后的容量保持率=（对应循环的放电容量/首次循环的放电容量）×100%。

3、测试结果

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下面两个表中示出了本申请实施例所用化学物质的英文缩写：

材料名称	缩写	材料名称	缩写
碳酸乙烯酯	EC	1,3-丙磺酸内酯	PS
碳酸丙烯酯	PC	硫酸乙烯酯	DTD
碳酸甲乙酯	EMC	丁二腈	SN
碳酸二甲酯	DMC	己二腈	ADN
		1,4-二氰基-2-丁烯	DCB
碳酸二乙酯	DEC	1,3,6-己烷三腈	HTCN-1
γ-丁内酯	GBL	1,2,6-己烷三腈	HTCN-2
γ-戊内酯	VL	1,3,5-戊三腈	PTCN
丙酸乙酯	EP	乙二醇二(2-氰基乙基) 醚	EDN
丙酸丙酯	PP	1,1-二氟-2,2-二氟乙基-2',2'二氟-3',3'-二氟丙基醚	FEPE
		2-三氟甲基-3-甲氧基全氟戊烷	TMMP
		2-（三氟-2-氟-3-二氟代）-3-二氟-4-氟-5-三氟戊烷	TPTP
碳酸亚乙烯酯	VC	1-丙基磷酸环酐	T3P
氟代碳酸亚乙酯	FEC	1-甲基磷酸环酐	TM3P
		1-乙基磷酸环酐	TE3P
		1,2,3-三(2-氰基乙氧基)丙烷	TCEP

二腈化合物	A	A_1:SN; A_2:ADN; A_3:EDN; A_4: DCB
三腈化合物	B	B_1:HTCN-1; B_2:HTCN-2; B_3:PTCN; B_4:TCEP
丙酸丙酯(PP)	C	
氟代醚	D	D_1: FEPE; D_2: TMMP ; D_3: TPTP
环状磷酸酐	E	E_1: T3P E_2: TM3P; E_3: TE3P
其他添加剂	F	F_1: VC; F_2: PS; F_3: DTD
环状羧酸酯	H	H_1: GBL；H_2: VL
单双面压实密度	G	

（1）在基础电解液中加入如表 1-1 和 1-2 中所示的不同含量的二腈化合物、三腈化合物和/或丙酸丙酯，将电解液注入按照上述方法制成的电池中并测试其 20%SOC 直流内阻。测试结果见表 1-1 和 1-2。

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表 1-1

	A_1 (Xwt%)	B_1 (Ywt%)	C (Zwt%)	X+Y	X/Y	20%SOC 直流内阻（mΩ）		
						新鲜电池	200 次循环后	400 次循环后
S1-1	4	1	30	5	4	50.8	84.3	91.2
S1-2	4	2	30	6	2	54.4	88.0	98.6
S1-3	4	3	30	7	1.3	55.7	88.9	99.4
S1-4	4	0.5	30	4.5	8	57.8	92.0	101.0
S1-5	3	0.5	30	3.5	6	57.1	91.2	93.5
S1-6	4	0.4	30	4.2	10	55.9	99.4	112.8
S1-7	3	2	30	5	1.5	52.3	84.4	91.5
S1-8	2	2	30	4	1	51.9	84.2	91.4
S1-9	1	2	30	3	0.5	52.3	86.5	92.4
S1-10	0.5	2	30	2.5	0.25	54.8	79.4	102.5
S1-11	0.2	2	30	2.2	0.1	59.2	91.8	105.3
S1-12	1	5	30	6	0.2	58.5	97.0	104.1
S1-13	7	3	30	10	2.3	60.4	92.9	107.3
D1-1	0	0	0	0	0	63.8	140.9	190.4
D1-2	0	1	0	1	0	62.3	138.5	188.2
D1-3	4	0	0	4	0	61.8	136.5	184.2
D1-4	0.1	1	0	1.1	0.1	63.8	120.9	126.4
D1-5	4	0.1	0	4.1	40	68.3	109.8	124.9
D1-6	7	5	0	12	1.4	69.2	112.3	133.0
D1-7	1	11	0	12	0.09	63.8	100.9	139.3
D1-8	11	1	0	12	10	72.0	116.3	135.4

表 1-2

	A(Xwt%)	B(Ywt%)	C(Zwt%)	X+Y	X/Y	20%SOC 直流内阻（mΩ）		
						新鲜电池	200 次循环后	400 次循环后
S1-14	A_2(4)	B_2(3)	30	7	1.3	55.5	88.1	98.7
S1-15	A_2(4)	B_2(0.5)	30	4.5	8	57.2	91.6	100.6
S1-16	A_2(3)	B_2(0.5)	30	3.5	6	55.9	89.4	98.8
S1-17	A_3(3)	B_3(2)	30	5	1.5	51.1	82.6	90.7
S1-18	A_3 (2)	B_3(2)	30	4	1	51.2	83.3	90.5
S1-19	A_3 (1)	B_3(2)	30	3	0.5	51.3	85.1	91.1
S1-20	A_3 (0.5)	B_4(2)	30	2.5	0.25	54.3	79.1	90.1
S1-21	A_2 (0.2)	B_2(2)	30	2.2	0.1	58.5	91.2	104.8
S1-22	A_2 (1)	B_2(5)	30	6	0.2	58.1	96.5	103.3
S1-23	A_2 (7)	B_2(3)	30	10	2.3	60.2	92.3	106.5
S1-24	A_4(2)	B_3(2)	30	4	1	57.9	86.1	93.4

如表 1-1 所示，对比例 D1-1 至 D1-8 中单独添加丁二腈或 1,3,6-己烷三腈，不添加丙酸丙酯，循环后电池的直流内阻增加很明显。

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当实施例 S1-1 至 S1-13 中同时使用丁二腈、1,3,6-己烷三腈和丙酸丙酯时，能够明显抑制电池循环后直流内阻的增加。

在丙酸丙酯含量不变，调整丁二腈含量 X 和 1,3,6-己烷三腈含量 Y 的关系时，发现当 X 和 Y 同时满足式(1)和式(2)所表示的条件：{约 2wt%≤(X+Y)≤约 11 wt% …(1)；和约 0.1≤(X/Y)≤约 8 …(2)}时，对电池循环后直流内阻增加的抑制效果明显。当 X 和 Y 满足约 2 wt%≤(X+Y)≤约 8 wt%且约 0.1≤(X/Y)≤约 6 时，组合添加剂能够表现出协同作用，能够充分地抑制直流内阻的增加。

图 1a 示出了本申请实施例 S1-1 和 S1-2 与对比例 D1-1 的新鲜电池在不同充电状态下（10%SOC、20%SOC、70%SOC）的直流内阻。图 1b 示出了本申请实施例 S1-1 和 S1-2 与对比例 D1-1 的电池在 200 次充放电后在不同充电状态下（10%SOC、20%SOC、70%SOC）的直流内阻。图 1c 示出了本申请实施例 S1-1 和 S1-2 与对比例 D1-1 的电池在 400 次充放电后在不同充电状态下（10%SOC、20%SOC、70%SOC）的直流内阻。可以看出，相较于对比例 D1-1，实施例 S1-1 和 S1-2 在循环过程直流内阻增加得到明显改善。

如表 1-2 所示，当二腈化合物是己二腈或乙二醇二(2-氰基乙基)醚，三腈化合物是 1,2,6-己烷三腈、1,2,6-己烷三腈或 1,2,3-三(2-氰基乙氧基)丙烷时，同样可以达到抑制直流内阻增加的效果。当二腈化合物是乙二醇二(2-氰基乙基)醚，或三腈化合物是 1,2,3-三(2-氰基乙氧基)丙烷时，抑制电池循环后直流内阻增加的效果更为明显。

（2）在基础电解液中加入如表 2 中所示的不同含量的二腈化合物、三腈化合物和/或丙酸丙酯，将电解液注入按照上述方法制成的电池中并测试其 20%SOC 直流内阻。测试结果见表 2。

表 2

	C(Zwt%)	A_1(Xwt%)	B_1(Ywt%)	Y/Z	20%SOC 直流内阻（mΩ）		
					新鲜电池	200 次循环后	400 次循环后
S1-1	30	4	1	0.03	50.8	84.3	91.2
S2-1	5	4	1	0.2	68.7	85.2	97.6
S2-2	10	4	1	0.1	60.3	83.1	95.7
S2-3	20	4	1	0.05	56.1	81.6	93.9
S2-4	40	4	1	0.025	47.5	78.2	87.2
S2-5	50	4	1	0.02	56.3	82.6	98.3
S2-6	10	4	3	0.3	64.3	89.5	97.7
S2-7	50	4	0.5	0.01	53.2	84.3	94.1
D2-1	4	4	1	0.25	72.1	108.5	118.9

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D2-2	60	4	1	0.017	42.0	100.1	113.9
D2-3	10	4	5	0.5	62.3	85.4	111.3
D2-4	50	4	0.1	0.0025	53.2	89.3	109.4

如表 2 所示，当丙酸丙酯的含量在 5%-50%范围内时，随着丙酸丙酯含量的增加，新鲜电池直流内阻不断减小。另外，当丙酸丙酯的含量小于 5%或超出 50%时，200 次循环后电池直流内阻出现大幅增加，性能恶化。组合添加剂可以形成正极保护膜从而减少副反应，从而有效控制了电池的极化和副反应。三腈化合物含量与丙酸丙酯的含量的比值对电池直流内阻变化有较大的影响，当 Y/Z 在 0.01-0.3 的范围内时，对直流内阻增加起到更好的抑制作用。

（3）在基础电解液中加入丙酸丙酯 30wt%，丁二腈（A1）4wt%和 1,3,6-己烷三腈(B1)1wt%以及如表 3 所示的不同含量的氟代醚，将得到的电解液注入按照上述方法制成的电池中并测试其 20%SOC 直流内阻和 60℃ 21 天厚度膨胀率。测试结果见表 3。

表 3

	D(含量 wt%)	新鲜电池 20%SOC 直流内阻（mΩ）	60℃ 21 天 厚度膨胀率
S1-1	0	50.8	7.6%
S3-1	D_1(0.1)	50.2	6.2%
S3-2	D_1(0.5)	49.8	6.0%
S3-3	D_1(1)	48.6	5.7%
S3-4	D_1(1.5)	48.5	5.1%
S3-5	D_1(2)	48.4	4.8%
S3-6	D_1(2.5)	48.3	4.9%
S3-7	D_1(3)	48.1	5.6%
S3-8	D_1(5)	49.3	6.8%
S3-9	D_2(1)	49.2	6.1%
S3-10	D_3(1)	49.4	5.7%
D3-1	D_1(6)	51.3	8.5%

从表 3 中可以看出，随着氟代醚的加入（0.1~5%），新鲜电池直流内阻和厚度膨胀率有一定改善，加入量多时存储性能略有下降，但仍在期望的范围内。当氟代醚含量大于 5%时，新鲜电池直流内阻和 60℃存储厚度膨胀率有所恶化。

（4）在基础电解液中加入丙酸丙酯 30wt%，丁二腈（A1）4wt%和 1,3,6-己烷三腈(B1)1wt%以及如表 4 所示的不同含量的环状磷酸酐，将得到的电解液注入按照上述方法制成的电池中并测试其 20%SOC 直流内阻和容量保持率。测试结果见表 4。

表 4

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	E(含量 wt%)	20%SOC 直流内阻（mΩ）			容量保持率		
		新鲜电池	200 次循环后	400 次循环后	新鲜电池	200 次循环后	400 次循环后
S1-1	0	50.8	84.3	91.2	100%	93.5%	86.3%
S4-1	E_1(0.1)	48.3	51.5	88.2	100%	95.7%	90.1%
S4-2	E_1(0.5)	45.4	48.2	82.3	100%	96.3%	91.4%
S4-3	E_1(1)	44.6	47.1	80.5	100%	96.1%	90.7%
S4-4	E_1(2)	45.6	47.3	81.6	100%	95.2%	89.6%
S4-5	E_1(3)	45.9	49.1	89.4	100%	94.7%	88.5%
S4-6	E_2(1)	45.2	48.3	88.3	100%	95.3%	91.0%
S4-7	E_3(1)	45.3	48.7	89.5	100%	95.1%	90.8%
D4-1	E_1(4)	46.1	58.6	105.3	100%	92.1%	85.3%

由表 4 可以看出，随着环状磷酸酐的加入（0.1~3%），新鲜电池及循环后直流内阻有一定改善，可能归因于组合添加剂所形成的复合保护膜结构比较稳定；循环性能随着环状磷酸酐的加入先变好后变差，当含量大于 3%时，循环性能受到影响，可能是环状磷酸酐分解造成。

（5）在基础电解液中加入丙酸丙酯 30wt%，丁二腈（A1）4wt%和 1,3,6-己烷三腈(B1)1wt%以及如表 5 所示的不同含量的氟代醚和环状磷酸酐，将得到的电解液注入按照上述方法制成的电池中并测试其 20%SOC 直流内阻、60℃ 21 天厚度膨胀率和容量保持率。测试结果见表 5。

表 5

	D_1(含量 wt%)	E_1(含量 wt%)	20%SOC 直流内阻（mΩ）			60℃ 21 天厚度膨胀率	容量保持率		
			新鲜电池	200 次循环后	400 次循环后		新鲜电池	200 次循环后	400 次循环后
S1-1	0	0	50.8	84.3	91.2	7.6%	100%	93.5%	86.3%
S3-1	0.1	0	50.2	83.1	90.4	6.2%	100%	94.2%	87.9%
S4-2	0	0.5	45.4	48.2	82.3	6.7%	100%	96.3%	91.4%
S5-1	0.1	0.5	44.7	47.2	80.8	6.0%	100%	96.4%	91.6%
S5-2	1	0.5	43.8	46.3	80.5	5.3%	100%	96.8%	91.7%
S5-3	1	0.3	44.1	48.2	79.3	4.3%	100%	97.1%	92.3%
S5-4	1	0.1	46.3	50.5	86.2	4.5%	100%	97.6%	92.9%
S5-5	3	2	43.5	47.1	81.3	4.0%	100%	94.8%	89.4%

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由表 5 可以看出，随着氟代醚和环状磷酸酐组合加入，新鲜电池及循环后的直流内阻、存储性能和循环性能都进一步改善。

（6）在基础电解液中加入丙酸丙酯 30wt%，丁二腈（A1）4wt%和 1,3,6-己烷三腈(B1)1wt%以及如表 6 所示的不同含量的其它添加剂，将得到的电解液注入按照上述方法制成的电池中并测试其 3.2V 85℃ 24h 存储电压降。测试结果见表 6。

表 6

	VC(含量 wt%)	VEC(含量 wt%)	FEC(含量 wt%)	PS(含量 wt%)	DTD(含量 wt%)	3.2V 85℃ 24h 存储电压降
S6-1	0.5	-	-	-	-	0.35V
S6-2	0.5	-	-	3	-	0.32V
S6-3	0.5	-	-	3	0.5	0.23V
S6-4	1	-	-	3	-	0.3V
S6-5	1	-	3	3	-	0.20V
S6-6	-	0.5	-	3	0.5	0.25V
D6-1	-	-	-	-	-	0.4V

VC、VEC、FEC、PS、DTD 等成膜添加剂的加入可以进一步提高电池的固体电解质界面膜(SEI)稳定性。多种添加剂的组合使用更有利于电池稳定性提升，有利于电池的长期存储，提升电池可靠性。

（7）在基础电解液中加入丙酸丙酯 30wt%，丁二腈（A1）4wt%和 1,3,6-己烷三腈(B1)1wt%，将得到的电解液注入按照上述方法制成的电池中。按照表 7 改变电池的极片压实密度比值（D1/D2），并测试其容量保持率，测试结果见表 7。

表 7

	压实密度比（D1/D2）	容量保持率		
		新鲜电池	200 次循环后	400 次循环后
S7-1	0.8	100%	93.8%	89.3%
S7-2	0.9	100%	95.3%	90.1%
S7-3	0.95	100%	95.9%	90.8%
S7-4	1.0	100%	96.8%	91.4%
S7-5	1.05	100%	95.8%	90.7%
S7-6	1.1	100%	95.2%	90.2%

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S7-7	1.2	100%	93.7%	88.8%
D7-1	1.3	100%	91.2%	83.6%
D7-1	0.7	100%	90.5%	82.7%

从表 7 中可以看出，锂离子电池的极片压实密度比（D1/D2）对锂离子电池的循环性能有显著影响。D1/D2 过大或过小均会损伤锂离子电池的循环性能。可以看出当 D1/D2 在 0.8~1.2 范围内时，获得较好的循环性能，可能归因于组合添加剂利于降低电极界面电阻和减小电池极化。

（8）在基础电解液中加入丙酸丙酯 30wt%，丁二腈（A1）4wt%和 1,3,6-已烷三腈(B1)1wt%以及如表 8 所示的不同含量的氟代醚和环状磷酸酐，将得到的电解液注入按照上述方法制成的电池中。并按照表 8 改变极片的压实密度比值（D1/D2），测试所得到的电池的容量保持率。测试结果请见表 8。

表 8

	D_1(含量)	E_1(含量)	G	容量保持率		
				新鲜电池	200 次循环后	400 次循环后
S8-1	1	-	0.8	100%	94.9%	90.1%
S8-2	1	-	1.0	100%	97.3%	92.5%
S8-3	1	-	1.2	100%	94.8%	89.9%
S8-4	-	0.3	0.8	100%	94.3%	89.6%
S85	-	0.3	1.0	100%	97.9%	92.2%
S8-6	-	0.3	1.2	100%	95.0%	90.5%
S8-7	1	0.3	1.0	100%	98.1%	93.3%

随着氟代醚或环状磷酸酐的加入，锂离子电池的极片压实密度比 D1/D2 在 0.8~1.2 范围内时，电池的循环性能得到了进一步提升。

（9）在基础电解液中加入丙酸丙酯 30wt%，丁二腈（A1）4wt%和 1,3,6-已烷三腈(B1)1wt%以及如表 9 所示的不同含量的环状羧酸酯，将得到的电解液注入按照上述方法制成的电池中。测试所得到的电池的间歇循环容量保持率。测试结果请见表 9。

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表 9

	H(含量 wt%)	间歇循环容量保持率			
		新鲜电池	30 次循环后	50 次循环后	100 次循环后
S1-1	0	100%	73.80%	64.30%	54.50%
S9-1	$H_1(1)$	100%	82.50%	74.60%	64.20%
S9-2	$H_1(10)$	100%	87.20%	81.40%	77.20%
S9-3	$H_1(20)$	100%	86.20%	81.30%	78.00%
S9-4	$H_1(30)$	100%	88.30%	83.30%	79.80%
S9-5	$H_1(40)$	100%	87.50%	80.60%	75.20%
S9-6	$H_1(50)$	100%	86.30%	74.40%	63.20%
S9-7	$H_1(60)$	100%	85.20%	71.60%	57.60%
S9-8	$H_2(1)$	100%	81.80%	73.20%	61.80%
S9-9	$H_2(10)$	100%	86.50%	80.80%	76.10%
S9-10	$H_2(20)$	100%	85.30%	81.30%	77.10%
S9-11	$H_2(30)$	100%	88.10%	83.00%	79.30%
S9-12	$H_2(40)$	100%	87.10%	80.10%	74.80%
S9-13	$H_2(50)$	100%	85.20%	73.70%	61.90%
S9-14	$H_2(60)$	100%	82.20%	70.10%	55.90%

