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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
12/817,028	06/16/2010	Xiaoping REN	042787-0109	4654

22428 7590 07/03/2014

FOLEY AND LARDNER LLP
SUITE 500
3000 K STREET NW
WASHINGTON, DC 20007

EXAMINER	
SIDDIQUEE, MUHAMMAD S	
ART UNIT	PAPER NUMBER
1726	

MAIL DATE	DELIVERY MODE
07/03/2014	PAPER

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 Abandonment	Application No.	Applicant(s)
	12/817,028	REN ET AL.
	Examiner	Art Unit
	MUHAMMAD SIDDIQUEE	1726

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

This application is abandoned in view of:

1. ☒ Applicant's failure to timely file a proper reply to the Office letter mailed on *13 May 2013*.
   (a) ☐ A reply was received on _____ (with a Certificate of Mailing or Transmission dated _____), which is after the expiration of the period for reply (including a total extension of time of _____ month(s)) which expired on _____.
   (b) ☐ A proposed reply was received on _____, but it does not constitute a proper reply under 37 CFR 1.113 to the final rejection. (A proper reply under 37 CFR 1.113 to a final rejection consists only of: (1) a timely filed amendment which places the application in condition for allowance; (2) a timely filed Notice of Appeal (with appeal fee); or (3) a timely filed Request for Continued Examination (RCE) in compliance with 37 CFR 1.114).
   (c) ☐ A reply was received on _____ but it does not constitute a proper reply, or a bona fide attempt at a proper reply, to the non-final rejection. See 37 CFR 1.85(a) and 1.111. (See explanation in box 7 below).
   (d) ☒ No reply has been received.

2. ☐ Applicant's failure to timely pay the required issue fee and publication fee, if applicable, within the statutory period of three months from the mailing date of the Notice of Allowance (PTOL-85).
   (a) ☐ The issue fee and publication fee, if applicable, was received on _____ (with a Certificate of Mailing or Transmission dated _____), which is after the expiration of the statutory period for payment of the issue fee (and publication fee) set in the Notice of Allowance (PTOL-85).
   (b) ☐ The submitted fee of $_____ is insufficient. A balance of $_____ is due.
   The issue fee required by 37 CFR 1.18 is $_____. The publication fee, if required by 37 CFR 1.18(d), is $_____.
   (c) ☐ The issue fee and publication fee, if applicable, has not been received.

3. ☐ Applicant's failure to timely file corrected drawings as required by, and within the three-month period set in, the Notice of Allowability (PTO-37).
   (a) ☐ Proposed corrected drawings were received on _____ (with a Certificate of Mailing or Transmission dated _____), which is after the expiration of the period for reply.
   (b) ☐ No corrected drawings have been received.

4. ☐ The letter of express abandonment which is signed by the attorney or agent of record or other party authorized under 37 CFR 1.33(b). See 37 CFR 1.138(b).

5. ☐ The letter of express abandonment which is signed by an attorney or agent (acting in a representative capacity under 37 CFR 1.34) upon the filing of a continuing application.

6. ☐ The decision by the Board of Patent Appeals and Interference rendered on _____ and because the period for seeking court review of the decision has expired and there are no allowed claims.

7. ☒ The reason(s) below:

The Examiner called the Applicant's attorney's office on 6/30/2014 and confirmed that the application is abandoned.

/PATRICK RYAN/ Supervisory Patent Examiner, Art Unit 1726	/MUHAMMAD SIDDIQUEE/ Examiner, Art Unit 1726

Petitions to revive under 37 CFR 1.137, or requests to withdraw the holding of abandonment under 37 CFR 1.181, should be promptly filed to minimize any negative effects on patent term.

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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
12/817,028	06/16/2010	Xiaoping REN	042787-0109	4654

22428 7590 01/08/2014

FOLEY AND LARDNER LLP
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3000 K STREET NW
WASHINGTON, DC 20007

EXAMINER	
SIDDIQUEE, MUHAMMAD S	
ART UNIT	PAPER NUMBER
1726	

MAIL DATE	DELIVERY MODE
01/08/2014	PAPER

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.