电池间歇循环后的容量保持率随着环状羧酸酯用量的增加而提高，可能是因为环状羧酸酯在正极表面形成钝化膜，但当环状羧酸酯接近 40%时，间歇循环性能有所变差，这主要是由于 $LiPF_6$ 同环状羧酸酯之间的副反应引起，因此环状羧酸酯的用量适度较好，不宜过大。

整个说明书中对“一些实施例”、“部分实施例”、“一个实施例”、“另一举例”、“举例”、“具体举例”或“部分举例”的引用，其所代表的意思是在本申请中的至少一个实施例或举例包含了该实施例或举例中所描述的特定特征、结构、材料或特性。因此，在整个说明书中的各处所出现的描述，例如：“在一些实施例中”、“在实施例中”、“在一个实施例中”、“在另一个举例中”，“在一个举例中”、“在特定举例中”或“举例“，其不必然是引用本申请中的相同的实施例或示例。此外，本文中的特定特征、结构、材料或特性可以以任何合适的方式在一个或多个实施例或举例中结合。

尽管已经演示和描述了说明性实施例，本领域技术人员应该理解上述实施例不能被解释为

Zhuhai CosMX Battery Co. - EX1002
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对本申请的限制，并且可以在不脱离本申请的精神、原理及范围的情况下对实施例进行改变，替代和修改。

Zhuhai CosMX Battery Co. - EX1002
Zhuhai CosMX Battery Co. v. Ningde Amperex Tech. Ltd.
IPR2025-00722
Page 180 of 273

说　明　书　附　图

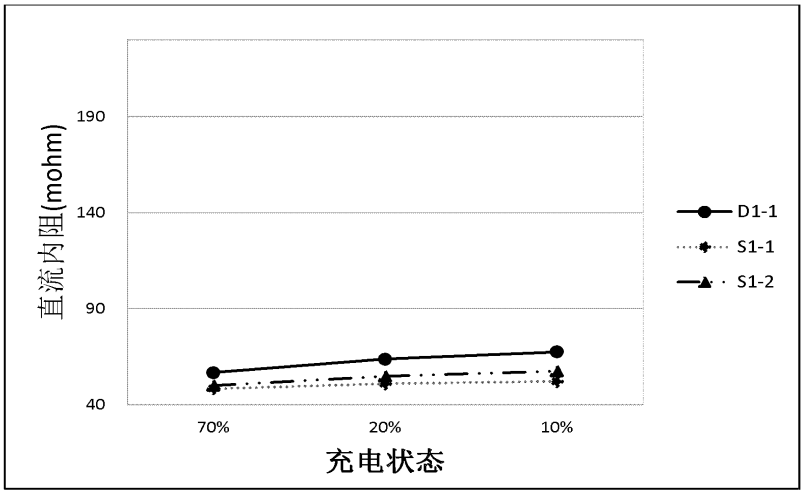


图 1a

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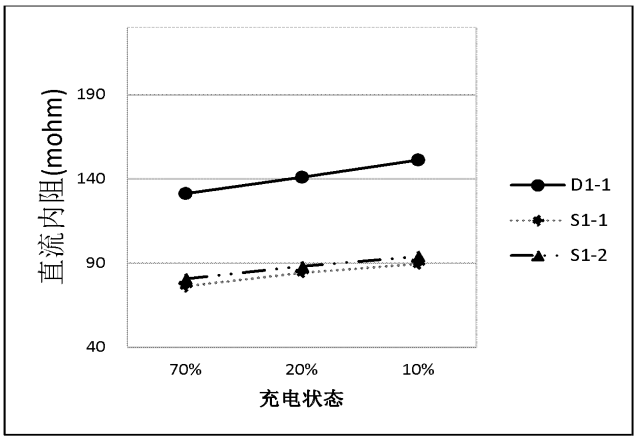


图 1b

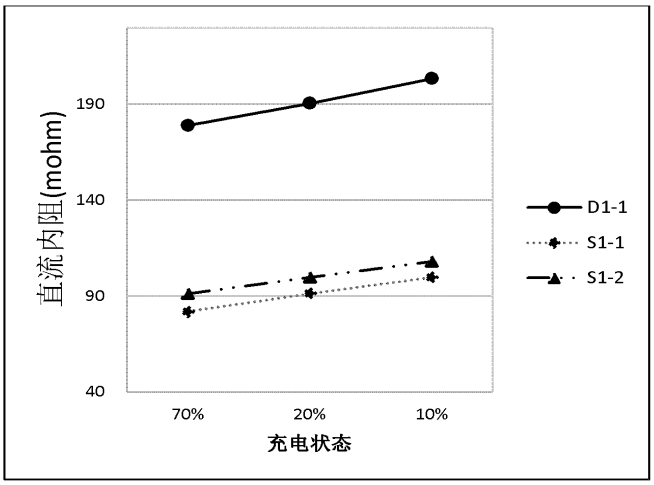


图 1c

Zhuhai CosMX Battery Co. - EX1002
Zhuhai CosMX Battery Co. v. Ningde Amperex Tech. Ltd.
IPR2025-00722
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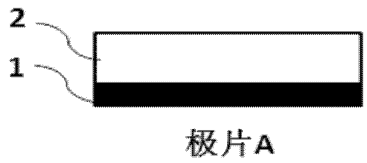


图 2

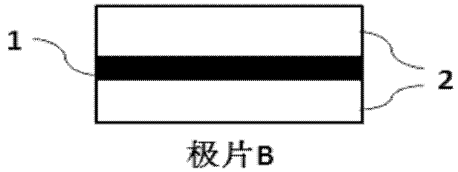


图 3

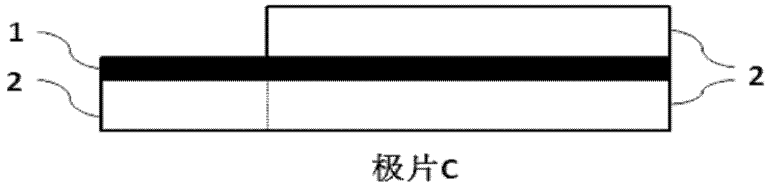


图 4

Zhuhai CosMX Battery Co. - EX1002
Zhuhai CosMX Battery Co. v. Ningde Amperex Tech. Ltd.
IPR2025-00722
Page 183 of 273

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

U.S. Patent Application: **Attorney Docket: 14850089COB**

U.S. Filing Date: August 11, 2022 **Group Art Unit: Unassigned**

Applicant: NINGDE AMPEREX TECHNOLOGY LIMITED **Examiner: Unassigned**

For: ELECTROLYTE AND ELECTROCHEMICAL DEVICE

INFORMATION DISCLOSURE STATEMENT

August 11, 2022

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

Sir:

It is respectfully requested that the references listed on the attached PTO/SB/08a form be made of record and considered with respect to the above-referenced U.S. patent application. Copies of the listed reference(s) were cited and/or filed in prior parent application Serial No. 17/064782 filed October 7, 2020; where required, as were either statements of relevancy or any readily available partial or full English translations of pertinent portions of any non-English language reference(s). Submission of the present Information Disclosure Statement should not be taken as an admission that the cited references are legally available prior art or that the same are pertinent or material.

Respectfully submitted,

/Timothy J. Maier/
Timothy J. Maier
Attorney for Applicant
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703-740-8322

PTO/SB/08a (01-22)
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INFORMATION DISCLOSURE STATEMENT BY APPLICANT (**Not for submission under 37 CFR 1.99)**		
	Application Number	
	Filing Date	2022-08-11
	First Named Inventor	Kefei WANG
	Art Unit	TBD
	Examiner Name	TBD
	Attorney Docket Number	14850089COB

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Examiner Initial*	Cite No	Patent Number	Kind Code[1]	Issue Date	Name of Patentee or Applicant of cited Document	Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear
	1	9812739	B2	2017-11-07	KEFEI	

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Examiner Initial*	Cite No	Publication Number	Kind Code[1]	Publication Date	Name of Patentee or Applicant of cited Document	Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear
	1	20110311864	A1	2011-12-22	SONY CORPORATION	
	2	20120313570	A1	2012-12-13	SONY CORPORATION	
	3	20170346127	A1	2017-11-30	MITSUI CHEMICALS, INC.	
	4	20170346136	A1	2017-11-30	Ningde Amperex Technology Limited	
	5	20090061325	A1	2009-03-05	Sony Corporation	

INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)		
	Application Number	
	Filing Date	2022-08-11
	First Named Inventor	Kefei WANG
	Art Unit	TBD
	Examiner Name	TBD
	Attorney Docket Number	14850089COB

	6	20170324116	A1	2017-11-09	MITSUBISHI CHEMICAL CORPORATION	
	7	20190214680	A1	2019-07-11	NINGDE AMPEREX TECHNOLOGY LIMITED	
	8	20170288268	A1	2017-10-05	SAMSUNG SDI CO., LTD.	
	9	20170018803	A1	2017-01-19	NingDe Contemporary Amperex Technology Limited	
	10	20190245245	A1	2019-08-08	Ningde Amperex Technology Limited	
	11	20180233778	A1	2018-08-16	SK Innovation Co., Ltd.	
	12	20180108947	A9	2018-04-19	Ningde Amperex Technology Ltd.	
	13	20160301103	A1	2016-10-13	SK INNOVATION CO., LTD.	
	14	20140322596	A1	2014-10-30	Samsung SDI Co., Ltd.	
	15	20170125845	A1	2017-05-04	LG Chem, Ltd.	
	16	20170069934	A1	2017-03-09	SAMSUNG SDI CO., LTD.	

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	Filing Date	2022-08-11
	First Named Inventor	Kefei WANG
	Art Unit	TBD
	Examiner Name	TBD
	Attorney Docket Number	14850089COB

	17	20170317385	A1	2017-11-02	BASF CORPORATION	

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	1	107210486	CN	A	2017-09-26	Mitsubishi Chem Corp.	Corresponds to US Publication 20170324116A1	
	2	108232300	CN	A	2018-06-29	Ningde Amperex Technology Ltd.	Corresponds to US Publication 20190214680A1	
	3	105845984	CN	A	2016-08-10	Dongguan Shanshan Battery Mat. Co., Ltd.	English abstract	
	4	106602131	CN	A	2017-04-26	Ningde Amperex Technology Ltd.	English abstract	
	5	105047992	CN	A	2015-11-11	Ningde Amperex Technology Ltd.	English abstract	
	6	105552439	CN	A	2016-05-04	Dongguan Shanshan Battery Mat. Co., Ltd.	English abstract	
	7	106099187	CN	A	2016-11-09	Dongguan Kaixin Battery Mat. Co., Ltd.	English abstract	
	8	106816633	CN	A	2017-06-09	University of Jiliang, China	English abstract	

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	Filing Date	2022-08-11
	First Named Inventor	Kefei WANG
	Art Unit	TBD
	Examiner Name	TBD
	Attorney Docket Number	14850089COB

	9	2017022108	JP	A	2017-01-26	Stella Chemifa Corp.	English abstract	
	10	105680088	CN	A	2016-06-15	Donguan Kaixin Battery Material Co., Ltd.	English abstract	
	11	103401020	CN	A	2013-11-20	Dongguan Shanshan Battery Materials Co., Ltd.	English abstract	
	12	103779607	CN	A	2014-05-07	Central South University	English abstract	
	13	104752769	CN	A	2015-07-01	Ningde Amperex Technology Ltd.	English abstract	
	14	106099185	CN	A	2016-11-09	Highpower Tech (Huizhou) Co., Ltd.	English abstract	
	15	104979589	CN	A	2015-10-14	Donguan Kaixin Battery Material Co., Ltd.	English abstract	
	16	103956517	CN	A	2014-07-30	South China Normal University	English abstract	
	17	105098237	CN	A	2015-11-25	Zhejiang Research Inst. of Chemical Industry Ltd.	English abstract	
	18	105355975	CN	A	2016-02-24	Ningde Amperex Technology Ltd.	English abstract	
	19	105529498	CN	A	2016-04-27	Donguan Kaixin Battery Material Co., Ltd.	English abstract	

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	Filing Date	2022-08-11
	First Named Inventor	Kefei WANG
	Art Unit	TBD
	Examiner Name	TBD
	Attorney Docket Number	14850089COB

	20	107394269	CN	A	2017-11-24	Ningde Amperex Technology Ltd.	English abstract	
	21	108242567	CN	A	2018-07-03	Ningde Contemporary Amperex Technology Co., Ltd.	English abstract	
	22	107275553	CN	A	2017-10-20	Dongguan Liwinon Energy Tech Co., Ltd.	English abstract	
	23	109301326	CN	A	2019-02-01	Ningde Amperex Technology Ltd.	English abstract	
	24	101195931	KR	B1	2012-10-30	LG Chemical Ltd.	English abstract	
	25	103633371	CN	A	2014-03-12	Shenzhen Capchem Technology Co., Ltd.	English abstract	
	26	104332653	CN	A	2015-02-04	Amperex Technology Ltd.	English abstract	
	27	102522590	CN	A	2012-06-27	Huawei Tech Co., Ltd.	English abstract	
	28	105609874	CN	A	2016-05-25	Dongguan Amperex Technology Ltd.	English abstract	
	29	103682416	CN	B	2018-02-09	Samsung SDI Co., Ltd.	English abstract	
	30	107408734	CN	A	2017-11-28	Mitsubishi Chem Corp.	English abstract	

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	Filing Date	2022-08-11
	First Named Inventor	Kefei WANG
	Art Unit	TBD
	Examiner Name	TBD
	Attorney Docket Number	14850089COB

	31	105355968	CN	A	2016-02-24	Ningde Amperex Technology Ltd.	English abstract	
	32	104766995	CN	A	2015-07-08	Ningde Amperex Technology Ltd.	English abstract	
	33	105895957	CN	A	2016-08-24	Contemporary Amperex Technology Co., Ltd.	English abstract	
	34	106784589	CN	A	2017-05-31	Ningde Contemporary Amperex Tech Co., Ltd.	English abstract	
	35	103348516	CN	A	2013-10-09	Sanyo Electric Co.	English abstract	
	36	102244294	CN	A	2011-11-16	Mitsubishi Chem Corp.	English abstract	
	37	106654128	CN	A	2017-05-10	Ningde Amperex Technology Ltd.	English abstract	
	38	20170051286	KR	A	2017-05-11	LG Chemical Ltd.	English abstract	
	39	105074993	CN	A	2015-11-18	SK Innovation Co., Ltd.	English abstract	
	40	101640290	CN	A	2010-02-03	Sanyo Electric Co.	English abstract	
	41	103928708	CN	A	2014-07-16	Samsung SDI Co., Ltd.	English abstract	

INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)		
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	First Named Inventor	Kefei WANG
	Art Unit	TBD
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	Attorney Docket Number	14850089COB

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	1	Extended European Search Report issued January 14, 2020 in European application 19198416.0; 7 pages in English	☒
	2	Chinese First Office Action issued January 19, 2020 in Chinese counterpart application 201811108529.X; 12 pages in Chinese	☐

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	Application Number	
	Filing Date	2022-08-11
	First Named Inventor	Kefei WANG
	Art Unit	TBD
	Examiner Name	TBD
	Attorney Docket Number	14850089COB

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	/Timothy J. Maier/	Date (YYYY-MM-DD)	2022-08-11
Name/Print	Timothy J. Maier	Registration Number	51986

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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Application Number:				
Filing Date:				
Title of Invention:	ELECTROLYTE AND ELECTROCHEMICAL DEVICE			
First Named Inventor/Applicant Name:	Kefei WANG			
Filer:	Timothy Joseph Maier/Yuriko Stankich			
Attorney Docket Number:	14850089COB			
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	320	320
UTILITY SEARCH FEE	1111	1	700	700
UTILITY EXAMINATION FEE	1311	1	800	800
Pages:				
Claims:				
Miscellaneous-Filing:				
Petition:				
Patent-Appeals-and-Interference:				

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Post-Allowance-and-Post-Issuance:				
Extension-of-Time:				
Miscellaneous:				
		Total in USD ($)		**1820**

Electronic Acknowledgement Receipt	
EFS ID:	46390630
Application Number:	17885920
International Application Number:	
Confirmation Number:	7924
Title of Invention:	ELECTROLYTE AND ELECTROCHEMICAL DEVICE
First Named Inventor/Applicant Name:	Kefei WANG
Customer Number:	62008
Filer:	Timothy Joseph Maier/Yuriko Stankich
Filer Authorized By:	Timothy Joseph Maier
Attorney Docket Number:	14850089COB
Receipt Date:	11-AUG-2022
Filing Date:	
Time Stamp:	15:02:18
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	yes
Payment Type	CARD
Payment was successfully received in RAM	$1820
RAM confirmation Number	E20228AF02503902
Deposit Account	505976
Authorized User	Yuriko Stankich
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37 CFR 1.19 (Document supply fees)

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Warnings:					
Information:					
2	Application Data Sheet	ADS.pdf	2226417 5a7c6975b375b31f7fba177739a22caa6b31e98b	no	9
Warnings:					
Information:					
3	Oath or Declaration filed	Declarations.pdf	981271 bce666c64fa74fa22bc8f2830b1990ca884d89e2	no	4
Warnings:					
Information:					
4	Power of Attorney	POA.pdf	238091 8d5548f4e2b3d0c100c60cb82daef658eac26920	no	2
Warnings:					
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5		Specification.pdf	432821 a2092e8170f80521d7ef73e45d51e93b474f1784	yes	55

Multipart Description/PDF files in .zip description

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6	Drawings-only black and white line drawings	Drawings.pdf	195513 32635d881291a71669a24cba5600748b05e1136b	no	3
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7	Information Disclosure Statement (IDS) Form (SB08)	IDS-Statement.pdf	20400 f117cd80f35bf965b4664bcfbc69e9238d623b89	no	1
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9	Fee Worksheet (SB06)	fee-info.pdf	44503 aa1324d59935c3e1bb537383e25f0e6a7eb5bd4f	no	2
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Application Number	
Filing Date	August 11, 2022
First Named Inventor	Kefei WANG
Title	ELECTROLYTE AND ELECTROCHEMICAL DEVICE
Art Unit	TBD
Examiner Name	TBD
Attorney Docket Number	14850089COB

SIGNATURE of Applicant or Patent Practitioner

Signature	/Timothy J. Maier/	Date (Optional)	August 11, 2022
Name	Timothy J. Maier	Registration Number	51,986
Title (if Applicant is a juristic entity)			
Applicant Name (if Applicant is a juristic entity)			

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

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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

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

Ningde Amperex Technology Limited

☐ Inventor or Joint Inventor (title not required below)

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

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

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SIGNATURE of Applicant for Patent

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

Signature	/Liangxin Yang/	Date (Optional)	
Name	Liangxin Yang		
Title	IP Senior Manager		

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ELECTROLYTE AND ELECTROCHEMICAL DEVICE

CROSS REFERENCE TO THE RELATED APPLICATIONS

The present application is a continuation application of US Application 17/064959, which is a continuation application of US Application 16/211,853, now US Patent 10/833,363, where 16/211,853 claims the benefit of priority from China Patent Application No. 201811108529.X, filed on 21 September 2018, the disclosure of which is hereby incorporated by reference in its entirety.

1. Technical Field

The present disclosure relates to the technical field of energy storage technologies, in particular to an electrolyte and an electrochemical device containing the electrolyte.

2. Background

With the rapid development of electronic devices and electric vehicles, the requirement for high capacity electrochemical devices has grown. In order to increase capacity density of electrochemical devices, there is a need for effective methods to develop high-voltage electrochemical devices.

At present, electrochemical devices with a working voltage above 4.4V have become a hot research area in many research institutes and enterprises. However, at high voltages, the oxidation activity of the positive electrode material increases, and the stability decreases, which makes the electrolyte decompose on the surface of the positive electrode easily or cause deterioration of the battery material, resulting in a decrease in battery capacity. In order to solve the above problems, it is definitely necessary to provide an improved electrochemical device.

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SUMMARY

An embodiment of the present application provides an electrolyte and an electrochemical device containing the electrolyte, wherein the electrolyte comprises a compound comprising two cyano groups (herein also referred to as "a dinitrile compound"), a compound comprising three cyano groups (herein also referred to as "a trinitrile compound"), and propyl propionate. The dinitrile compound can form a protective film on the cathode of the electrochemical device, so as to inhibit the decomposition of the solvent in the electrochemical device. However, since the protective film itself is decomposed on the surface of the cathode at a high potential, the effect of inhibiting decomposition of the solvent cannot be sustained for a long time. The present inventors unexpectedly found that by using a mixture of a dinitrile compound, a trinitrile compound and propyl propionate, a firm protective film which is not easily decomposed on the surface of the cathode at a high potential can be formed. The electrolyte according to the embodiment of the present application can effectively inhibit the increase in DC internal resistance of the electrochemical device.

In an embodiment, the present application provides an electrolyte. The electrolyte comprises a dinitrile compound, a trinitrile compound, and propyl propionate, wherein, based on the total weight of the electrolyte, the weight percentage (X) of the dinitrile compound and the weight percentage (Y) of the trinitrile compound based on the total weight of the electrolyte solution meet the conditions represented by Formula (1) and Formula (2):

$$\text{about } 2 \text{ wt\%} \leq (X+Y) \leq \text{about } 11 \text{ wt\%} \quad \ldots \quad (1); \text{ and}$$

$$\text{about } 0.1 \leq (X/Y) \leq \text{about } 8 \quad (2).$$

According to an embodiment of the present application, the weight percentage (Y) of the trinitrile compound and the weight percentage (Z) of the propyl propionate based on the total weight of the electrolyte meet the condition represented by Formula (3):

$$\text{about } 0.01 \leq (Y/Z) \leq \text{about } 0.3 \quad (3).$$

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According to an embodiment of the present application, the weight percentage of the dinitrile compound is X, and X is about 0.01-10 wt%; the weight percentage of the trinitrile compound is Y, and Y is about 0.01-10 wt%; and the weight percentage of the propyl propionate is Z, and Z is about 5-50 wt%. The electrolyte according to the embodiments of the present application can effectively inhibit the increase in DC internal resistance of the electrochemical device, thereby achieving a better effect.

According to an embodiment of the present application, the electrolyte further comprises a fluoroether, wherein based on the total weight of the electrolyte, the content of fluoroether is about 0.01-10 wt%. The fluoroether can form a better protective film with the trinitrile compound, thereby improving the DC internal resistance and the storage performance of the electrochemical device.

According to an embodiment of the present application, the electrolyte further comprises a cyclic phosphonic anhydride, wherein, based on the total weight of the electrolyte, the content of the cyclic phosphonic anhydride is about 0.01-10 wt%. The addition of the cyclic phosphonic anhydride can further inhibit the increase in DC internal resistance during the cycle.

According to an embodiment of the present application, the electrolyte further comprises one selected from the group consisting of: a cyclic carbonate ester having a carbon-carbon double bond, a fluorinated chain carbonate ester, a fluorinated cyclic carbonate ester, a compound having a sulfur-oxygen double bond, and any combination thereof. These compounds can form a firm protective film which is not easily to be decomposed at the electrode interface with the dinitrile compound, the trinitrile compound and propyl propionate, thereby further inhibiting the side reactions in the electrochemical device and reducing the voltage drop during storage of the electrochemical device, so as to improve the long-term storage performance and reliability of the electrochemical device.

In another embodiment, the present application provides an electrochemical device and an electronic device using the electrochemical

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device. The electrochemical device comprises electrodes and an electrolyte which is any of the electrolyte described above.

According to an embodiment of the present application, the electrode includes a current collector and a coating on the current collector. The coating includes a single-sided coating, a double-sided coating, or a combination thereof. The single-sided coating is a coating formed by applying a slurry on one surface of the current collector. The double-sided coating is a coating formed by applying a slurry on two surfaces of the current collector. The electrode with the single-sided coating has an electrode compaction density D1, and the electrode with the double-sided coating has an electrode compaction density D2, wherein D1 and D2 meet the following relationship: about $0.8 \leq D1/D2 \leq$ about 1.2.

According to an embodiment of the present application, the electrode s include a cathode and an anode In some embodiments, when the electrode is an cathode, about 3.5 $g/cm^3 \leq D2 \leq$ about 4.3 g/cm^3. In some other embodiments, when the electrode is an anode , about 1.2 $g/cm^3 \leq D2 \leq 1.8$ g/cm^3.

In the electrochemical device according to the embodiments of the present application, when the electrolyte of the electrochemical device comprises a compound comprising two cyano groups, a compound comprising three cyano groups, and propyl propionate, and the electrode compaction densities meet the above relationships, the electrode can have good electrical conductivity, the effects of the cathode and anode active materials are well exerted, which is important to controlling the expansion of electrochemical devices. Therefore, the electrochemical device according to the embodiments of the present application achieves high capacity density and has excellent cycle and storage performances.

In another embodiment, the present application provides an electronic device including the electrochemical device.

Additional aspects and advantages of the embodiments of the present

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application will be partially described, illustrated or explained by way of examples in the description as follows.

BRIEF DESCRIPTION OF THE DRAWINGS

The invention will be described according to the appended drawings in which:

The drawings needed for describing the embodiments of the present application or the prior art will be briefly described below to facilitate the description of the embodiments of the present application. Obviously, the drawings in the following description are only a portion of the embodiments of the present application. For those skilled in the art, the drawings of other embodiments can be obtained according to the structures illustrated in the drawings without creative efforts.

Fig. 1A shows the DC internal resistances of fresh batteries of Examples S1-1 and S1-2 of the present application and Comparative Example D1-1 at different charge states (10% SOC, 20% SOC, and 70% SOC).

Fig. 1B shows the DC internal resistances of batteries of Examples S1-1 and S1-2 of the present application and Comparative Example D1-1 at different charge states (10% SOC, 20% SOC, and 70% SOC) after 200 cycles of charge and discharge.

Fig. 1C shows the DC internal resistances of batteries of Examples S1-1 and S1-2 of the present application and Comparative Example D1-1 at different charge states (10% SOC, 20% SOC, and 70% SOC) after 400 cycles of charge and discharge.

Fig. 2 is a view schematically showing the structure of an electrode A with a single-sided coating of the present application.

Fig. 3 is a view schematically showing the structure of an electrode B with a double-sided coating of the present application.

Fig. 4 is a view schematically showing the structure of an electrode C

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with a single-sided coating and a double-sided coating of the present application.

DETAILED DESCRIPTION

Embodiments of the present application will be described in detail below. Throughout the specification of the present application, the same or similar components and components having the same or similar functions are denoted by similar reference numerals. The embodiments described herein with respect to the figures are explanatory, and illustrative, and are provided to facilitate the basic understanding of the application. The embodiments of the present application should not be interpreted as limitations to the present application. Unless otherwise expressly indicated, the following terms used herein have the meanings indicated below.

As used herein, the term "about" is used to describe and depict minor variations. When used in connection with an event or circumstance, the term may refer to an example in which the event or circumstance occurs precisely, and an example in which the event or circumstance occurs approximately. For example, when used in connection with a value, the term may refer to a range of variation less than or equal to ±10% of the stated value, such as 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 values are sometimes presented in a range format in this application. It is to be understood that such a range format is provided for convenience and simplicity, and should be understood flexibly to include not only the numerical values that are explicitly defined in the range, but also all the individual values or sub-ranges that are included in the range, as if each value and sub-range are explicitly specified.

As used herein, "hydrocarbyl" covers alkyl, alkenyl, and alkynyl groups. For example, the hydrocarbyl may be a straight-chain hydrocarbon

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structure having 1 to 20 carbon atoms. The hydrocarbon group also may be a branched or cyclic hydrocarbon structure having 3 to 20 carbon atoms. When a hydrocarbon group having a specific number of carbon atoms is defined, it may cover all geometric isomers having the carbon number. The hydrocarbon group herein may also be a hydrocarbon group having 1 to 15 carbon atoms, a hydrocarbon group having 1 to 10 carbon atoms, a hydrocarbon group having 1 to 5 carbon atoms, a hydrocarbon group having 5 to 20 carbon atoms, a hydrocarbon group having 5 to 15 carbon atoms or a hydrocarbon group having 5 to 10 carbon atoms. Additionally, the hydrocarbon group may be optionally substituted. For example, the hydrocarbon group may be substituted by halo including fluorine, chlorine, bromine, and iodine, an alkyl group, an aryl group or a heteroaryl group.

As used herein, the "alkyl group" may be a linear saturated hydrocarbon structure having 1 to 20 carbon atoms. The alkyl group also may be a branched or cyclic hydrocarbon structure having 3 to 20 carbon atoms. For example, the alkyl group may be an alkyl group having 1-20 carbon atoms, an alkyl group having 1-10 carbon atoms, an alkyl group having 1-5 carbon atoms, an alkyl group having 5-20 carbon atoms, an alkyl group having 5-15 carbon atoms, or alkyl group having 5-10 carbon atoms. When an alkyl group having a specific number of carbon atoms is defined, it may cover all geometric isomers having the carbon number. Therefore, for example, "butyl" means n-butyl, sec-butyl, isobutyl, tert-butyl and cyclobutyl; and "propyl" includes n-propyl, isopropyl and cyclopropyl. Examples of the alkyl group include, but are not limited to, methyl, ethyl, n-propyl, isopropyl, cyclopropyl, n-butyl, isobutyl, sec-butyl, tert-butyl, cyclobutyl, n-pentyl, isoamyl, neopentyl, cyclopentyl, methylcyclopentyl, ethylcyclopentyl, n-hexyl, isohexyl, cyclohexyl, n-heptyl, octyl, cyclopropyl, cyclobutyl, norbornanyl and so on. Additionally, the alkyl group may be optionally substituted.

As used herein, the term "alkylene group" means a linear or branched divalent saturated hydrocarbon group. For example, the alkylene group may be an alkylene group having 1-20 carbon atoms, an alkylene group

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having 1-15 carbon atoms, an alkylene group having 1-10 carbon atoms, an alkylene group having 1-5 carbon atoms, an alkylene group having 5-20 carbon atoms, an alkylene group having 5-15 carbon atoms, or alkylene group having 5-10 carbon atoms. Representative alkylene group includes (for example) methylene, ethane-1,2-diyl ("ethylene"), propane-1,2-diyl, propane-1,3-diyl, butane-1,4-diyl, pentane-1,5-diyl and the like. Additionally, the alkylene group may be optionally substituted.

As used herein, the term "alkenylene group" covers both linear and branched alkenylene groups. When an alkenylene group having a specific number of carbon atoms is defined, it may cover all geometric isomers having the carbon number. For example, the alkenylene group may be an alkenylene group having 2-20 carbon atoms, an alkenylene group having 2-15 carbon atoms, an alkenylene group having 2-10 carbon atoms, an alkenylene group having 2-5 carbon atoms, an alkenylene group having 5-20 carbon atoms, an alkenylene group having 5-15 carbon atoms, or alkenylene group having 5-10 carbon atoms. Representative alkenylene group includes (for example) ethenylene, propenylene, butenylene and the like. Additionally, the alkenylene group may be optionally substituted.

As used herein, the term "aryl" encompasses both monocyclic and polycyclic systems. A polycyclic ring may have two or more rings in which two carbons are shared by two adjacent rings (where the rings are "fused"), in which at least one of the rings is aromatic and other rings may be for example, a cycloalkyl group, a cycloalkenyl group, an aryl group, a heterocyclyl group and/or a heteroaryl group. For example, the aryl group may be a C_6-C_{50} aryl group, a C_6-C_{40} aryl group, a C_6-C_{30} aryl group, a C_6-C_{20} aryl group, or a C_6-C_{10} aryl group. Representative aryl group includes (for example) phenyl, methylphenyl, propylphenyl, isopropylphenyl, benzyl and naphthalen-1-yl, naphthalen-2-yl and the like. Additionally, the aryl group may be optionally substituted.

As used herein, the term "heteroaryl group" covers a monocyclic heteroaromatic group which may include one to three heteroatoms, for example, pyrrole, furan, thiophene, imidazole, oxazole, thiazole, triazole,

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pyrazole, pyridine, pyrazine, pyrimidine, and the like. The term heteroaryl group also includes a polycyclic heteroaromatic system having two or more rings in which two atoms are shared by two adjacent rings (where the ring is "fused"), in which at least one of the rings is a heteroaryl group, and other rings may be a cycloalkyl group, a cycloalkenyl group, an aryl group, a heterocyclyl group and/or a heteroaryl group. The heteroatom in the heteroaryl group may be for example O, S, N, Se, and so on. For example, the heteroaryl group may be a C_2-C_{50} heteroaryl group, a C_2-C_{40} heteroaryl group, a C_2-C_{30} heteroaryl group, a C_2-C_{20} heteroaryl group, or a C_2-C_{10} heteroaryl group. Additionally, the aryl group may be optionally substituted.

When the above substituents are substituted, the substituent is selected from the group consisting of halogen, an alkyl group, a cycloalkyl group, an alkenyl group, an aryl group, and a heteroaryl group.

As used herein, the content of each component is obtained based on the total weight of the electrolyte.

I. Electrolyte

An embodiment of the present application provides an electrolyte, which comprises an electrolyte and a solvent in which the electrolyte is dissolved. It is one of the main characteristics of the electrolyte of the present application that the electrolyte comprises a dinitrile compound, a trinitrile compound, and propyl propionate, wherein, based on the total weight of the electrolyte, the weight percentage of the is X and the weight percentage of the trinitrile compound is Y, and X and Y meet the conditions represented by Formula (1) and Formula (2):

about 2 wt% $\leq$ (X+Y) $\leq$ about 11wt% …(1); and

about 0.1 $\leq$ (X/Y) $\leq$ about 8 …(2).

In some embodiments, X and Y meet about 2 wt% $\leq$ (X+Y) $\leq$ about 8 wt% and about 0.1 $\leq$ (X/Y) $\leq$ about 6 simultaneously. In some

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embodiments, X and Y meet about 3 wt% ≤ (X+Y) ≤ 6 wt% and about 0.2 ≤ (X/Y) ≤ about 5 simultaneously. In some embodiments, X and Y meet about 4 wt% ≤ (X+Y) ≤ about 5 wt% and about 0.3 ≤ (X/Y) ≤ about 4 simultaneously. In some embodiments, X and Y meet about 2 wt% ≤ (X+Y) ≤ about 5 wt% and about 0.1 ≤ (X/Y) ≤ about 1 simultaneously.

In some embodiments, based on the total weight of the electrolyte, the weight percentage of the trinitrile compound is Y and the weight percentage of the propyl propionate is Z, and Y and Z meet the condition represented by Formula (3):

about 0.01 ≤ (Y/Z) ≤ about 0.3 …(3).

In some embodiments, Y and Z meet about 0.01 ≤ (Y/Z) ≤ about 0.2. In some embodiments, Y and Z meet about 0.02 ≤ (Y/Z) ≤ about 0.1.

In some embodiments, the weight percentage of the dinitrile compound is about 0.01-10 wt%. In some embodiments, the weight percentage of the dinitrile compound is not less than about 0.01 wt%, not less than about 0.1 wt%, not less than about 0.3 wt%, or not less than about 0.5 wt%. In some embodiments, the weight percentage of the dinitrile compound is not greater than about 10 wt%, not greater than about 8 wt%, or not greater than about 6 wt%.

In some embodiments, the weight percentage of the trinitrile compound is about 0.01-10 wt%. In some embodiments, the weight percentage of the trinitrile compound is not less than about 0.01 wt%, not less than about 0.1 wt%, not less than about 0.3 wt%, or not less than about 0.5 wt%. In some embodiments, the weight percentage of the trinitrile compound is not greater than about 10 wt%, not greater than about 8 wt%, not greater than about 5 wt%, not greater than about 4 wt%, or not greater than about 3 wt%.

In some embodiments, the weight percentage of the propyl propionate is about 5-50wt%. In some embodiments, the weight percentage (Z) of the propyl propionate is about 5-40 wt%, about 10-40 wt%, about 10-30 wt%, about 20-50 wt%, about 20-40 wt%, about 20-30 wt%, or about 25-30 wt%.

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Compound comprising two cyano groups (Dinitrile compound)

In some embodiments, the dinitrile compound according to the present application includes a compound of Formula [4] or [5]:

$CN\text{-}R_1\text{-}CN$ [4],

$CN\text{-}R_2\text{-}(O\text{-}R_3)_n\text{-}O\text{-}R_4\text{-}CN$ [5],

or a combination thereof,

wherein in Formula [4] or [5], R_1, R_2, R_3 and R_4 are each independently an alkylene having 1-20 carbon atoms, for example, an alkylene group having 1-15 carbon atoms, an alkylene group having 1-10 carbon atoms, an alkylene group having 1-5 carbon atoms, an alkylene group having 5-10 carbon atoms, an alkylene group having 5-20 carbon atoms, an alkylene group having 5-15 carbon atoms, an alkenylene group having 2-20 carbon atoms, an alkenylene group having 2-15 carbon atoms, an alkenylene group having 2-10 carbon atoms, an alkenylene group having 2-5 carbon atoms, an alkenylene group having 5-20 carbon atoms, an alkenylene group having 5-15 carbon atoms, or an alkenylene group having 5-10 carbon atoms, and n is an integer from 0 to 5.