Application Number	Application/Control No.	Applicant(s)/Patent under Reexamination	
	12/817,028	REN ET AL.	
	PATRICK RYAN	Art Unit 1726	
Document Code - AP.PRE.DEC			

Notice of Panel Decision from Pre-Appeal Brief Review

This is in response to the Pre-Appeal Brief Request for Review filed 11/27/2013.

1. ☐ **Improper Request** – The Request is improper and a conference will not be held for the following reason(s):

☐ The Notice of Appeal has not been filed concurrent with the Pre-Appeal Brief Request.
☐ The request does not include reasons why a review is appropriate.
☐ A proposed amendment is included with the Pre-Appeal Brief request.
☐ Other: .

The time period for filing a response continues to run from the receipt date of the Notice of Appeal or from the mail date of the last Office communication, if no Notice of Appeal has been received.

2. ☒ **Proceed to Board of Patent Appeals and Interferences** – A Pre-Appeal Brief conference has been held. The application remains under appeal because there is at least one actual issue for appeal. Applicant is required to submit an appeal brief in accordance with 37 CFR 41.37. The time period for filing an appeal brief will be reset to be one month from mailing this decision, or the balance of the two-month time period running from the receipt of the notice of appeal, whichever is greater. Further, the time period for filing of the appeal brief is extendible under 37 CFR 1.136 based upon the mail date of this decision or the receipt date of the notice of appeal, as applicable.

☒ The panel has determined the status of the claim(s) is as follows:
Claim(s) allowed: _____.
Claim(s) objected to: _____.
Claim(s) rejected: *4, 5 & 9* .
Claim(s) withdrawn from consideration: *1-3 & 6-8*.

3. ☐ **Allowable application** – A conference has been held. The rejection is withdrawn and a Notice of Allowance will be mailed. Prosecution on the merits remains closed. No further action is required by applicant at this time.

4. ☐ **Reopen Prosecution** – A conference has been held. The rejection is withdrawn and a new Office action will be mailed. No further action is required by applicant at this time.

All participants:

(1) */Patrick Ryan/*.

(2) */Muhammad Siddiquee/*.

(3)*/William Krynski/*.

(4)_____.

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Applicants:	Xiaoping REN *et al.*
Title:	SECONDARY LITHIUM ION CELL OR BATTERY, AND PROTECTING CIRCUIT, ELECTRONIC DEVICE AND CHARGING DEVICE OF THE SAME
Appl. No.:	12/817,028
Filing Date:	6/16/2010
Examiner:	Muhammad S. Siddiquee
Art Unit:	1726
Conf. No.:	4654

PRE-APPEAL BRIEF REQUEST FOR REVIEW

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

Commissioner:

In accordance with the **Pre-Appeal Brief Conference Pilot Program**, announced July 11, 2005, this Pre-Appeal Brief Request is filed together with a Notice of Appeal.

A. Independent claim 4

Independent claim 4 is directed to an electronic device that uses a secondary lithium ion cell or battery as energy source. In pertinent part claim 4 recites that "the ratio of positive electrode material to negative electrode material of the single lithium ion cell is from 1:1.0 to 1:2.5, as calculated by the theoretic capacity with the charge cut-off voltage set at 4.2V."

B. Background

The "Background Art" section of the application states that 4.2V is an accepted charge cut-off voltage for secondary lithium ion batteries. Using a charge cut-off voltage greater than 4.2V results in an improved capacity and improved operating voltage. With that expediency, however, come negative side effects, such as structural changes in the positive and negative

electrode materials, decomposition of the electrolyte, and reduced recycle properties, which have kept the battery industry from using a charge cut-off voltage greater than 4.2V.

The documents summarized in the background section of the application explicitly underscore these points. In contravention of the contemporaneous common opinion thus evidenced, however, applicants discovered an approach for raising the cut-off voltage above 4.2V that substantially avoids changes to the electrode materials and decomposition of the electrolyte.

In a manner wholly unforeseen by the art, therefore, applicants' approach also does not diminish the recycle property of the secondary lithium ion battery. By the same token, applicants' claimed invention comprises using a ratio from 1:1.0 to 1:2.5 for positive electrode material to negative electrode material of the single lithium ion cell, as calculated by the theoretic capacity with the charge cut-off voltage set at 4.2V.

Employing the ratio as presently recited cedes properties to a lithium ion battery that, as noted above, would have been unexpected in view of the art of record.

C. Outstanding Claim Rejection

The Final Action rejects claims 4, 5 and 9 under 35 U.S.C. § 103(a) over U.S. patent No. 5,260,148 to Idota in view of WO 93/21665 to Guyomard *et al.* and U.S. patent No. 6,326,770 to Patino *et al.* Applicants traverse these rejections because the Idota, Guyomard, and Patino references fail to disclose or even to suggest the features of the claimed invention, including use of a ratio from 1:1.0 to 1:2.5 for positive electrode material to negative electrode material of the single lithium ion cell, as calculated by the theoretic capacity with the charge cut-off voltage set at 4.2V.

No permutation of teachings reasonably gleaned from Idota, Guyomard, and Patino could have directed the skilled artisan, contrary to contemporaneous common opinion, to a ratio from 1:1.0 to 1:2.5 for positive electrode material to negative electrode material of the single lithium ion cell, as calculated by the theoretic capacity with the charge cut-off voltage set at 4.2V

The Final Action relies on Idota in column 3, lines 14-19, for an alleged disclosure of the ratio recited in claim 4. Applicants respectfully disagree, however, that Idota or any prior art of record implicates this ratio.

To the contrary, Idota fails to disclose the prescribed ratio of from 1:1.0 to 1:2.5 for positive electrode material to negative electrode material of the single lithium ion cell, as calculated by the theoretic capacity with the charge cut-off voltage set at 4.2V. Rather, the cited section of Idota advances a calculation of the ratio of the positive electrode material to negative electrode material by "ratio of equivalent amount," not "as calculated by the theoretic capacity with the charge cut-off voltage set at 4.2V."

Idota suggests nothing by way of whether the disclosed value is a weight ratio or a volume ratio. In either case, the ratio is not calculated based on capacity, as the claims prescribe. Accordingly, Idota does not disclose the capacity ratio recited in claim 4.

Neither Guyomard nor Patino implicates the calculation method of capacity-based ratio, per claim 4. Even were Idota, Guyomard and Patino combined, therefore, the result would not have suggested the ratio feature recited in claim 4; that is, a ratio from 1:1.0 to 1:2.5 for positive electrode material to negative electrode material of the single lithium ion cell, as calculated by the theoretic capacity with the charge cut-off voltage set at 4.2V.

Moreover, none of the cited references realizes or even hints at applicants' approach for raising the cut-off voltage above 4.2V, which mitigates changes to the electrode materials and decomposition of the electrolyte and which, through the recited ratio, does not diminish the recycle property of the secondary lithium ion battery. In light of the assert combination of references, that is, the skilled artisan could not have foreseen the effect where, in raising the cut-off voltage above 4.2V, changes to the electrode materials and decomposition of the electrolyte are substantially avoided without diminishing the recycle property of the secondary lithium ion battery. These unexpected advantages achieved via applicants' approach further substantiates the patentability of the present claims over the art of record.\

The present application provides support throughout for the claimed ratio of the positive electrode material to negative electrode material, as calculated by the theoretic capacity with a cut-off voltage at 4.2V, and for the relationship of the recited ratio on mitigating changes to the electrode materials and decomposition of the electrolyte, and thus not diminishing the recycle property of the secondary lithium ion battery

The Final Action contains this passage:

> Applicant's argument regarding ratio of the positive electrode material to negative electrode material in connection with theoretic capacity and charge cut-off voltage is not persuasive because they are not related and also, the applicant did not disclose any relationship in the specification.