In some embodiments, the dinitrile compound according to the present application is a compound of Formula [4] or [5].

In some embodiments, the dinitrile compound of the present application includes, but is not limited to, butanedinitrile, glutaronitrile, adiponitrile, 1,5-dicyanopentane, 1,6-dicyanohexane, 1,7-dicyanoheptane, 1,8-dicyanooctane, 1,9-dicyanononane, 1,10-dicyanodecane, 1,12-dicyanododecane, tetramethylbutanedinitrile, 2-methylglutaronitrile, 2,4-dimethylglutaronitrile, 2,2,4,4-tetramethylglutaronitrile, 1,4-dicyanopentane, 2,6-dicyanoheptane, 2,7-dicyanooctane, 2,8-dicyanononane, 1,6-dicyanodecane, 1,2-dicyanobenzene, 1,3-dicyanobenzene, 1,4-dicyanobenzene, 3,5-dioxa-pimelonitrile, 1,4-bis(cyanoethoxy)butane, ethylene glycol bis(2-cyanoethyl)ether, diethylene

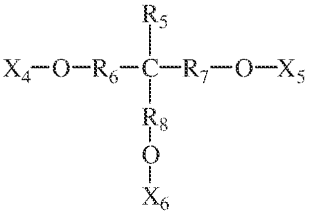
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glycol bis(2-cyanoethyl)ether, triethylene glycol bis(2-cyanoethyl)ether, tetraethylene glycol bis(2-cyanoethyl)ether, 3,6,9,12,15,18-hexaoxaeicosanoic dinitrile, 1,3-bis(2-cyanoethoxy)propane, 1,4-bis(2-cyanoethoxy)butane, 1,5-bis(2-cyanoethoxy)pentane, ethylene glycol bis(4-cyanobutyl)ether, 1,4-dicyano-2-butene, 1,4-dicyano-2-methyl-2-butene, 1,4-dicyano-2-ethyl-2-butene, 1,4-dicyano-2,3-dimethyl-2-butene, 1,4-dicyano-2,3-diethyl-2-butene, 1,6-dicyano-3-hexene, 1,6-dicyano-2-methyl-3-hexene, or 1,6-dicyano-2-methyl-5-methyl-3-hexene. The dinitrile compounds may be used alone or in combination of two or more thereof.

Compound comprising three cyano groups (Trinitrile compound)

In some embodiments, the trinitrile compound according to the present application includes a compound of Formula [6] or [7]:

$$CN\text{-}(CH_2)_x\text{-}CH\{(CH_2)_y\text{-}CN\}\text{-}(CH_2)_z\text{-}CN \quad [6],$$



[7],

or a combination thereof,

wherein in Formula [6], x, y, and z represents an integer from 0 to 5 and x, y, and z are not 0 at the same time; and

in Formula [7], R_5 may be hydrogen or an alkyl group having 1-20 carbon atoms, for example, an alkyl group having 1-10 carbon atoms, an alkyl group having 1-5 carbon atoms, an alkyl group having 5-20 carbon atoms, an alkyl group having 5-15 carbon atoms, or an alkyl group having 5-10 carbon atoms; R_6, R_7, and R_8 each independently may be an alkylene group having 1-20 carbon atoms, for example, an alkylene group having 1-15 carbon atoms, an alkylene group having 1-10 carbon atoms, an alkylene group having 1-5 carbon atoms, an alkylene group having 5-20 carbon

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atoms, an alkylene group having 5-15 carbon atoms, or an alkylene group having 5-10 carbon atoms; and X_4, X_5 and X_6 each independently may be -R_9-CN, wherein R_9 may be an alkylene group having 1-20 carbon atoms, for example, an alkylene group having 1-15 carbon atoms, an alkylene group having 1-10 carbon atoms, an alkylene group having 1-5 carbon atoms, an alkylene group having 5-20 carbon atoms, an alkylene group having 5-15 carbon atoms, or an alkylene group having 5-10 carbon atoms.

In some embodiments, the trinitrile compound according to the present application is a compound of Formula [6] or [7].

In some embodiments, the trinitrile compound of the present application includes, but is not limited to, 1,3,5-pentanetricarbonitrile , 1,2,3-propanetrinitrile, 1,3,6-hexanetricarbonitrile , 1,2,6-hexanetricarbonitrile , 1,2,3-tris(2-cyanoethoxy)propane, 1,2,4-tris(2-cyanoethoxy)butane, 1,1,1-tris(cyanoethoxymethylene)ethane , 1,1,1-tris(cyanoethoxymethylene)propane, 3-methyl-1,3,5-tris(cyanoethoxy)pentane, 1,2,7-tris(cyanoethoxy)heptane, 1,2,6-tris(cyanoethoxy)hexane, or 1,2,5-tris(cyanoethoxy)pentane. The trinitrile compounds may be used alone or in combination of two or more thereof.

Fluoroether compound

In some embodiments, the fluoroether compound of the present application includes at least one of the compounds of Formula [8], Formula [9], Formula [10], or Formula [11]:

Rf1–O – Rf2 [8];

Rf1–O – R [9];

Rf1–O –(R' –O)$_n$– Rf2 [10]; and

Rf1–O –(R' –O)$_n$– R [11],

where in Formulae [8], [9], [10], and [11], Rf1 and Rf2 are each independently a linear or branched C_1 to C_{12} fluoroalkyl group at least one

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hydrogen atom of which is replaced with fluorine, R is a linear or branched C_1 to C_{12} alkyl group, and R' is a linear or branched C_1 to C_5 alkylene group, and n is an integer from 1 to 5.

In some embodiments, the fluoroether compound of the present application is a compound of Formula [8], Formula [9], Formula [10], or Formula [11].

In some embodiments, Rf1 or Rf2 is each independently a fluoroalkyl group selected from the group consisting of HCF_2-, CF_3-, HCF_2CF_2-, CH_3CF_2-, CF_3CH_2-, CF_3CF_2-, $(CF_3)_2CH$-, $HCF_2CF_2CH_2$-, $CF_3CH_2CH_2$-, $HCF_2CF_2CF_2CH_2$-, $HCF_2CF_2CF_2CF_2CH_2$-, $CF_3CF_2CH_2$-, $CF_3CFHCF_2CH_2$-, $HCF_2CF(CF_3)CH_2$-, and $CF_3CF_2CH_2CH_2$-.

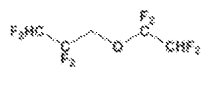
The fluoroether can form a better protective film with the trinitrile compound, thereby further improving the DC internal resistance and the storage performance of the battery.

In some embodiments, the fluoroether of the present application includes, but is not limited to:

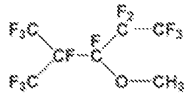
$HCF_2CF_2CH_2OCF_2CF_2H$(FEPE), $(CF_3)_2CFCF(CF_2CF_3)(OCH_3)$ (TMMP), $CF_3CHFCF_2CH(CH_3)OCF_2CHFCF_3$(TPTP), $HCF_2CF_2CH_2OCF_2CF_2CF_2CF_2H$, $HCF_2CF_2OCH_2CF_3$, $HCF_2CF_2OCH_2CH_2OCF_2CF_2H$, $HCF_2CF_2OCH_2CH_2CH_2OCF_2CF_2H$, $HCF_2CF_2CH_2OCF_2CF_2CF_2H$, $HCF_2CF_2OCH_2CH_2OCF_2CF_2CF_2H$, $HCF_2CF_2OCH_2CH_2CH_2OCF_2CF_2CF_2H$, $CH_3OCH_2CH_2OCH_2CH_2F$, $CH_3OCH_2CH_2OCH_2CF_3$, $CH_3OCH_2CH(CH_3)OCH_2CH_2F$, $CH_3OCH_2CH(CH_3)OCH_2CF_3$, $FCH_2CH_2OCH_2CH_2OCH_2CH_2F$, $FCH_2CH_2OCH_2CH(CH_3)OCH_2CH_2F$, $CF_3CH_2O(CH_2CH_2O)_2CH_2CF_3$ or $CF_3CH_2OCH_2CH(CH_3)OCH_2CF_3$. The fluoroether may be used alone or in combination of two or more thereof.

The structural formulas of FEPE, TMMP, and TPTP are shown below:

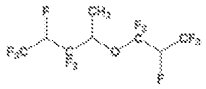
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1,1-difluoro-2,2-difluoroethyl-2',2'-difluoro-3', 3'-difluoropropyl ether, (FEPE)



2-trifluoromethyl-3-methoxyperfluoropentane, (TMMP)

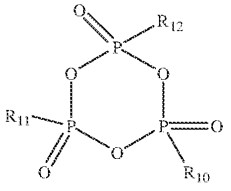


2-(trifluoro-2-fluoro-3-difluoropropoxy)-3-difluoro-4-fluoro-5-trifluoropentane. (TPTP)

In some embodiments, based on the total weight of the electrolyte, the content of the fluoroether is not less than about 0.01 wt%, not less than about 0.1 wt%, or not less than about 0.5 wt%. In some embodiments, the content of the fluoroether is not greater than about 5wt%, not greater than about 4 wt%, not greater than about 3wt%, or not greater than about 2 wt%.

Cyclic phosphonic anhydride compound

In some embodiments, the cyclic phosphonic anhydride according to the present application includes one or more of the compounds of Formula [12]:



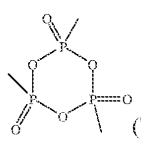
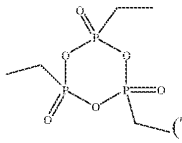
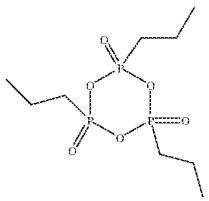
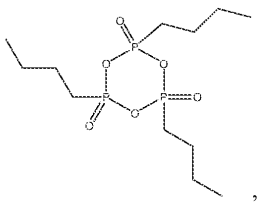
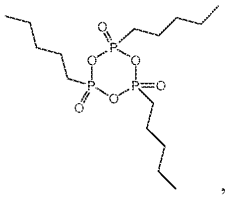
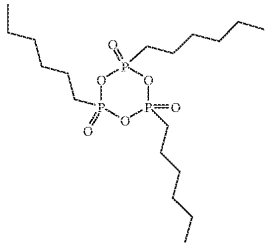
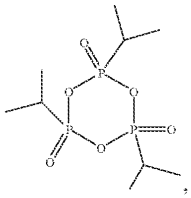
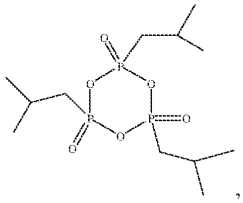
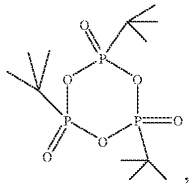
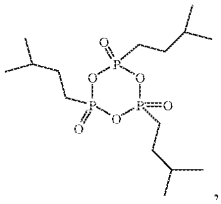
[12],

wherein in Formula [12], R_{10}, R_{11}, and R_{12} each independently may be hydrogen; each independently may be an alkyl group having 1-20 carbon atoms, for example, an alkyl group having 1-15 carbon atoms, an alkyl group having 1-10 carbon atoms, an alkyl group having 1-5 carbon atoms, an alkyl group having 5-20 carbon atoms, an alkyl group having 5-15 carbon atoms, and an alkyl group having 5-10 carbon atoms; and each independently may be an aryl group having 6-50 carbon atoms, for example, an aryl group having 6-30 carbon atoms, an aryl group having 6-26 carbon atoms, an aryl group having 6-20 carbon atoms, an aryl group having 10-50 carbon atoms, an aryl group having 10-30 carbon atoms, an aryl group having 10-26 carbon

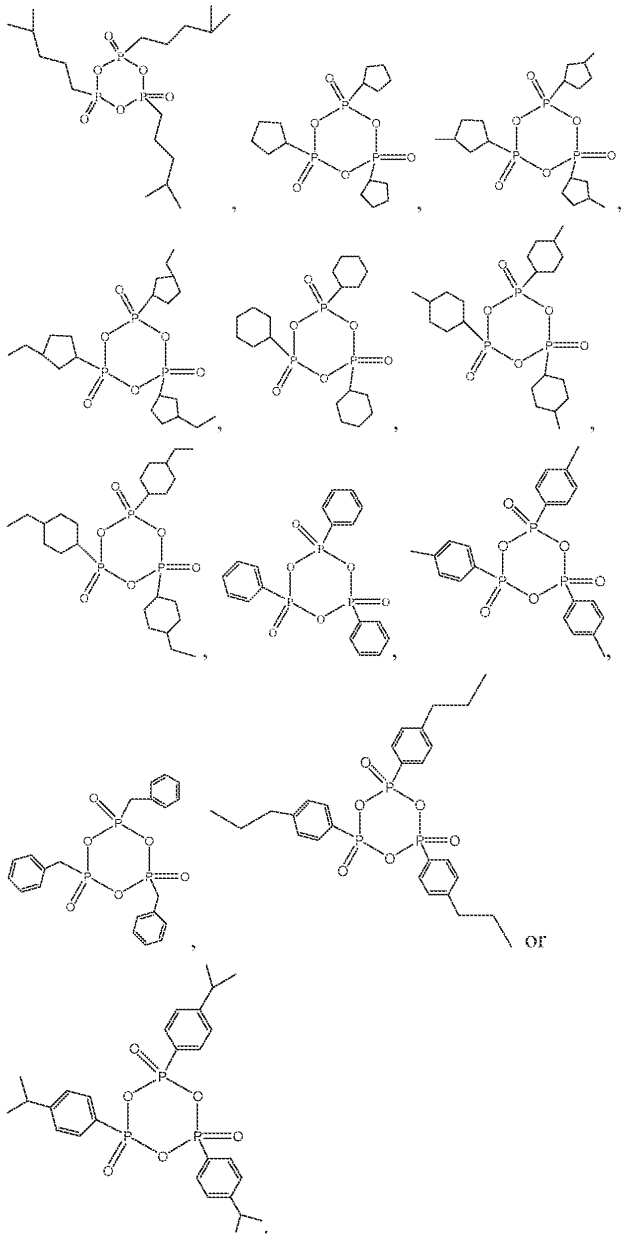
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atoms, or an aryl group having 10-20 carbon atoms, wherein R_{10}, R_{11}, and R_{12} may be different from or the same as each other, or any two of them are the same.

In some embodiments, the cyclic phosphonic anhydride compound of the present application includes, but is not limited to, compounds of following formulae, which may be used alone, or in combination of two or more thereof:


(TM3P),

(TE3P),

(T3P),

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In some embodiments, based on the total weight of the electrolyte, the content of the cyclic phosphonic anhydride is not less than about 0.01 wt %

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or not less than about 0.1 wt%. In some embodiments, the content of the cyclic phosphonic anhydride is not less than about 0.3 wt% or not less than about 0.5 wt%. In some embodiments, the content of the cyclic phosphonic anhydride is not greater than about 4 wt% or not greater than about 3wt%.

Other additives

The electrolyte of the present application may further comprises one or more selected from the group consisting of: a cyclic carbonate ester having a carbon-carbon double bond, a fluoro chain carbonate ester, a fluorinated cyclic carbonate ester, or a compound having a sulfur-oxygen double bond.

In some embodiments, the cyclic carbonate ester having a carbon-carbon double bond useful in the present application includes, but is not limited to: vinylene carbonate, methyl vinylene carbonate, ethyl vinylene carbonate, 1,2-dimethyl vinylene carbonate, 1,2-diethyl vinylene carbonate, fluorovinylene carbonate, and trifluoromethylvinylene carbonate; vinyl ethylene carbonate, 1-methyl-2-vinylethylene carbonate, 1-ethyl-2-vinylethylene carbonate, 1-n-propyl-2-vinylethylene carbonate, 1-methyl-2-vinylethylene carbonate, 1,1-divinylethylene carbonate, and 1,2-divinylethylene carbonate; and 1,1-dimethyl-2-methylene ethylene carbonate, and 1,1-diethyl-2-methylene ethylene carbonate. The cyclic carbonate ester having a carbon-carbon double bond may be used alone or in combination of two or more thereof.

In some embodiments, based on the total weight of the electrolyte, the content of the cyclic carbonate ester having a carbon-carbon double bond is not less than about 0.01 wt%, not less than about 0.1 wt%, or not less than about 0.3 wt%. In some embodiments, the content of the cyclic carbonate ester having a carbon-carbon double bond is not less than about 0.5 wt%. In some embodiments, the content of the cyclic carbonate ester having a carbon-carbon double bond is not greater than about 5 wt%, not greater than about 3 wt%, or not greater than about 1 wt%.

In some embodiments, the fluorinated chain carbonate ester according

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to the present application includes, but is not limited to: fluoromethmetyl carbonate, difluoromethmethyl carbonate, trifluoromethmethyl carbonate, trifluoroethmethyl carbonate, or bis(trifluoroethyl) carbonate. The fluorinated chain carbonate ester may be used alone or in combination of two or more thereof.

In some embodiments, based on the total weight of the electrolyte, the content of the fluorinated chain carbonate ester is not less than about 0.01wt% or not less than about 0.1wt%. In some embodiments, the content of the fluorinated chain carbonate ester is not less than about 0.3 wt%. In some embodiments, the content of the fluorinated chain carbonate ester is not less than about 0.5 wt%. In some other embodiments, the content of the fluorinated chain carbonate ester is not greater than about 3 wt% or not greater than about 5 wt%. In some other embodiments, the content of the fluorinated chain carbonate ester is not greater than about 1 wt%. In some embodiments, the fluorinated cyclic carbonate ester according to the present application includes, but is not limited to, fluoroethylene carbonate, 4,4-difluoroethylene carbonate, 4,5-difluoroethylene carbonate, 4-fluoro-4-methylethylene carbonate, 4,5-difluoro-4-methylethylene carbonate, 4-fluoro-5-methylethylene carbonate, 4,4-difluoro-5-methylethylene carbonate, 4-(fluoromethyl)-ethylene carbonate, 4-(difluoromethyl)-ethylene carbonate, 4-(trifluoromethyl)-ethylene carbonate, 4-(fluoromethyl)-4-fluoroethylene carbonate, 4-(fluoromethyl)-5-fluoroethylene carbonate, 4-fluoro-4,5-dimethylethylene carbonate, 4,5-difluoro-4,5-dimethylethylene carbonate, and 4,4-difluoro-5,5-dimethylethylene carbonate. The fluorinated cyclic carbonate esters may be used alone or in combination of two or more thereof.

In some embodiments, the content of the fluorinated cyclic carbonate ester is not less than about 0.1 wt% based on the total weight of the electrolyte. In some embodiments, the content of the fluoro cyclic carbonate ester is not less than about 0.5 wt%. In some embodiments, the content of the fluorinated cyclic carbonate ester is not less than about 2 wt%. In some embodiments, the content of the fluorinated cyclic carbonate ester is not less

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than about 4 wt%. In some embodiments, the content of the fluorinated cyclic carbonate ester is not greater than about 15 wt%. In some embodiments, the content of the fluorinated cyclic carbonate ester is not greater than about 10 wt%. In some embodiments, the content of the fluorinated cyclic carbonate ester is not greater than about 8 wt%.