Page 2 (emphasis added). Yet, throughout the application there is disclosure regarding the ratio of the positive electrode material to negative electrode material, as calculated by the theoretic capacity with a cut-off voltage at 4.2V.

For instance, the application on page 4, lines 12-14, teaches the recited ratio, as calculated by the specific capacity with the charge voltage limited to 4.2 V. In the same vein, the application states that "the ratio of positive electrode material to negative electrode material of cell is 1:1.0 to 1:2.5 calculated by the theoretical capacity under the charge cut-off of 4.2V" (page 9, lines 8-10).

Moreover, the relationship of the recited ratio on mitigating changes to the electrode materials and decomposition of the electrolyte, and thus not diminishing the recycle property of the secondary lithium ion battery is also disclosed in the specification. For instance, on page 9 at lines 16-20 the application discusses adjusting the ratio by the theoretical capacity where the operating voltage is greatly improved but the recycle property is not affected. There also is discussion that, for a ratio below 1.0, the recycle life is excessively reduced, while for a ratio above 2.5 the volume efficiency is notably reduced (see page 10, lines 9-13).

In view of the foregoing, applicants submit that the pending Section 103 rejection is unfounded and should be withdrawn, and the application passed on to allowance.

Respectfully submitted,

Date November 27, 2013

By /Stephen A. Bent/

FOLEY & LARDNER LLP
Customer Number: 22428
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Stephen A. Bent
Attorney for Applicant
Registration No. 29,768

Electronic Patent Application Fee Transmittal					
Application Number:	12817028				
Filing Date:	16-Jun-2010				
Title of Invention:	SECONDARY LITHIUM ION CELL OR BATTERY, AND PROTECTING CIRCUIT, ELECTRONIC DEVICE AND CHARGING DEVICE OF THE SAME				
First Named Inventor/Applicant Name:	Xiaoping REN				
Filer:	Stephen A. Bent/Sharon Andrews				
Attorney Docket Number:	042787-0109				
Filed as Small Entity					
Utility under 35 USC 111(a) Filing Fees					
Description		**Fee Code**	**Quantity**	**Amount**	**Sub-Total in USD($)**
Basic Filing:					
Pages:					
Claims:					
Miscellaneous-Filing:					
Petition:					
Patent-Appeals-and-Interference:					
Notice of Appeal		2401	1	400	400
Post-Allowance-and-Post-Issuance:					
Extension-of-Time:					

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Extension - 3 months with $0 paid	2253	1	700	700
Miscellaneous:				
		Total in USD ($)		**1100**

Electronic Acknowledgement Receipt	
EFS ID:	17522115
Application Number:	12817028
International Application Number:	
Confirmation Number:	4654
Title of Invention:	SECONDARY LITHIUM ION CELL OR BATTERY, AND PROTECTING CIRCUIT, ELECTRONIC DEVICE AND CHARGING DEVICE OF THE SAME
First Named Inventor/Applicant Name:	Xiaoping REN
Customer Number:	22428
Filer:	Stephen A. Bent/Sharon Andrews
Filer Authorized By:	Stephen A. Bent
Attorney Docket Number:	042787-0109
Receipt Date:	27-NOV-2013
Filing Date:	16-JUN-2010
Time Stamp:	13:39:52
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	yes
Payment Type	Credit Card
Payment was successfully received in RAM	$1100
RAM confirmation Number	1306
Deposit Account	
Authorized User	

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)

1	Notice of Appeal Filed	Notice_of_Appeal.pdf	39558 2c2c0df33eb1b0041a704646f51ea54bbec9c0b9	no	2
Warnings:					
Information:					
2	Pre-Brief Conference request	Pre_Appeal_Brief_Request.pdf	123611 2de514b2259960b58a149427fa6152fbc3827406	no	4
Warnings:					
Information:					
3	Fee Worksheet (SB06)	fee-info.pdf	32571 136bff9fe0a9b43dbad16f3e9389376f8b20b90d	no	2
Warnings:					
Information:					
			Total Files Size (in bytes):	195740	

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

<u>New Applications Under 35 U.S.C. 111</u>
If a new application is being filed and the application includes the necessary components for a filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application.

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

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

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

1st Inventor Name:	Xiaoping REN
Title:	SECONDARY LITHIUM ION CELL OR BATTERY, AND PROTECTING CIRCUIT, ELECTRONIC DEVICE AND CHARGING DEVICE OF THE SAME
Appl. No.:	12/817,028
Filing Date:	6/16/2010
Examiner:	Muhammad S. Siddiquee
Art Unit:	1726
Confirmation No.:	4654

NOTICE OF APPEAL FROM THE EXAMINER TO THE PATENT TRIAL AND APPEAL BOARD

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

Commissioner:

Applicant hereby appeals to the Patent Trial and Appeal Board from the examiner's decision in the Office action dated May 31, 2013, finally rejecting claims 4, 5 and 9.

[**X**] Applicant claims small entity status.

[**X**] Applicant hereby petitions for an extension of time under 37 C.F.R. §1.136(a) for the total number of months checked below:

[**X**] Notice of Appeal Fee

[**X**]To be paid as detailed below

[ ]Not required (Fee paid in prior appeal)

The required fees are calculated below:

[X]	Notice of Appeal Fee	$400.00
[X]	Extension for response filed within the third month:	$700.00
[ ]	Extension:	$0.00
	TOTAL FEE:	$1100.00

The above-identified fees of $1100 are paid by credit card via EFS-Web. The Commissioner is hereby authorized to charge any additional fees to Deposit Account No. 19-0741. Should no proper payment accompany this paper, then the Commissioner is authorized to charge the unpaid amount to the same deposit account.

Please direct all correspondence to the undersigned attorney at the indicated address.

Respectfully submitted,

Date November 27, 2013

By /Stephen A. Bent/

FOLEY & LARDNER LLP
Customer Number: 22428
Telephone: (202) 672-5404
Facsimile: (202) 672-5399

Stephen A. Bent
Attorney for Applicant
Registration No. 29,768

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12/817,028	06/16/2010	Xiaoping REN	042787-0109	4654

22428 7590 05/31/2013
FOLEY AND LARDNER LLP
SUITE 500
3000 K STREET NW
WASHINGTON, DC 20007

EXAMINER	
SIDDIQUEE, MUHAMMAD S	
ART UNIT	PAPER NUMBER
1726	

MAIL DATE	DELIVERY MODE
05/31/2013	PAPER

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.

Office Action Summary	Application No. 12/817,028	Applicant(s) REN ET AL.	
	Examiner MUHAMMAD SIDDIQUEE	Art Unit 1726	AIA (First Inventor to File) Status No

-- 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* MONTH(S) OR THIRTY (30) DAYS, WHICHEVER IS LONGER, 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 *26 February 2013*.

☐ 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) *1-9* is/are pending in the application.

5a) Of the above claim(s) *1-3 and 6-8* is/are withdrawn from consideration.

6)☐ Claim(s) _____ is/are allowed.

7)☒ Claim(s) *4-5 and 9* is/are rejected.

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

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

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

Application Papers

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

11)☐ The drawing(s) filed on _____ is/are: a)☐ accepted or b)☐ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).

Priority under 35 U.S.C. § 119

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

Certified copies:

a)☐ All b)☐ Some * c)☐ None of the:

1.☐ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. _____.

3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

Interim copies:

a)☐ All b)☐ Some c)☐ None of the: Interim copies of the priority documents have been received.