In some embodiments, the compound having a sulfur-oxygen double bond according to the present application includes, but is not limited to: a cyclic sulfate ester, a chain sulfate ester, a chain sulfonate ester, a cyclic sulfonate ester, a chain sulfite ester, a cyclic sulfite ester, a chain sulfone, a cyclic sulfones, and so on. The compound having a sulfur-oxygen double bond may be used alone or in combination of two or more thereof.

In some embodiments, based on the total weight of the electrolyte, the content of the compound having a sulfur-oxygen double bond is not less than about 0.01 wt%,. In some embodiments, the content of the compound having a sulfur-oxygen double bond is not less than about 0.1 wt%. In some embodiments, the content of the compound having a sulfur-oxygen double bond is not less than about 0.3 wt%. In some embodiments, the content of the compound having a sulfur-oxygen double bond is not less than about 0.5 wt%. In some other embodiments, the content of the compound having a sulfur-oxygen double bond is not greater than about 5 wt%. In some embodiments, the content of the compound having a sulfur-oxygen double bond is not greater than about 4 wt%. In some embodiments, the content of the compound having a sulfur-oxygen double bond is not greater than about 3 wt%.

In some embodiments, the cyclic sulfate ester according to the present application includes, but is not limited to: 1,2-ethylene glycol sulfate, 1,2-propylene glycol sulfate, 1,3-propylene glycol sulfate, 1,2-butylene glycol sulfate, 1,3-butylene glycol sulfate, 1,4-butylene glycol sulfate, 1,2-pentylene glycol sulfate, 1,3-pentylene glycol sulfate, 1,4-pentylene glycol sulfate, and 1,5-pentylene glycol sulfate. The cyclic sulfate ester may be used alone or in combination of two or more thereof.

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In some embodiments, the chain sulfate ester according to the present application includes, but is not limited to: a dialkyl sulfate such as dimethyl sulfate, methyl ethyl sulfate, and diethyl sulfate. The chain sulfate ester may be used alone or in combination of two or more thereof.

In some embodiments, the chain sulfonate ester according to the present application includes, but is not limited to: methyl fluorosulfonate, ethyl fluorosulfonate, methyl methanesulfonate, ethyl methanesulfonate, butyl dimesylate, methyl 2-(methylsulfonyloxy)propionate, ethyl 2-(methylsulfonyloxy)propionate, methyl methylsulfonyloxyacetate, ethyl methylsulfonyloxyacetate, phenyl methylsulfonate, and pentafluorophenyl methylsulfonate. The chain sulfonate ester may be used alone or in combination of two or more thereof.

In some embodiments, the cyclic sulfonate ester according to the present application includes, but is not limited to: 1,3-propanesultone, 1-fluoro-1,3-propanesultone, 2-fluoro-1,3-propanesultone, 3-fluoro-1,3-propanesultone, 1-methyl-1,3-propanesultone, 2-methyl-1,3-propanesultone, 3-methyl-1, 3-propanesultone, 1-propene-1,3-sultone, 2-propene-1,3-sultone, 1-fluoro-1-propene-1,3-sultone, 2-fluoro-1-propene-1,3-sultone, 3-fluoro-1-propene-1,3-sultone, 1-fluoro-2-propene-1,3-sultone, 2-fluoro-2-propene-1,3-sultone, 3-fluoro-2-propene-1,3-sultone, 1-methyl-1-propene-1,3-sultone, 2-methyl-1-propene-1,3-sultone, 3-methyl-1-propene-1,3-sultone, 1-methyl-2-propene-1,3-sultone, 2-methyl-2-propene-1,3-sultone, 3-methyl-2-propene-1,3-sultone, 1,4-butane sultone, 1,5-pentane sultone, methylene methanedisulfonate, and ethylene methanedisulfonate. The cyclic sulfonate ester may be used alone or in combination of two or more thereof.

In some embodiments, the chain sulfite ester according to the present application includes, but is not limited to: dimethyl sulfite, methyl ethyl sulfite, and diethyl sulfite. The chain sulfite ester may be used alone or in combination of two or more thereof.

In some embodiments, the cyclic sulfite ester according to the present application includes, but is not limited to: 1,2-ethylene glycol sulfite, 1,2-

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propylene glycol sulfite, 1,3-propylene glycol sulfite, 1,2-butylene glycol sulfite, 1,3-butylene glycol sulfite, 1,4-butylene glycol sulfite, 1,2-pentylene glycol sulfite, 1,3-pentylene glycol sulfite, 1,4-pentylene glycol sulfite, and 1,5-pentylene glycol sulfite. The cyclic sulfite ester may be used alone or in combination of two or more thereof.

In some embodiments, the chain sulfone ester according to the present application includes, but is not limited to: a dialkyl sulfone compound such as dimethyl sulfone, and diethyl sulfone.

In some embodiments, the cyclic sulfone according to the present application includes, but is not limited to: sulfolane, methyl sulfolane, 4,5-dimethyl sulfolane, and sulfolene. The cyclic sulfone may be used alone or in combination of two or more thereof.

Electrolyte

The electrolyte used in the electrolyte according to the embodiments of the present application may be an electrolyte known in the prior art, including, but not limited to: an inorganic lithium salt, for example $LiClO_4$, $LiAsF_6$, $LiPF_6$, $LiBF_4$, $LiSbF_6$, $LiSO_3F$, and $LiN(FSO_2)_2$; a fluorine-containing organic lithium salt, for example $LiCF_3SO_3$, $LiN(FSO_2)(CF_3SO_2)$, $LiN(CF_3SO_2)_2$, $LiN(C_2F_5SO_2)_2$, cyclic lithium 1,3-hexafluoropropane disulfonimide, cyclic lithium 1,2-tetrafluoroethane disulfonimide, $LiN(CF_3SO_2)(C_4F_9SO_2)$, $LiC(CF_3SO_2)_3$, $LiPF_4(CF_3)_2$, $LiPF_4(C_2F_5)_2$, $LiPF_4(CF_3SO_2)_2$, $LiPF_4(C_2F_5SO_2)_2$, $LiBF_2(CF_3)_2$, $LiBF_2(C_2F_5)_2$, $LiBF_2(CF_3SO_2)_2$, and $LiBF_2(C_2F_5SO_2)_2$; and a lithium salt containing a dicarboxylic acid complex, for example, lithium bis(oxalato)borate, lithium difluoro(oxalato)borate, lithium tris(oxalato)phosphate, lithium difluorobis(oxalato)phosphate, and lithiumtetrafluoro(oxalato)phosphate. In addition, the electrolyte may be used alone or in combination of two or more thereof. For example, in some embodiments, the electrolyte includes a combination of $LiPF_6$ and $LiBF_4$. In some embodiments, the electrolyte includes a combination of an inorganic lithium salt such as $LiPF_6$ or $LiBF_4$ and a fluorine-containing organic lithium

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salt such as $LiCF_3SO_3$, $LiN(CF_3SO_2)_2$, or $LiN(C_2F_5SO_2)_2$. In some embodiments, the concentration of the electrolyte is in the range of about 0.8-about 3 mol/L, for example, about 0.8-about 2.5 mol/L, about 0.8-about 2 mol/L, about 1-about 2 mol/L, for example, 1 mol/L, 1.15 mol/L, 1.2 mol/L, 1.5 mol/L, 2 mol/L or 2.5 mol/L.

Solvent

The solvent used in the electrolyte according to the embodiments of the present application may be any non-aqueous solvent known in the art as a solvent for an electrolyte.

In some embodiments, the non-aqueous solvent useful in the present application includes, but is not limited to: a cyclic carbonate ester, a chain carbonate ester, a cyclic carboxylate ester, a chain carboxylate ester, a cyclic ether, a chain ether, a phosphorus-containing organic solvent, a sulfur-containing organic solvent, an aromatic fluorine-containing solvent or any combination thereof.

In some embodiments, the cyclic carbonate ester according to the present application generally has 3-6 carbon atoms, and includes, but is not limited to: for example, ethylene carbonate, propylene carbonate, butylene carbonate, and other cyclic carbonates.

In some embodiments, the chain carbonate ester according to the present application includes, but is not limited to: a chain carbonate ester such as dimethyl carbonate, ethyl methyl carbonate, diethyl carbonate, methyl n-propyl carbonate, ethyl n-propyl carbonate, and di-n-propyl carbonate; and a fluorinated chain carbonate ester, for example, bis(fluoromethyl) carbonate, bis(difluoromethyl) carbonate, bis(trifluoromethyl) carbonate, bis(2-fluoroethyl) carbonate, bis(2,2-difluoroethyl) carbonate, bis(2,2,2-trifluoroethyl) carbonate, 2-fluoroethylmethyl carbonate, 2,2-difluoroethylmethyl carbonate, and 2,2,2-trifluoroethylmethyl carbonate.

In some embodiments, the cyclic carboxylate ester according to present application includes, but is not limited to: γ-butyrolactone, γ-valerolactone,

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and the like, and a cyclic carboxylate ester some hydrogen atoms of which are substituted with fluorine.

In some embodiments, the chain carboxylate ester according to the present application includes, but is not limited to: methyl acetate, ethyl acetate, propyl acetate, isopropyl acetate, butyl acetate, sec-butyl acetate, isobutyl acetate, tert-butyl acetate, methyl propionate, ethyl propionate, propyl propionate, isopropyl propionate, methyl butyrate, ethyl butyrate, propyl butyrate, methyl isobutyrate, ethyl isobutyrate, methyl valerate, ethyl valerate, methyl pivalate and ethyl pivalate or the like, and a chain carboxylate ester some hydrogen atoms of which are substituted with fluorine. The fluorinated chain carboxylate ester includes, but is not limited to: methyl trifluoroacetate, ethyl trifluoroacetate, propyl trifluoroacetate, butyl trifluoroacetate and 2,2,2-trifluoroethyl trifluoroacetate.

In some embodiments, the cyclic ether according to the present application includes, but is not limited to: tetrahydrofuran, 2-methyltetrahydrofuran, 1,3-dioxolane, 2-methyl-1,3-dioxolane, 4-methyl-1,3-dioxolane, 1,3-dioxane, 1,4-dioxane and dimethoxypropane. In some embodiments, the chain ether according to the present application includes, but is not limited to: dimethoxymethane, 1,1-dimethoxyethane, 1,2-dimethoxyethane, diethoxymethane, 1,1-diethoxyethane, 1,2-di ethoxyethane, ethoxymethoxymethane, 1,1-ethoxymethoxyethane and 1,2-ethoxymethoxyethane.

In some embodiments, the phosphorus-containing organic solvent according to the present application includes, but is not limited to: trimethyl phosphate, triethyl phosphate, dimethyl ethyl phosphate, methyl diethyl phosphate, ethylene methyl phosphate, ethylene ethyl phosphate, triphenyl phosphate, trimethyl phosphite, triethyl phosphite, triphenyl phosphite, tris(2,2,2-trifluoroethyl) phosphate and tris(2,2,3,3,3-pentafluoropropyl) phosphate.

In some embodiments, the sulfur-containing organic solvent according to the present application includes, but is not limited to: sulfolane, 2-

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methylsulfolane, 3-methylsulfolane, dimethyl sulfone, diethyl sulfone, ethyl methyl sulfone, methyl propyl sulfone, dimethyl sulfoxide, methyl methanesulfonate, ethyl methanesulfonate, methyl ethanesulfonate, ethyl ethanesulfonate, dimethyl sulfate, diethyl sulfate and dibutyl sulfate, as well as a sulfur-containing organic solvent some hydrogen atoms of which are substituted with fluorine.

In some embodiments, the aromatic fluorine-containing organic solvent according to the present application includes, but is not limited to: fluorobenzene, difluorobenzene, trifluorobenzene, tetrafluorobenzene, pentafluorobenzene, hexafluorobenzene, and trifluoromethylbenzene.

In some embodiments, the non-aqueous solvent of the present application may be used alone, or in combination of two or more thereof:

II. Electrochemical device

The electrochemical device of the present invention includes any device in which an electrochemical reaction takes place, and 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. In some embodiments, the electrochemical device of the present application is an electrochemical device having a cathode having a cathode active material capable of absorbing and releasing metal ions; an anode having a anode active material capable of absorbing and releasing metal ions, and characterized by comprising any of the electrolytes of the present application.

Electrolyte

The electrolyte used in the electrochemical device of the present application is any of the aforementioned electrolytes according to the present application. Moreover, the electrolyte used in the electrochemical device of the present application may include other electrolytes falling within the

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scope of present application.

Anode

The anode material used in the electrochemical device according to the embodiments of the present application can be prepared using materials, construction and manufacturing methods well known in the art. For example, the anode of the present application can be prepared using the technique described in US9812739B, the entire contents of which are incorporated herein by reference.

In some embodiments, the anode active material is any substance capable of electrochemically absorbing and releasing a metal ion such as lithium ion. In some embodiments, the anode active material includes a carbonaceous material, a silicon-carbon material, an alloy material or a lithium-containing metal composite oxide material. In some embodiments, the anode active material includes one or more of those described above.

In some embodiments, the anode can be formed by adding a binder and a solvent to, and if necessary, adding a thickener, a conductive material, a filler, or the like the anode active material, to prepare a slurry, coating the slurry to a current collector, drying, and then pressing.

In some embodiments, when the anode includes an alloy-based material, a thin film layer (anode active material layer) as an anode active material can be formed by vapor deposition, sputtering, or plating.

In some embodiments, when the anode includes lithium metal, an anode active material layer is formed from, for example, a conductive skeleton of twisted spherical shape and metal particles dispersed in the conductive skeleton, wherein the conductive skeleton of twisted spherical shape may have a porosity of about 5% to about 85%, and a protective layer may be further disposed on the anode active material layer of lithium metal.

Cathode

The cathode material used in the electrochemical device of the present

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application can be prepared using materials, construction and manufacturing methods well known in the art. In some embodiments, the cathode of the present application can be prepared using the technique described in US9812739B, the entire contents of which are incorporated herein by reference.

In some embodiments, the cathode active material includes, but is not limited to: a sulfide, a phosphate salt compound and a lithium-transition metal composite oxide. In some embodiments, the cathode active material includes a lithium-transition metal compound which has a structure capable of removing and intercalating lithium ions. In some embodiments, the composition of the lithium-transition metal compound can refer to the technical content described in US9812739B.

In some embodiments, the cathode is prepared by forming a cathode material from a cathode active material layer including a lithium-transition metal compound powder and a binder on a current collector.

In some embodiments, the cathode active material layer can generally be produced by: dry mixing a cathode material and a binder (and a conductive material and a thickener, if necessary) to form flakes, pressing the obtained flakes on a cathode current collector or dissolving or dispersing the material in a liquid medium to form a slurry, coating the slurry on a cathode current collector, and drying. In some embodiments, the material of the cathode active material layer includes any material known in the art. In some embodiments, the cathode active material layer includes materials described in US9812739B.

Electrode compaction density

The electrochemical device of the present application comprises a cathode and an anode, a separator and an electrolyte. The electrode includes a current collector and a coating on the current collector. The coating includes a single-sided coating, a double-sided coating, or a combination thereof. The single-sided coating is a coating formed by applying a slurry on

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one surface of the current collector. The double-sided coating is a coating formed by applying a slurry on two opposite surfaces of the current collector.

In some embodiments, as shown in Fig. 2, an electrode A includes a current collector 1 and a coating 2 on the current collector 1. As shown in Fig. 2, the coating 2 is only present on one surface of the current collector, and such coating is a single-sided coating.

In some embodiments, as shown in Fig. 3, an electrode B includes a current collector 1 and a coating 2 on the current collector. As shown in Fig. 3, the coating 2 is present on two opposite surfaces of the current collector, and such coating is a double-sided coating.

In some embodiments, as shown by an electrode C in Fig. 4, one surface of a portion of a current collector 1 is coated with a slurry to form a coating 2 and the two opposite surfaces of the other portion of the current collector 1 are coated with a slurry to form a coating 2. Such coating includes both a single-sided coating and a double-sided coating.

In a wound electrochemical device, the cathode and the cathode are usually each formed by winding an elongated electrode, so that both a single-sided coating and a double-sided coating are present on the elongated electrode. In a laminated electrochemical device, the cathode and the anode are usually formed by laminating-shaped electrodes, and there is only a single-sided coating or a double-sided coating on the same electrode. In an electrochemical device in which the wound and laminated electrode s are assembled in combination, the cathode and anode generally comprise an elongated electrode having both a single-sided coating and a double-sided coating, and a -shaped electrode having only a single-sided coating or a double-sided coating.

The electrode has an electrode compaction density. The electrode compaction density is obtained by: measuring the thickness of an electrode using a precise measurement tool, such as a ten-thousandths micrometer; then taking the electrode of a certain area and accurately measuring the

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area and weight; and calculating the electrode compaction density by a formula below:

Electrode compaction density = (Weight of electrode - Weight of current collector) / Area of electrode /(Thickness of electrode - Thickness of current collector)

A lower compaction density makes the porosity higher, making some of the particles in an insulating state, and unable to participate in charge and discharge, thereby resulting in a low specific discharge capacity, thus affecting the performance of the electrochemical device. A too high compaction density may cause difficulty in infiltrability of the electrolyte and decrease in solution retention, such that the cycle and rate performances cannot be guaranteed. Properly controlling the electrodecompaction density of the single-sided and double-sided coating is important to obtain electrochemical devices with high capacity density, and excellent cycle and storage performances.

In some embodiments, the electrode with a single-sided coating has an electrode compaction density D1, and an electrode with a double-sided coating has an electrode compaction density D2, and D1 and D2 meet the relationship: about $0.8 \leq D1/D2 \leq$ about 1.2, under this circumstance, the effects of the cathode and anode active materials are well exerted, so that the electrode can obtain good electrical conductivity, which is also important to control the expansion of electrochemical devices. Therefore, the obtained electrochemical device has high capacity density and excellent cycle and storage performances.

In some embodiments, D1 and D2 meet the relationship: about $0.9 \leq$ D1/D2 $\leq$ about 1.1. Under this circumstance, the performance of the electrochemical device can be further improved.

In some embodiments, D1 and D2 meet the relationship: about $0.9 \leq$ D1/D2 $\leq$ about 1.1.

In some embodiments, D1 and D2 meet the relationship: about $0.95 \leq$

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D1/D2 ≤ about 1.05. Under this circumstance, the distributions of pores and pore sizes in the single-sided coating and the double-sided coating are more uniform, the distributions of the conductive agent and the binder are more uniform, the contact resistance and charge exchange resistance of the electrode are lowered, and the active area capable of participating in the reaction is increased, thereby significantly improving the electrochemical performance of the material and further improving the performances of the electrochemical device.