Attachment(s)

1) ☐ Notice of References Cited (PTO-892)

2) ☐ Information Disclosure Statement(s) (PTO/SB/08) Paper No(s)/Mail Date _____.

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

4) ☐ Other: _____.

DETAILED ACTION

Response to Arguments

1. Applicant's arguments filed 2/26/2013 have been fully considered but they are not persuasive. Applicant's argument regarding ratio of the positive electrode material to negative electrode material in connection with theoretic capacity and the charge cut-off voltage is not persuasive because these are not related and also, the applicant did not disclose any relationship in the specification.

Claim Rejections - 35 USC § 103

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

> (a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made.

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

4. Claims 4-5 and 9 are rejected under 35 U.S.C. 103(a) as being unpatentable over Idota (US 5,260,148) in view of Guyomard et al (WO 93/21665) and Patino et al (US 6,326,770).

Regarding claims 4-5 and 9, Idota discloses a lithium secondary battery comprising an anode and a cathode where the ratio of the equivalent amount of the anode (negative electrode) active material to that of the cathode (positive electrode) active material be larger than 1 (i.e., the amount of the anode active material is more than equivalent to the cathode active material). The ratio thereof is more preferably from 1.1 to 5, most preferably from 1.1 to 3.5. [column 3, lines 14-19]. Idota does not specifically disclose battery is capable of being charged to between 4.2 volts to 5.8 volts. However, it is the position of the examiner that such properties are inherent, given that both Idota and the present application utilize the same ratio of anode active material and cathode active material. A reference which is silent about a claimed invention's features is inherently anticipatory if the missing feature is necessarily present in that which is described in the reference. *In re Robertson, 49 USPQ2d 1949 (1999).* Moreover, Guyomard discloses a battery where cut-off voltage is used up to 5 voltage for increased cycle life and enhanced cell capacity [Pages 1-4]. Idota/Guyomard remains silent about a protection circuit. However, Patino discloses electronic devices comprising battery system where protection circuit is used to limit voltage in the battery [column 1, lines 11-28]. Therefore, it would have been obvious to a person of ordinary skill in the art at the time the invention was made to a protection circuit as taught by Patino in the battery of Idota/Guyomard in order to have a safer device.

Conclusion

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

A shortened statutory period for reply to this final action is set to expire THREE MONTHS from the mailing date of this action. In the event a first reply is filed within TWO MONTHS of the mailing date of this final action and the advisory action is not mailed until after the end of the THREE-MONTH shortened statutory period, then the shortened statutory period will expire on the date the advisory action is mailed, and any extension fee pursuant to 37 CFR 1.136(a) will be calculated from the mailing date of the advisory action. In no event, however, will the statutory period for reply expire later than SIX MONTHS from the mailing date of this final action.

Any inquiry concerning this communication or earlier communications from the examiner should be directed to MUHAMMAD SIDDIQUEE whose telephone number is (571)270-3719. The examiner can normally be reached on Monday-Thursday, 7:30 am to 5:30 pm EST.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Patrick Ryan can be reached on 571-272-1292. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see http://pair-direct.uspto.gov. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free). If you would like assistance from a USPTO Customer Service Representative or access to the automated information system, call 800-786-9199 (IN USA OR CANADA) or 571-272-1000.

/Muhammad Siddiquee/
Examiner, Art Unit 1726

/Patrick Joseph Ryan/
Supervisory Patent Examiner, Art Unit 1726

Index of Claims	Application/Control No.	Applicant(s)/Patent Under Reexamination
	12817028	REN ET AL.
	Examiner	Art Unit
	MUHAMMAD SIDDIQUEE	1795

✓	Rejected	-	Cancelled	N	Non-Elected	A	Appeal
=	Allowed	÷	Restricted	I	Interference	O	Objected

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

CLAIM		DATE								
Final	Original	08/11/2010	11/07/2010	04/22/2011	11/21/2012	05/29/2013				
	1	÷	N	N	N	N				
	2	÷	N	N	N	N				
	3	÷	N	N	N	N				
	4	÷	✓	✓	✓	✓				
	5	÷	✓	✓	✓	✓				
	6	÷	N	N	N	N				
	7	÷	N	N	N	N				
	8	÷	N	N	N	N				
	9				✓	✓				

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Applicants: Xiaoping REN *et al.*

Title: SECONDARY LITHIUM ION CELL OR BATTERY, AND PROTECTING CIRCUIT, ELECTRONIC DEVICE AND CHARGING DEVICE OF THE SAME

Appl. No.: 12/817,028

Filing Date: 6/16/2010

Examiner: Muhammad S. Siddiquee

Art Unit: 1726

Conf. No.: 4654

REPLY UNDER 37 CFR §1.111

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

Commissioner:

This communication is responsive to a non-final Office Action, dated November 26, 2012, concerning the captioned application.

A listing of claims begins on page 2 of this document.

Remarks/Arguments begin on page 4.

This listing replaces all prior versions and listings of claims in the application.

Listing of Claims

1. (Withdrawn) A secondary lithium ion cell or battery, characterized in that the single secondary lithium ion cell has a charge cut-off voltage of greater than 4.2 V but less than 5.8 V, and the ratio of positive electrode material to negative electrode material of the single cell is from 1:1.0 to 1:2.5, as calculated by the theoretic capacity with the charge cut-off voltage set at 4.2 V.

2. (Withdrawn) A protecting circuit for the secondary lithium ion cell or battery according to claim 1, characterized in that the single lithium ion cell of said protecting circuit has a first overcharge protection voltage of greater than 4.35 V, and an overcharging protection release voltage of greater than 4.15 V.

3. (Withdrawn) A protecting circuit according to claim 2, characterized in that the single lithium ion cell of said protecting circuit has a first overcharge protection voltage of greater than 4.45 V, and an overcharge protection release voltage of greater than 4.25 V.

4. (Previously Presented) An electronic device using a secondary lithium ion cell or battery as energy source, characterized in that said electronic device comprises a protecting circuit, wherein the single lithium ion cell has a first overcharging protection voltage of greater than 4.35 V, and an overcharge protection release voltage of greater than 4.15 V, and wherein the ratio of positive electrode material to negative electrode material of the single lithium ion cell is from 1:1.0 to 1:2.5, as calculated by the theoretic capacity with the charge cut-off voltage set at 4.2V.

5. (Original) An electronic device according to claim 4, characterized in that said electronic device comprises a protecting circuit, wherein the single lithium ion cell has a first overcharging protection voltage of greater than 4.45 V, and an overcharge protection release voltage of greater than 4.25 V.

6. (Withdrawn) A charging device for a secondary lithium ion cell or battery, characterized in that said charging device controls a charge cut-off voltage to the single lithium ion cell within the range of greater than 4.3 V but less than 5.8 V.

7. (Withdrawn) A charging device according to claim 6, characterized in that said charging device controls a charge cut-off voltage to the single lithium ion cell within the range from 4.3 V to 5.2 V.

8. (Withdrawn) A charging device according to claim 6, characterized in that said charging device controls a charge cut-off voltage to the single lithium ion cell within the range from 4.3 V to 4.8 V.

9. (Previously Presented) An electronic device according to claim 4, wherein the ratio of positive electrode material to negative electrode material of the single lithium ion cell is from 1:1.15 to 1:2.5, as calculated by the theoretic capacity with the charge cut-off voltage set at 4.2V.

REMARKS

No claims are amended presently. Claims 1-9 are pending, with claims 1-3 and 6-8 withdrawn from consideration. Applicants request reconsideration of the application in view of the following comments.