In some embodiments, the electrode may be a cathode or an anode. When the electrode is a cathode, about 3.5 g/cm^3 ≤ D2 ≤ about 4.3 g/cm^3. When D2 is within this range, the cathode can have good electrical conductivity, and the effect of the cathode active material can be well exerted. When the electrode is an anode, about 1.2 g/cm^3 ≤ D2 ≤ about 1.8 g/cm^3. When D2 is within this range, the anode can have a higher breaking strength, thereby preventing the electrode particles from falling off during the cycle.

Separator

In some embodiments, the electrochemical device of the present application is provided with a separator between the positive electrode and the negative electrode to prevent short circuit. The material and shape of the separator used in the electrochemical device of the present application are not particularly limited, and may be any of the techniques disclosed in the prior art. In some embodiments, the separator includes a polymer or an inorganic substance or the like formed from a material which is stable to the electrolyte of the present application.

For example, the separator may include a substrate layer and a surface treatment layer. The substrate layer is a non-woven fabric, film, or composite film having a porous structure, and the material of the substrate layer is at least one selected from polyethylene, polypropylene, polyethylene terephthalate, and polyimide. Particularly, a porous polypropylene film, a porous polyethylene film, a polypropylene nonwoven fabric, a polyethylene

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nonwoven fabric, or a porous polypropylene-polyethylene-polypropylene composite film may be used.

At least one surface of the substrate layer is provided with a surface treatment layer, which may be a polymer layer or an inorganic layer, or a layer formed by mixing a polymer and an inorganic substance.

The inorganic layer comprises inorganic particles and a binder. The inorganic particles are one or more selected from alumina, silica, magnesia, titanium oxide, hafnium dioxide, tin oxide, cerium dioxide, nickel oxide, zinc oxide, calcium oxide, zirconia, yttria, silicon carbide, boehmite, aluminum hydroxide, magnesium hydroxide, calcium hydroxide and barium sulfate. The binder is one or more selected from polyvinylidene fluoride, a copolymer of vinylidene fluoride-hexafluoropropylene, a polyamide, polyacrylonitrile, a polyacrylate ester, polyacrylic acid, a polyacrylate salt, polyvinylpyrrolidone, polyvinyl ether, polymethyl methacrylate, polytetrafluoroethylene, and polyhexafluoropropylene. The polymer layer contains a polymer, and the material of the polymer includes at least one of a polyamide, polyacrylonitrile, a polyacrylate ester, polyacrylic acid, a polyacrylate salt, polyvinylpyrrolidone, polyvinyl ether, polyvinylidene fluoride or poly(vinylidene fluoride-hexafluoropropylene).

III. Application

At a high voltage, the oxidizability of the cathode material is increased, and the stability is lowered, which makes the electrolyte easily decompose on the surface of the positive electrode or results in deterioration of the materials of the electrochemical device, so that the capacity of the electrochemical device is decreased. Prior to the present application, the primary solution is to add a film-forming additive to the electrolyte. However, doing so will cause an increase in the DC internal resistance of the battery, thereby resulting in a decrease in the cycle performance and a decrease in the capacity retention rate.

The electrolyte according to the embodiments of the present application

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can be used to inhibit the increase in DC internal resistance of an electrochemical device, and thus applicable to an electronic device comprising the electrochemical device.

The use of the electrochemical device according to the present application is not particularly limited, and can be used in various known applications, such as notebook computers, pen-input computers, mobile computers, e-book players, portable phones, portable fax machines, portable copiers, portable printers, head-mounted stereo headphones, video recorders, LCD TVs, portable cleaners, portable CD players, Mini discs, transceivers, electronic notebooks, calculators, memory cards, portable recorders, radios, backup power sources, motors, vehicles, motorcycles, motorbicycle, bicycles, lighting apparatus, toys, game consoles, clocks, electric tools, flashing light, cameras, large batteries for household use, or lithium ion capacitors.

Examples

Hereinafter, the present application will be specifically described by way of examples and comparative examples; however, the present application is not limited thereto as long as they do not deviate from the spirit of the present application.

1. Preparation of lithium-ion battery

(1) Preparation of an anode

Graphite, conductive carbon black (Super-P), styrene-butadiene rubber, and sodium carboxymethyl cellulose (CMC) were mixed at a weight ratio of about 95: 2:2:1 in deionized water as a solvent, and stirred uniformly, to obtain an anode slurry. The slurry was coated on a copper foil having a thickness of about 12 μm, dried, cold pressed, and cut, and then a tab was welded, to obtain an anode.

(2) Preparation of a cathode

Lithium cobalt oxide ($LiCoO_2$), conductive carbon black (Super-P), and

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polyvinylidene fluoride (PVDF) were mixed at a weight ratio of about 95:2:3 in N-methylpyrrolidone as a solvent, and stirred uniformly, to obtain a cathode slurry. The slurry was coated on an aluminum foil having a thickness of about 12 μm, dried, cold pressed, and cut, and then a tab was welded, to obtain a cathode.

(3) Preparation of an electrolyte:

Under a dry argon atmosphere, EC, PC, and DEC (at a weight ratio of about 1:1:1) were mixed, and then $LiPF_6$ was added and mixed uniformly, to form a basic electrolyte, in which the concentration of $LiPF_6$ is 1.15 mol/L. Different amounts of substances shown in Tables 1-1 to 9 were added to the basic electrolyte to obtain the electrolytes of different examples and comparative examples, wherein the contents of each substance in the electrolyte described below were obtained based on the total weight of the electrolyte.

(4) Preparation of a separator

A porous PE polymer film was used as a separator.

(5) Preparation of lithium-ion battery

The obtained cathode, anode and separator were wound in sequence and placed in the outer packaging foil, with a liquid injection port being left. The electrolyte was injected via the liquid injection port, encapsulated, formed and capacity graded to obtain a lithium ion battery. The fresh battery herein refers to a battery which is obtained through aforementioned preparation process and is ready for shipping.

2. Test methods of battery performance

(1) Test method for change in DC internal resistance at 20% SOC

At 25°C, the battery was charged to 4.45 V at a constant current of 1 C (nominal capacity) and then charged to a current of ≤ 0.05 C at a constant voltage of 4.45 V, allowed to stand for 5 min, and discharged to a cut-off

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voltage of 3 V at a constant current of 1 C. The actual discharge capacity was recorded. The battery was adjusted to 50% of the full charge capacity required with the actual capacity, continuously discharged for 10s at a current of 0.3C. The DC internal resistances (DCIRs) (average of the measurements from 15 batteries) after one cycle, 200 cycles and 400 cycles was obtained by dividing the current with the difference between the voltage before discharge and the voltage at the end of discharge, .

(2) Test method for storage performance at high temperature of 60°C

The battery was allowed to stand at 25°C for 30 minutes, charged to 4.45 V at a constant current of 0.5 C and then charged to 0.05 C at a constant voltage of 4.45 V, allowed to stand for 5 minutes, and then stored at 60°C for 21 days. The thickness expansion rate of the battery was measured and calculated by a formula below:

Thickness expansion rate =[(Thickness after storage-Thickness before storage)/Thickness before storage] x 100%

(3) Test method for battery capacity retention rate

At 45°C, the battery was charged to 4.45 V at a constant current of 1 C and then charged to a current of 0.05 C at a constant voltage, and discharged to 3.0 V at a constant current of 1 C, the above being the first cycle. Multiple cycles were performed on the battery under the above conditions. The capacity retention rate of the fresh battery and the battery after 200 cycles and 400 cycles was calculated respectively. The capacity retention rate after cycles is calculated by a formula below:

Capacity retention rate after the cycle = (Discharge capacity after corresponding cycles / Discharge capacity after the first cycle) x 100%

(4) Test method for voltage drop

At 25°C, the battery was charged to 4.45 V at a constant current of 1 C and then charged to a current of 0.05 C at a constant voltage, discharged to 3.2 V at a constant current of 1 C, and allowed to stand for 5 minutes. Then

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the voltage was tested, and after 24 h's storage at 85°C, the voltage was tested again. Voltage drop = Voltage before storage - Voltage after storage.

(5) Intermittent cycle test method

At 50°C, the lithium ion battery was charged to 4.45 V at a constant voltage of 0.5 C and then to a cut-off current of 0.05 C at a constant current, allowed to stand for 20 h, and then discharged to 3.0 V at a constant current of 0.5 C. Repeating charge/discharge as above, the capacity retention rate of the fresh battery, and the battery after 30, 50, and 100 cycles was calculated respectively. Capacity retention rate after cycles = (Discharge capacity after corresponding cycles / Discharge capacity of the first cycle) x 100%

3. Test results

The abbreviations for the chemical materials used in the examples of present application are shown in the following two tables:

Material	Abbreviation	Material Name	Abbreviation
Ethylene carbonate	EC	1,3-propanesultone	PS
Propylene carbonate	PC	Ethylene sulfate	DTD
Ethyl methyl carbonate	EMC	Butanedinitrile	SN
Dimethyl carbonate	DMC	Adiponitrile	ADN
		1,4-dicyano-2-butene	DCB
Diethyl carbonate	DEC	1,3,6-Hexanetricarbonitrile	HTCN-1
γ-butyrolactone	GBL	1,2,6- Hexanetricarbonitrile	HTCN-2
γ-valerolactone	VL	1,3,5-Pentanetricarbonitrile	PTCN
Ethyl propionate	EP	Ethylene glycol bis(2-cyanoethyl) ether	EDN
Propyl propionate	PP	1,1-difluoro-2,2-difluoroethyl-2',2'difluoro-3',3'-difluoropropyl ether	FEPE
		2-trifluoromethyl-3-methoxyperfluoropentane	TMMP
		2-(trifluoro-2-fluoro-3-difluoro)-3-difluoro-4-fluoro-5-trifluoropentane	TPTP
Vinylene carbonate	VC	1-Propylphosphonic cyclic anhydride	T3P

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Fluoroethylene carbonate	FEC	1-Methylphosphonic cyclic anhydride	TM3P
		1-Ethylphosphonic cyclic anhydride	TE3P
		1,2,3-tris(2-cyanoethoxy)propane	TCEP

Dinitrile compound	A	A_1: SN; A_2: ADN; A_3: EDN; A_4: DCB
Trinitrile compound	B	B_1: HTCN-1; B_2: HTCN-2; B_3: PTCN; B_4: TCEP
Propyl propionate (PP)	C	
Fluoroether	D	D_1: FEPE; D_2: TMMP; D_3: TPTP
Cyclic phosphonic anhydride	E	E_1: T3P E_2: TM3P; E_3: TE3P
Other additives	F	F_1: VC; F_2: PS; F_3: DTD
Cyclic carboxylate ester	H	H_1: GBL; H_2: VL
Single- and double-side compaction density	G	

(1) Different amounts of a compound comprising two cyano groups, a compound comprising three cyano groups and/or propyl propionate as shown in Tables 1-1 and 1-2 were added to the basic electrolyte. The electrolyte was injected into a battery prepared according to the above method. The DC internal resistance at 20% SOC of the batteries was tested. The test results are shown in Tables 1-1 and 1-2.

Table 1-1

	A_1 (X wt%)	B_1 (Y wt%)	C (Z wt%)	X+Y	X/Y	DC internal resistance (mΩ) at 20% SOC		
						Fresh Battery	After 200 cycles	After 400 cycles
S1-1	4	1	30	5	4	50.8	84.3	91.2
S1-2	4	2	30	6	2	54.4	88.0	98.6
S1-3	4	3	30	7	1.3	55.7	88.9	99.4
S1-4	4	0.5	30	4.5	8	57.8	92.0	101.0
S1-5	3	0.5	30	3.5	6	57.1	91.2	93.5
S1-6	4	0.4	30	4.2	10	55.9	99.4	112.8
S1-7	3	2	30	5	1.5	52.3	84.4	91.5

S1-8	2	2	30	4	1	51.9	84.2	91.4
S1-9	1	2	30	3	0.5	52.3	86.5	92.4
S1-10	0.5	2	30	2.5	0.25	54.8	79.4	102.5
S1-11	0.2	2	30	2.2	0.1	59.2	91.8	105.3
S1-12	1	5	30	6	0.2	58.5	97.0	104.1
S1-13	7	3	30	10	2.3	60.4	92.9	107.3
D1-1	0	0	0	0	0	63.8	140.9	190.4
D1-2	0	1	0	1	0	62.3	138.5	188.2
D1-3	4	0	0	4	0	61.8	136.5	184.2
D1-4	0.1	1	0	1.1	0.1	63.8	120.9	126.4
D1-5	4	0.1	0	4.1	40	68.3	109.8	124.9
D1-6	7	5	0	12	1.4	69.2	112.3	133.0
D1-7	1	11	0	12	0.09	63.8	100.9	139.3
D1-8	11	1	0	12	10	72.0	116.3	135.4

Tables 1-2

	A (X wt%)	B (Y wt%)	C (Z wt%)	X+Y	X/Y	DC internal resistance (mΩ) at 20% SOC		
						Fresh Battery	After 200 cycles	After 400 cycles
S1-14	A_2(4)	B_2 (3)	30	7	1.3	55.5	88.1	98.7
S1-15	A_2(4)	B_2 (0.5)	30	4.5	8	57.2	91.6	100.6
S1-16	A_2(3)	B_2 (0.5)	30	3.5	6	55.9	89.4	98.8
S1-17	A_3(3)	B_3 (2)	30	5	1.5	51.1	82.6	90.7
S1-18	A_3 (2)	B_3 (2)	30	4	1	51.2	83.3	90.5
S1-19	A_3 (1)	B_3 (2)	30	3	0.5	51.3	85.1	91.1
S1-20	A_3 (0.5)	B_4 (2)	30	2.5	0.25	54.3	79.1	90.1
S1-21	A_2 (0.2)	B_2 (2)	30	2.2	0.1	58.5	91.2	104.8
S1-22	A_2 (1)	B_2 (5)	30	6	0.2	58.1	96.5	103.3
S1-23	A_2 (7)	B_2 (3)	30	10	2.3	60.2	92.3	106.5
S1-24	A_4(2)	B_3 (2)	30	4	1	57.9	86.1	93.4

As shown in Table 1-1, in Comparative Examples D1-1 to D1-8, butanedinitrile or 1,3,6-hexanetricarbonitrile was added alone, and no propyl propionate was added. The DC internal resistance of the battery was significantly increased after cycles.

When butanedinitrile, 1,3,6-hexanetricarbonitrile and propyl propionate were used in Examples S1-1 to S1-13 simultaneously, the increase in DC

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internal resistance of the battery after cycles was obviously inhibited.

When the propyl propionate content is kept unchanged, and the relation between the butanedinitrile content X and the 1,3,6-hexanetricarbonitrile content Y is adjusted, it is found that when X and Y meet the conditions represented by both Formula (1) and Formula (2): {about 2 wt% ≤ (X+Y) ≤ about 11 wt% ...(1); and about 0.1 ≤ (X/Y) ≤ about 8 ...(2)}, the inhibition effect on the increase in DC internal resistance of the battery after cycles is remarkable. When X and Y meet about 2 wt% ≤ (X+Y) ≤ about 8 wt% and about 0.1 ≤ (X/Y) ≤ about 6, the combination of the additives can exhibit synergistic effect and can sufficiently suppress the increase in DC internal resistance.

Fig. 1A shows the DC internal resistances of fresh batteries of Examples S1-1 and S1-2 of the present application and Comparative Example D1-1 at different charge states (10% SOC, 20% SOC, and 70% SOC). Fig. 1B shows the DC internal resistances of batteries of Examples S1-1 and S1-2 of the present application and Comparative Example D1-1 at different charge states (10% SOC, 20% SOC, and 70% SOC) after 200 cycles of charge and discharge. Fig. 1C shows the DC internal resistances of batteries of Examples S1-1 and S1-2 of the present application and Comparative Example D1-1 at different charge states (10% SOC, 20% SOC, and 70% SOC) after 400 cycles of charge and discharge. It can be seen that the increase in DC internal resistance during cycles in Examples S1-1 and S1-2 is significantly improved compared with Comparative Example D1-1.

As shown in Table 1-2, when the dinitrile compound is adiponitrile or ethylene glycol bis(2-cyanoethyl)ether, and the trinitrile compound is 1,2,6-hexanetricarbonitrile, 1,3,6-Hexanetricarbonitrile, or 1,2,3-tris(2-cyanoethoxy)propane, the effect of inhibiting the increase in DC internal resistance can also be achieved. When the dinitrile compound is ethylene glycol bis(2-cyanoethyl)ether, or the trinitrile compound is 1,2,3-tris(2-cyanoethoxy)propane, the effect of inhibiting the increase in DC internal resistance of the battery after cycles is more significant.

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(2) Different amounts of a compound comprising two cyano groups, a compound comprising three cyano groups and/or propyl propionate as shown in Table 2 were added to the basic electrolyte. The electrolyte was injected into a battery prepared according to the above method. The DC internal resistance at 20% SOC of the battery was tested. The test results are shown in Table 2.

Table 2

	C (Z wt%)	A_1 (X wt%)	B_1 (Y wt%)	Y/Z	DC internal resistance (mΩ) at 20% SOC		
					Fresh battery	After 200 cycles	After 400 cycles
S1-1	30	4	1	0.03	50.8	84.3	91.2
S2-1	5	4	1	0.2	68.7	85.2	97.6
S2-2	10	4	1	0.1	60.3	83.1	95.7
S2-3	20	4	1	0.05	56.1	81.6	93.9
S2-4	40	4	1	0.025	47.5	78.2	87.2
S2-5	50	4	1	0.02	56.3	82.6	98.3
S2-6	10	4	3	0.3	64.3	89.5	97.7
S2-7	50	4	0.5	0.01	53.2	84.3	94.1
D2-1	4	4	1	0.25	72.1	108.5	118.9
D2-2	60	4	1	0.017	42.0	100.1	113.9
D2-3	10	4	5	0.5	62.3	85.4	111.3
D2-4	50	4	0.1	0.0025	53.2	89.3	109.4

As shown in Table 2, when the content of propyl propionate is within the range of 5 wt% to 50 wt%, the DC internal resistance of the fresh battery decreases continuously with the propyl propionate content increasing. In addition, when the content of the propyl propionate is less than 5 wt% or greater than 50wt%, the DC internal resistance of the battery is greatly increased after 200 cycles, and the performance is deteriorated. The combination of additives can form a cathode protection film so as to reduce the side reactions, thereby effectively controlling the polarization and side reactions of the battery. The ratio of the content of the trinitrile compound to the content of propyl propionate has great effect on the change in DC internal resistance of the battery. When Y/Z is within the range of 0.01-0.3, a better inhibition effect on the increase in DC internal resistance is achieved.

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(3) To the basic electrolyte, 30 wt% of propyl propionate, 4 wt% of butanedinitrile (A1), 1 wt% of 1,3,6-hexanetricarbonitrile (B1) and a fluoroether of different contents as shown in Table 3 were added. The obtained electrolyte was injected to a battery prepared according to the above method. The DC internal resistance at 20% SOC and the 21-day thickness expansion rate at 60°C were tested. The test results are shown in Table 3.

Table 3

	D (content, wt%)	DC internal resistance (mΩ) of fresh battery at 20% SOC	21-day thickness expansion rate at 60°C
S1-1	0	50.8	7.6%
S3-1	D_1(0.1)	50.2	6.2%
S3-2	D_1(0.5)	49.8	6.0%
S3-3	D_1(1)	48.6	5.7%
S3-4	D_1(1.5)	48.5	5.1%
S3-5	D_1(2)	48.4	4.8%
S3-6	D_1(2.5)	48.3	4.9%
S3-7	D_1(3)	48.1	5.6%
S3-8	D_1(5)	49.3	6.8%
S3-9	D_2(1)	49.2	6.1%
S3-10	D_3(1)	49.4	5.7%
D3-1	D_1(6)	51.3	8.5%

As can be seen from Table 3, with the addition of fluoroether (0.1-5 wt%), the DC internal resistance and the thickness expansion rate of the fresh battery are improved to a certain extent, and the storage performance is slightly decreased when the addition amount is large, but it is still within the desired range. When the fluoroether content is more than 5 wt%, the DC internal resistance and the thickness expansion rate after storage at 60°C of the fresh battery are deteriorated.

(4) To the basic electrolyte, 30 wt% of propyl propionate, 4 wt% of butanedinitrile (A1), 1 wt% of 1,3,6-hexanetricarbonitrile (B1) and a cyclic phosphonic anhydride of different contents as shown in Table 4 were added. The obtained electrolyte was injected to a battery prepared according to the above method. The DC internal resistance at 20% SOC and the capacity

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retention ratio of the battery were tested. The test results are shown in Table 4.

Table 4

	E (content, wt%)	DC internal resistance (mΩ) at 20% SOC			Capacity retention rate		
		Fresh battery	After 200 cycles	After 400 cycles	Fresh battery	After 200 cycles	After 400 cycles
S1-1	0	50.8	84.3	91.2	100%	93.5%	86.3%
S4-1	E_1(0.1)	48.3	51.5	88.2	100%	95.7%	90.1%
S4-2	E_1(0.5)	45.4	48.2	82.3	100%	96.3%	91.4%
S4-3	E_1(1)	44.6	47.1	80.5	100%	96.1%	90.7%
S4-4	E_1(2)	45.6	47.3	81.6	100%	95.2%	89.6%
S4-5	E_1(3)	45.9	49.1	89.4	100%	94.7%	88.5%
S4-6	E_2(1)	45.2	48.3	88.3	100%	95.3%	91.0%
S4-7	E_3(1)	45.3	48.7	89.5	100%	95.1%	90.8%
D4-1	E_1(4)	46.1	58.6	105.3	100%	92.1%	85.3%

It can be seen from Table 4 that with the addition of cyclic phosphonic anhydride (0.1-3 wt%), the DC internal resistance of the fresh battery and the battery after cycles is improved to a certain extent, which may be attributed to the relatively stable structure of the composite protective film formed by the combined additives; and the cycle performance is improved first and then deteriorated with the addition of the cyclic phosphonic anhydride. When the content is more than 3 wt%, the cycle performance is affected, which may be caused by the decomposition of the cyclic phosphonic anhydride.

(5) To the basic electrolyte, 30 wt% of propyl propionate, 4 wt% of butanedinitrile (A1), 1 wt% of 1,3,6-hexanetrinitrile (B1) and a fluoroether and a cyclic phosphonic anhydride of different contents as shown in Table 5 were added. The obtained electrolyte was injected to a battery prepared according to the above method. The DC internal resistance at 20% SOC, the 21-day thickness expansion rate at 60°C, and the capacity retention rate of the battery were tested. The test results are shown in Table 5.

Table 5

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	D_1 (content: wt%)	E_1 (content: wt%)	DC internal resistance (mΩ) at 20% SOC			21-day thickness expansion rate at 60°C	Capacity retention rate		
			Fresh battery	After 200 cycles	After 400 cycles		Fresh battery	After 200 cycles	After 400 cycles
S1-1	0	0	50.8	84.3	91.2	7.6%	100%	93.5%	86.3%
S3-1	0.1	0	50.2	83.1	90.4	6.2%	100%	94.2%	87.9%
S4-2	0	0.5	45.4	48.2	82.3	6.7%	100%	96.3%	91.4%
S5-1	0.1	0.5	44.7	47.2	80.8	6.0%	100%	96.4%	91.6%
S5-2	1	0.5	43.8	46.3	80.5	5.3%	100%	96.8%	91.7%
S5-3	1	0.3	44.1	48.2	79.3	4.3%	100%	97.1%	92.3%
S5-4	1	0.1	46.3	50.5	86.2	4.5%	100%	97.6%	92.9%
S5-5	3	2	43.5	47.1	81.3	4.0%	100%	94.8%	89.4%

As can be seen from Table 5, with the addition of the fluoroether and the cyclic phosphonic anhydride, the DC internal resistance, the storage performance and the cycle performance of the fresh battery and the battery after cycles are further improved.

(6) To the basic electrolyte, 30 wt% of propyl propionate, 4 wt% of butanedinitrile (A1), 1 wt% of 1,3,6-hexanetricarbonitrile (B1) and other additives of different contents as shown in Table 6 were added. The obtained electrolyte was injected to a battery prepared according to the above method. The voltage drop after storage at 3.2V and 85°C for 24 h of the battery were tested. The test results are shown in Table 6.

Table 6

	VC (content: wt%)	VEC (content: wt%)	FEC (content: wt%)	PS (content: wt%)	DTD (content: wt%)	Voltage drop after storage at 3.2V and 85°C for 24 hrs
S6-1	0.5	-	-	-	-	0.35V
S6-2	0.5	-	-	3	-	0.32V
S6-3	0.5	-	-	3	0.5	0.23V
S6-4	1	-	-	3	-	0.3V

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S6-5	1	-	3	3	-	0.20V
S6-6	-	0.5	-	3	0.5	0.25V
D6-1	-	-	-	-	-	0.4V

The addition of the film-forming additives VC, VEC, FEC, PS, DTD can further improve the stability of the solid electrolytic interface (SEI) film of the battery. Using a combination of various additives is more conducive to improve the stability of the battery, which is beneficial to the long-term storage of the battery and thus improves the battery reliability.

(7) To the basic electrolyte, 30 wt% of propyl propionate, 4 wt% of butanedinitrile (A1), 1 wt% of 1,3,6-hexanetricarbonitrile (B1) were added. The obtained electrolyte was injected to a battery prepared according to the above method. The electrode compaction density ratio (D1/D2) of the battery was changed according to Table 7, and the capacity retention rate of the battery was tested. The test results are shown in Table 7.

Table 7

	Compaction density ratio (D1/D2)	Capacity retention rate		
		Fresh battery	After 200 cycles	After 400 cycles
S7-1	0.8	100%	93.8%	89.3%
S7-2	0.9	100%	95.3%	90.1%
S7-3	0.95	100%	95.9%	90.8%
S7-4	1.0	100%	96.8%	91.4%
S7-5	1.05	100%	95.8%	90.7%
S7-6	1.1	100%	95.2%	90.2%
S7-7	1.2	100%	93.7%	88.8%
D7-1	1.3	100%	91.2%	83.6%
D7-1	0.7	100%	90.5%	82.7%

As can be seen from Table 7, the electrode compaction density ratio (D1/D2) of the lithium ion battery has a significant effect on the cycle performance of the lithium ion battery. A too large or too small D1/D2 will damage the cycle performance of lithium-ion batteries. It can be seen that when D1/D2 is within the range of 0.8-1.2, a better cycle performance is obtained, possibly because the combined additives facilitate the reduction of the electrode interface resistance and the reduction of the cell polarization.

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(8) To the basic electrolyte, 30 wt% of propyl propionate, 4 wt% of butanedinitrile (A1), 1 wt% of 1,3,6-hexanetricarbonitrile (B1) and a cyclic phosphonic anhydride of different contents as shown in Table 8 were added. The obtained electrolyte was injected to a battery prepared according to the above method. The electrode compaction density ratio (D1/D2) was changed according to Table 8, and the capacity retention rate of the obtained battery was tested. The test results are shown in Table 8.

Table 8

	D_1 (content:)	E_1 (content:)	G	Capacity retention rate		
				Fresh battery	After 200 cycles	After 400 cycles
S8-1	1	-	0.8	100%	94.9%	90.1%
S8-2	1	-	1.0	100%	97.3%	92.5%
S8-3	1	-	1.2	100%	94.8%	89.9%
S8-4	-	0.3	0.8	100%	94.3%	89.6%
S85	-	0.3	1.0	100%	97.9%	92.2%
S8-6	-	0.3	1.2	100%	95.0%	90.5%
S8-7	1	0.3	1.0	100%	98.1%	93.3%

With the addition of the fluoroether or the cyclic phosphonic anhydride, the cycle performance of the lithium ion battery is further improved when the electrode compaction density of the battery is within the range of 0.8-1.2.

(9) To the basic electrolyte, 30 wt% of propyl propionate, 4 wt% of butanedinitrile (A1), 1 wt% of 1,3,6-hexanetricarbonitrile (B1) and a cyclic carboxylate ester of different contents as shown in Table 9 were added. The obtained electrolyte was injected to a battery prepared according to the above method. The capacity retention rate after intermittent cycle of the obtained battery was tested. The test results are shown in Table 9.

Table 9

	H (content: wt%)	Capacity retention rate after intermittent cycle			
		Fresh	After 30	After 50	After 100

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		battery	cycles	cycles	cycles
S1-1	0	100%	73.80%	64.30%	54.50%
S9-1	H_1(1)	100%	82.50%	74.60%	64.20%
S9-2	H_1(10)	100%	87.20%	81.40%	77.20%
S9-3	H_1(20)	100%	86.20%	81.30%	78.00%
S9-4	H_1(30)	100%	88.30%	83.30%	79.80%
S9-5	H_1(40)	100%	87.50%	80.60%	75.20%
S9-6	H_1(50)	100%	86.30%	74.40%	63.20%
S9-7	H_1(60)	100%	85.20%	71.60%	57.60%
S9-8	H_2(1)	100%	81.80%	73.20%	61.80%
S9-9	H_2(10)	100%	86.50%	80.80%	76.10%
S9-10	H_2(20)	100%	85.30%	81.30%	77.10%
S9-11	H_2(30)	100%	88.10%	83.00%	79.30%
S9-12	H_2(40)	100%	87.10%	80.10%	74.80%
S9-13	H_2(50)	100%	85.20%	73.70%	61.90%
S9-14	H_2(60)	100%	82.20%	70.10%	55.90%

The capacity retention rate after intermittent cycle of the battery increases with the increase of the amount of the cyclic carboxylate ester, possibly because the cyclic carboxylate forms a passivated film on the surface of the cathode. However, when the cyclic carboxylate ester content is close to 40 wt%, the intermittent cycle performance deteriorates to a certain extent, which is mainly caused by a side reaction between $LiPF_6$ and the cyclic carboxylate ester. Therefore, the amount of the cyclic carboxylate ester is preferably moderate and should not be too large.

References throughout the specification to "some embodiments", "partial embodiments", "one embodiment", "another example", "example", "specific example" or "partial examples" mean that at least one embodiment or example of the application includes specific features, structures, materials or characteristics described in the embodiments or examples. Thus, the descriptions appear throughout the specification, such as "in some embodiments", "in an embodiment", "in one embodiment", "in another example", "in an example", "in a particular example" or "for example", are not necessarily the same embodiment or example in the application. Furthermore, the particular features, structures, materials or characteristics herein may be combined in any suitable manner in one or more embodiments

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or examples.

While the illustrative embodiments have been shown and described, it will be understood by those skilled in the art that the embodiments are not to be construed as limiting the present invention, and modifications, substitutions and changes can be made to the embodiments without departing from the spirit and scope of the present application.

The above-described embodiments of the present invention are intended to be illustrative only. Numerous alternative embodiments may be devised by persons skilled in the art without departing from the scope of the following claims.

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CLAIMS

What is claimed is:

1. An electrochemical device, comprising:

an electrode; and

an electrolyte comprising a dinitrile compound, a trinitrile compound, and propyl propionate; wherein,

based on a total weight of the electrolyte, a weight percentage of the dinitrile compound is X, and a weight percentage of the trinitrile compound is Y; wherein,

about 2 wt% ≤ (X+Y) ≤ about 11 wt%, and

about 0.1 ≤ (X/Y) ≤ about 8; wherein,

the electrode comprises a current collector, a single-sided coating and a double-sided coating;

a first part of the current collector is provided with the single-sided coating and a second part of the current collector is provided with the double-sided coating; and

an electrode compaction density of the single-sided coating is D1, and, an electrode compaction density of the double-sided coating is D2, wherein, about 0.8 ≤ D1/D2 ≤ about 1.2.

2. The electrochemical device according to Claim 1, wherein the electrode is a cathode, and 3.5 g/cm^3 ≤ D2 ≤ 4.3 g/cm^3.

3. The electrochemical device according to Claim 1, wherein the electrode is an anode, and 1.2 g/cm^3 ≤ D2 ≤ 1.8 g/cm^3.

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4. The electrochemical device according to Claim 1, wherein based on the total weight of the electrolyte, a weight percentage of the propyl propionate is Z; wherein,

about 0.01 ≤ (Y/Z) ≤ about 0.3.

5. The electrochemical device according to Claim 1, wherein the dinitrile compound further comprises a compound of Formula (4):

$CN\text{-}R_1\text{-}CN$ (4);

where R_1 selected from an alkylene group having 1-5 carbon atoms or an alkenylene group having 2-5 carbon atoms.

6. The electrochemical device according to Claim 1, wherein the dinitrile compound is one selected from the group consisting of butanedinitrile, glutaronitrile, adiponitrile, 1,5-dicyanopentane, 1,6-dicyanohexane, 1,7-dicyanoheptane, 1,8-dicyanooctane, 1,9-dicyanononane, 1,10-dicyanodecane, 1,12-dicyanododecane, tetramethylbutanedinitrile, 2-methylglutaronitrile, 2,4-dimethylglutaronitrile, 2,2,4,4-tetramethylglutaronitrile, 1,4-dicyanopentane, 2,6-dicyanoheptane, 2,7-dicyanooctane, 2,8-dicyanononane, 1,6-dicyanodecane, 1,2-dicyanobenzene, 1,3-dicyanobenzene, 1,4-dicyanobenzene, 3,5-dioxa-pimelonitrile, 1,4-bis(cyanoethoxy)butane, ethylene glycol bis(2-cyanoethyl)ether, diethylene glycol bis(2-cyanoethyl)ether, triethylene glycol bis(2-cyanoethyl)ether, tetraethylene glycol bis(2-cyanoethyl)ether, 3,6,9,12,15,18-hexaoxaeicosanoic dinitrile, 1,3-bis(2-cyanoethoxy)propane, 1,4-bis(2-cyanoethoxy)butane, 1,5-bis(2-cyanoethoxy)pentane, ethylene glycol bis(4-cyanobutyl)ether, 1,4-dicyano-2-butene, 1,4-dicyano-2-methyl-2-butene, 1,4-dicyano-2-ethyl-2-butene, 1,4-dicyano-2,3-dimethyl-2-butene, 1,4-dicyano-2,3-

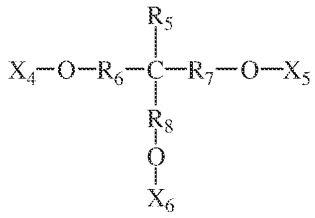
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diethyl-2-butene, 1,6-dicyano-3-hexene, 1,6-dicyano-2-methyl-3-hexene, 1,6-dicyano-2-methyl-5-methyl-3-hexene, and any combination thereof.

7. The electrochemical device according to Claim 1, wherein the trinitrile compound comprises a compound of Formula (6)

$$CN\text{-}(CH_2)_x\text{-}CH\{(CH_2)_y\text{-}CN\}\text{-}(CH_2)_z\text{-}CN \quad (6);$$

Formula (7)



(7);

or a combination thereof,

where in Formula (6), x, y, and z represent an integer from 0 to 5, and x, y, and z are not 0 at the same time; and

in Formula (7), R_5 represents hydrogen or an alkyl group having 1-5 carbon atoms, R_6, R_7 and R_8 are each independently an alkylene group having 1-5 carbon atoms, and X_4, X_5 and X_6 are each independently $-R_9-CN$, in which R_9 represents an alkylene group having 1-5 carbon atoms.

8. The electrochemical device according to Claim 1, wherein the trinitrile compound is one selected from the group consisting of 1,3,5-pentanetricarbonitrile; 1,2,3-propanetrinitrile; 1,3,6-hexanetricarbonitrile; 1,2,6-hexanetricarbonitrile; 1,2,3-tris(2-cyanoethoxy)propane; 1,2,4-tris(2-cyanoethoxy)butane; 1,1,1-tris(cyanoethoxymethylene)ethane; 1,1,1-

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tris(cyanoethoxymethylene)propane; 3-methyl-1,3,5-tris(cyanoethoxy)pentane; 1,2,7-tris(cyanoethoxy)heptane; 1,2,6-tris(cyanoethoxy)hexane; 1,2,5-tris(cyanoethoxy)pentane; and any combination thereof.

9. The electrochemical device according to Claim 1, wherein X is about 0.01-10 wt%, Y is about 0.01-10 wt%, and a weight percentage Z of the propyl propionate is about 5-50 wt%.

10. The electrochemical device according to Claim 1, wherein the electrolyte further comprising a fluoroether comprising at least one of the compounds of Formula (8), Formula (9), Formula (10) or Formula (11):

$$Rf1–O–Rf2 \quad (8);$$

$$Rf1–O–R \quad (9)$$

$$Rf1–O–(R'–O)_n–Rf2 \quad (10); \text{ and}$$

$$Rf1–O–(R'–O)_n–R \quad (11);$$

wherein Formulae (8), (9), (10), and (11), Rf1 and Rf2 are each independently a linear or branched C_1 to C_{12} fluoroalkyl group having at least one hydrogen atom substituted with fluoro, R is a linear or branched C_1 to C_{12} alkyl group, and R' is a linear or branched C_1 to C_5 alkylene group, and n is an integer from 1 to 5.

11. The electrochemical device according to Claim 9, wherein Rf1 or Rf2 is each independently a fluoroalkyl group selected from the group consisting of HCF_2-, CF_3-, HCF_2CF_2-, CH_3CF_2-, CF_3CH_2-, CF_3CF_2-, $(CF_3)_2CH$-, $HCF_2CF_2CH_2$-, $CF_3CH_2CH_2$-, $HCF_2CF_2CF_2CH_2$-, $HCF_2CF_2CF_2CF_2CH_2$-, $CF_3CF_2CH_2$-, $CF_3CFHCF_2CH_2$-,

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$HCF_2CF(CF_3)CH_2$-, and $CF_3CF_2CH_2CH_2$-.

12. The electrochemical device according to Claim 9, wherein the fluoroether is one selected from the group consisting of $HCF_2CF_2CH_2OCF_2CF_2H$, $(CF_3)_2CFCF(CF_2CF_3)(OCH_3)$, $CF_3CHFCF_2CH(CH_3)OCF_2CHFCF_3$, $HCF_2CF_2CH_2OCF_2CF_2CF_2CF_2H$, $HCF_2CF_2OCH_2CF_3$, $HCF_2CF_2OCH_2CH_2OCF_2CF_2H$, $HCF_2CF_2OCH_2CH_2CH_2OCF_2CF_2H$, $HCF_2CF_2CH_2OCF_2CF_2CF_2H$, $HCF_2CF_2OCH_2CH_2OCF_2CF_2CF_2H$, $HCF_2CF_2OCH_2CH_2CH_2OCF_2CF_2CF_2H$, $CH_3OCH_2CH_2OCH_2CH_2F$, $CH_3OCH_2CH_2OCH_2CF_3$, $CH_3OCH_2CH(CH_3)OCH_2CH_2F$, $CH_3OCH_2CH(CH_3)OCH_2CF_3$, $FCH_2CH_2OCH_2CH_2OCH_2CH_2F$, $FCH_2CH_2OCH_2CH(CH_3)OCH_2CH_2F$, $CF_3CH_2O(CH_2CH_2O)_2CH_2CF_3$, $CF_3CH_2OCH_2CH(CH_3)OCH_2CF_3$, and any combination thereof.

13. The electrochemical device according to Claim 1, wherein the electrolyte further comprising a cyclic phosphonic anhydride, based on the total weight of the electrolyte, a content of cyclic phosphonic anhydride is about 0.01-10 wt%.

14. The electrochemical device according to Claim 1, wherein the electrolyte further comprising one selected from a group consisting of: a cyclic carbonate ester having a carbon-carbon double bond, a fluorinated chain carbonate ester, a fluorinated cyclic carbonate ester, a compound having a sulfur-oxygen double bond, and any combination thereof.

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15. The electrochemical device according to Claim 1, wherein the electrolyte further comprising a cyclic carboxylate ester, including γ-butyrolactone or γ-valerolactone or a combination thereof.

16. An electrochemical device, comprising:

electrodes; and

an electrolyte comprising a dinitrile compound, a trinitrile compound, and propyl propionate; wherein,

based on a total weight of the electrolyte, a weight percentage of the dinitrile compound is X, and a weight percentage of the trinitrile compound is Y; wherein,

about 2 wt% ≤ (X+Y) ≤ about 11 wt%, and

about 0.1 ≤ (X/Y) ≤ about 8; wherein,

the electrodes comprise a first electrode and a second electrode, wherein

the first electrode comprises a first current collector and a single-sided coating;

the second electrode comprises a second current collector and a double-sided coating; and

an electrode compaction density of the single-sided coating is D1, and, an electrode compaction density of the double-sided coating is D2, wherein, about 0.8 ≤ D1/D2 ≤ about 1.2.

17. The electrochemical device according to Claim 16, wherein the first electrode is a cathode, the second electrode is a cathode, and 3.5 g/cm^3 ≤ D2 ≤ 4.3 g/cm^3.

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18. The electrochemical device according to Claim 16, wherein the first electrode is an anode, the second electrode is an anode, and 1.2 g/cm^3 ≤ D2 ≤ 1.8 g/cm^3.

19. The electrochemical device according to Claim 16, wherein based on the total weight of the electrolyte, a weight percentage of the propyl propionate is Z; wherein,

about 0.01 ≤ (Y/Z) ≤ about 0.3.

20. The electrochemical device according to Claim 16, wherein the dinitrile compound is one selected from the group consisting of butanedinitrile, glutaronitrile, adiponitrile, 1,5-dicyanopentane, 1,6-dicyanohexane, 1,7-dicyanoheptane, 1,8-dicyanooctane, 1,9-dicyanononane, 1,10-dicyanodecane, 1,12-dicyanododecane, tetramethylbutanedinitrile, 2-methylglutaronitrile, 2,4-dimethylglutaronitrile, 2,2,4,4-tetramethylglutaronitrile, 1,4-dicyanopentane, 2,6-dicyanoheptane, 2,7-dicyanooctane, 2,8-dicyanononane, 1,6-dicyanodecane, 1,2-dicyanobenzene, 1,3-dicyanobenzene, 1,4-dicyanobenzene, 3,5-dioxa-pimelonitrile, 1,4-bis(cyanoethoxy)butane, ethylene glycol bis(2-cyanoethyl)ether, diethylene glycol bis(2-cyanoethyl)ether, triethylene glycol bis(2-cyanoethyl)ether, tetraethylene glycol bis(2-cyanoethyl)ether, 3,6,9,12,15,18-hexaoxaeicosanoic dinitrile, 1,3-bis(2-cyanoethoxy)propane, 1,4-bis(2-cyanoethoxy)butane, 1,5-bis(2-cyanoethoxy)pentane, ethylene glycol bis(4-cyanobutyl)ether, 1,4-dicyano-2-butene, 1,4-dicyano-2-methyl-2-butene, 1,4-dicyano-2-ethyl-2-butene, 1,4-dicyano-2,3-dimethyl-2-butene, 1,4-dicyano-2,3-diethyl-2-butene, 1,6-dicyano-3-hexene, 1,6-dicyano-2-methyl-3-

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hexene, 1,6-dicyano-2-methyl-5-methyl-3-hexene, and any combination thereof.

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ABSTRACT

An electrochemical device, including an electrode and an electrolyte. The electrolyte including a dinitrile compound, a trinitrile compound, and propyl propionate. Based on the total weight of the electrolyte, the weight percentage of the dinitrile compound is X, the weight percentage of the trinitrile compound is Y, and the weight percentage of the propyl propionate is Z. Wherein about 2 wt% ≤ (X+Y) ≤ about 11wt%, about 0.1 ≤ (X/Y) ≤ about 8. The electrode including a coating, which including a single-sided sub-coating and a double-sided coating, the electrode with the single-sided sub-coating has an electrode compaction density D1, and the electrode with the double-sided coating has an electrode compaction density D2, where about 0.8 ≤ D1/D2 ≤ about 1.2. The electrolyte and D1/D2 of the electrodes has a significant effect on the cycle performance of the electrochemical device.

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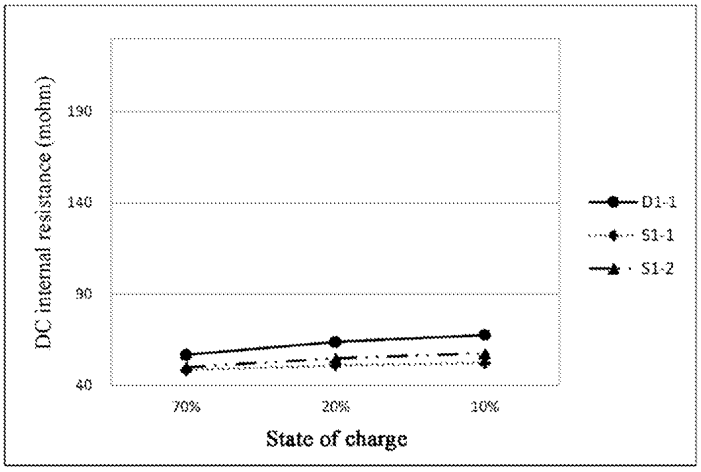

DC internal resistance (mohm)
190
140
90
40
70%
20%
10%
State of charge
D1-1
S1-1
S1-2

FIG. 1A

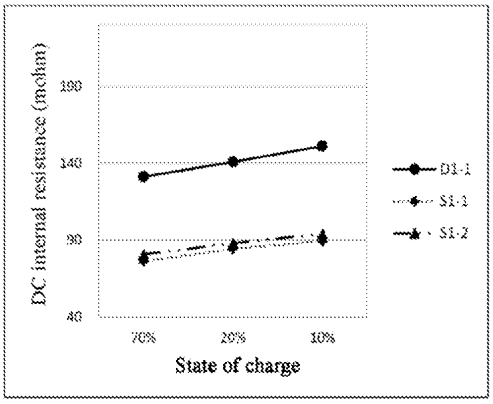

DC internal resistance (mohm)
100
140
90
40
70%
20%
10%
State of charge
D1-1
S1-1
S1-2

FIG. 1B

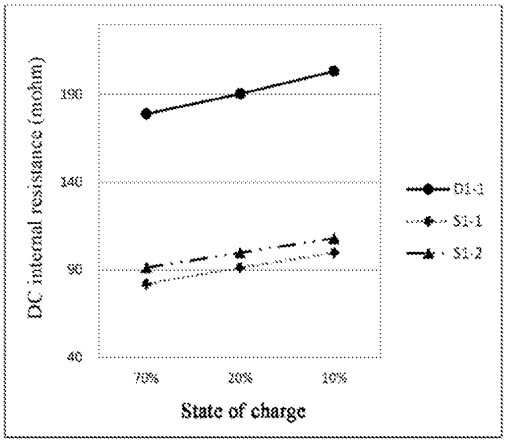

DC internal resistance (mohm)
190
140
90
40
70%
20%
10%
State of charge
D1-1
S1-1
S1-2

FIG. 1C

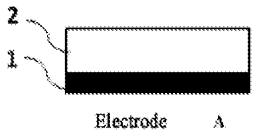


FIG. 2

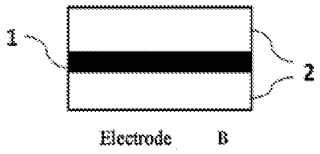


FIG. 3

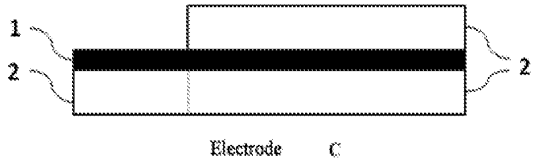


FIG. 4

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UTILITY PATENT APPLICATION TRANSMITTAL

(Only for new nonprovisional applications under 37 CFR 1.53(b))

Attorney Docket No.	14850089COB
First Named Inventor	Kefei WANG
Title	ELECTROLYTE AND ELECTROCHEMICAL DEVICE
Priority Mail Express® Label No.	

APPLICATION ELEMENTS

See MPEP chapter 600 concerning utility patent application contents.

1. ☐ **Fee Transmittal Form** (PTO/SB/17 or equivalent)
2. ☐ **Applicant asserts small entity status.** See 37 CFR 1.27
3. ☐ **Applicant certifies micro entity status.** See 37 CFR 1.29. Applicant must attach form PTO/SB/15A or B or equivalent.
4. ☑ **Specification** [*Total Pages* 55] Both the claims and abstract must start on a new page. *(See MPEP § 608.01(a) for information on the preferred arrangement)*
5. ☑ **Drawing(s)** (35 U.S.C. 113) [*Total Sheets* 3]
6. **Inventor's Oath or Declaration** [*Total Pages* 4] *(including substitute statements under 37 CFR 1.64 and assignments serving as an oath or declaration under 37 CFR 1.63(e))*
   a. ☐ Newly executed (original or copy)
   b. ☑ A copy from a prior application (37 CFR 1.63(d))
7. ☑ **Application Data Sheet** ** See note below.* See 37 CFR 1.76 (PTO/AIA/14 or equivalent)
8. **CD-ROM or CD-R** in duplicate, large table, or Computer Program (*Appendix*)
   ☐ Landscape Table on CD
9. **Nucleotide and/or Amino Acid Sequence Submission** (*if applicable, items a. – c. are required*)
   a. ☐ Computer Readable Form (CRF)
   b. ☐ Specification Sequence Listing on:
      i. ☐ CD-ROM or CD-R (2 copies); or
      ii. ☐ Paper
   c. ☐ Statements verifying identity of above copies

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ACCOMPANYING APPLICATION PAPERS

10. ☐ **Assignment Papers** (cover sheet & document(s)) Name of Assignee _____
11. ☐ **37 CFR 3.73(c) Statement** (*when there is an assignee*) ☑ **Power of Attorney**
12. ☐ **English Translation Document** (*if applicable*)
13. ☑ **Information Disclosure Statement** (PTO/SB/08 or PTO-1449)
    ☐ Copies of citations attached
14. ☐ **Preliminary Amendment**
15. ☐ **Return Receipt Postcard** (*MPEP § 503*) (*Should be specifically itemized*)
16. ☐ **Certified Copy of Priority Document(s)** (*if foreign priority is claimed*)
17. ☐ **Nonpublication Request** Under 35 U.S.C. 122(b)(2)(B)(i). Applicant must attach form PTO/SB/35 or equivalent.
18. ☑ **Other:** IDS Statement

*Note: (1) Benefit claims under 37 CFR 1.78 and foreign priority claims under 1.55 **must** be included in an Application Data Sheet (ADS).
(2) For applications filed under 35 U.S.C. 111, the application must contain an ADS specifying the applicant if the applicant is an assignee, person to whom the inventor is under an obligation to assign, or person who otherwise shows sufficient proprietary interest in the matter. See 37 CFR 1.46(b).

19. CORRESPONDENCE ADDRESS

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Name					
Address					
City		State		Zip Code	
Country		Telephone		Email	

Signature	/Timothy J. Maier/	Date	August 11, 2022
Name (Print/Type)	Timothy J. Maier	Registration No. (Attorney/Agent)	51986

This collection of information is required by 37 CFR 1.53(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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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.
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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 inspection or an issued patent.
9. A record from this system of records may be disclosed, as a routine use, to a Federal, State, or local law enforcement agency, if the USPTO becomes aware of a violation or potential violation of law or regulation.

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Application Data Sheet 37 CFR 1.76	Attorney Docket Number	14850089COB
	Application Number	
Title of Invention	ELECTROLYTE AND ELECTROCHEMICAL DEVICE	

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

Secrecy Order 37 CFR 5.2:

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

Inventor Information:

Inventor 1 Remove

Legal Name

Prefix	Given Name	Middle Name	Family Name	Suffix
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Address 2	Jiaocheng District

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Postal Code	352100	Country [i]	CN

Inventor 2 Remove

Legal Name

Prefix	Given Name	Middle Name	Family Name	Suffix
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Residence Information (Select One) US Residency ◉ Non US Residency Active US Military Service

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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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Application Data Sheet 37 CFR 1.76	Attorney Docket Number	14850089COB
	Application Number	
Title of Invention	ELECTROLYTE AND ELECTROCHEMICAL DEVICE	

Prefix	Given Name	Middle Name	Family Name	Suffix
	Liangzhen		XIAO	

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

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Mailing Address of Inventor:

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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
	Fei		WU	

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:

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Address 2	Jiaocheng District		
City	Ningde City, Fujian Province	State/Province	
Postal Code	352100	Country [i]	CN

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Correspondence Information:

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For further information see 37 CFR 1.33(a).

☐ **An Address is being provided for the correspondence Information of this application.**

Customer Number	62008		
Email Address	patent@maierandmaier.com	Add Email	Remove Email

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Application Data Sheet 37 CFR 1.76	Attorney Docket Number	14850089COB
	Application Number	
Title of Invention	ELECTROLYTE AND ELECTROCHEMICAL DEVICE	

Application Information:

Title of the Invention	ELECTROLYTE AND ELECTROCHEMICAL DEVICE		
Attorney Docket Number	14850089COB	**Small Entity Status Claimed** ☐	
Application Type	Nonprovisional		
Subject Matter	Utility		
Total Number of Drawing Sheets (if any)	3	**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	62008		

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Application Data Sheet 37 CFR 1.76	Attorney Docket Number	14850089COB
	Application Number	
Title of Invention	ELECTROLYTE AND ELECTROCHEMICAL DEVICE	

Domestic Benefit/National Stage Information:

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

Prior Application Status	Pending	Remove

Application Number	Continuity Type	Prior Application Number	Filing or 371(c) Date (YYYY-MM-DD)
	Continuation of	17064782	2020-10-07

Prior Application Status	Patented	Remove

Application Number	Continuity Type	Prior Application Number	Filing Date (YYYY-MM-DD)	Patent Number	Issue Date (YYYY-MM-DD)
17064782	Continuation of	16211853	2018-12-06	10833363	2020-11-10

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)
201811108529.X	CN	2018-09-21	9ED1

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	14850089COB
	Application Number	
Title of Invention	ELECTROLYTE AND ELECTROCHEMICAL DEVICE	

Authorization or Opt-Out of Authorization to Permit Access:

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

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

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

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

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

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

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

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

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

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

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

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Application Data Sheet 37 CFR 1.76	Attorney Docket Number	14850089COB
	Application Number	
Title of Invention	ELECTROLYTE AND ELECTROCHEMICAL DEVICE	

Applicant Information:

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

Applicant 1 — Remove

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

Clear

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

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

Name of the Deceased or Legally Incapacitated Inventor:

If the Applicant is an Organization check here. ☒

Organization Name	NINGDE AMPEREX TECHNOLOGY LIMITED		
Mailing Address Information For Applicant:			
Address 1	No. 1, Xingang Road, Zhangwan Town		
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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Application Data Sheet 37 CFR 1.76	Attorney Docket Number	14850089COB
	Application Number	
Title of Invention	ELECTROLYTE AND ELECTROCHEMICAL DEVICE	

Assignee 1

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

Remove

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

Organization Name	NINGDE AMPEREX TECHNOLOGY LIMITED

Mailing Address Information For Assignee including Non-Applicant Assignee:

Address 1	No. 1, Xingang Road, Zhangwan Town		
Address 2	Jiaocheng District		
City	Ningde City, Fujian Province	**State/Province**	
Country i	CN	Postal Code	352100
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	/Timothy J. Maier/			Date (YYYY-MM-DD)	2022-08-11
First Name	Timothy	Last Name	Maier	Registration Number	51986

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	14850089COB
	Application Number	
Title of Invention	ELECTROLYTE AND ELECTROCHEMICAL DEVICE	

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

Privacy Act Statement

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

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

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

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

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.

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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	ELECTROLYTE AND ELECTROCHEMICAL DEVICE

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:

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: Kefei WANG Date (Optional): _____

Signature: Kefei WANG

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.

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Title of Invention	ELECTROLYTE AND ELECTROCHEMICAL DEVICE

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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.

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LEGAL NAME OF INVENTOR

Inventor: Qiao ZENG Date (Optional) _____

Signature: Qiao ZENG

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.

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- [x] The attached application, or
- [ ] United States application or PCT international application number _____ filed on _____.

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LEGAL NAME OF INVENTOR

Inventor: Liangzhen XIAO Date (Optional): _____

Signature: Liangzhen 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.

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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	ELECTROLYTE AND ELECTROCHEMICAL DEVICE

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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: Fei Wu Date (Optional): _____

Signature: Fei Wu

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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