A. Background

The "Background Art" section of the application states that 4.2V is an accepted charge cut-off voltage for secondary lithium ion batteries. Using a charge cut-off voltage greater than 4.2V results in an improved capacity and improved operating voltage. With that expediency, however, come negative side effects, such as structural changes in the positive and negative electrode materials, decomposition of the electrolyte, and reduced recycle properties, which have kept the battery industry from using a charge cut-off voltage greater than 4.2V.

The documents summarized in the background section of the application explicitly underscore these points. In contravention of the contemporaneous common opinion thus evidenced, however, applicants discovered an approach for raising the cut-off voltage above 4.2V that substantially avoids changes to the electrode materials and decomposition of the electrolyte.

In a manner wholly unforeseen by the art, therefore, applicants' approach also does not diminish the recycle property of the secondary lithium ion battery. By the same token, applicants' claimed invention comprises using a ratio from 1:1.0 to 1:2.5 for positive electrode material to negative electrode material of the single lithium ion cell, as calculated by the theoretic capacity with the charge cut-off voltage set at 4.2V.

Employing the ratio as presently recited cedes properties to a lithium ion battery that, as noted above, would have been unexpected in view of the art of record.

B. Outstanding Claim Rejection

The Office Action rejects claims 4 and 5 under 35 U.S.C. § 103(a) over U.S. patent No. 5,260,148 to Idota in view of WO 93/21665 to Guyomard *et al.* and U.S. patent No. 6,326,770 to Patino *et al*. Applicants traverse these rejections because the Idota, Guyomard, and Patino references fail to disclose or even to suggest the features of the claimed invention,

including use of a ratio from 1:1.0 to 1:2.5 for positive electrode material to negative electrode material of the single lithium ion cell, as calculated by the theoretic capacity with the charge cut-off voltage set at 4.2V.

No permutation of teachings reasonably gleaned from Idota, Guyomard, and Patino could have directed the skilled artisan, contrary to contemporaneous common opinion, to a ratio from 1:1.0 to 1:2.5 for positive electrode material to negative electrode material of the single lithium ion cell, as calculated by the theoretic capacity with the charge cut-off voltage set at 4.2V

The Office Action relies on Idota in column 3, lines 14-19, for an alleged disclosure of the ratio recited in claim 4. Applicants respectfully disagree, however, that Idota or any prior art of record implicates this ratio.

To the contrary, Idota fails to disclose the prescribed ratio of from 1:1.0 to 1:2.5 for positive electrode material to negative electrode material of the single lithium ion cell, as calculated by the theoretic capacity with the charge cut-off voltage set at 4.2V. Rather, the cited section of Idota advances a calculation of the ratio of the positive electrode material to negative electrode material by "ratio of equivalent amount," not "as calculated by the theoretic capacity with the charge cut-off voltage set at 4.2V."

Idota suggests nothing by way of whether the disclosed value is a weight ratio or a volume ratio. In either case, the ratio is not calculated based on capacity, as the claims prescribe. Accordingly, Idota does not disclose the capacity ratio recited in claim 4.

Neither Guyomard nor Patino implicates the calculation method of capacity-based ratio, per claim 4. Even were Idota, Guyomard and Patino combined, therefore, the result would not have suggested the ratio feature recited in claim 4; that is, a ratio from 1:1.0 to 1:2.5 for positive electrode material to negative electrode material of the single lithium ion cell, as calculated by the theoretic capacity with the charge cut-off voltage set at 4.2V.

Moreover, none of the cited references realizes or even hints at applicants' approach for raising the cut-off voltage above 4.2V, which mitigates changes to the electrode materials and decomposition of the electrolyte and which, through the recited ratio, does not diminish the recycle property of the secondary lithium ion battery. In light of the assert combination of references, that is, the skilled artisan could not have foreseen the effect where, in raising the cut-

off voltage above 4.2V, changes to the electrode materials and decomposition of the electrolyte are substantially avoided without diminishing the recycle property of the secondary lithium ion battery. These unexpected advantages achieved via applicants' approach further substantiates the patentability of the present claims over the art of record.

CONCLUSION

Applicants submit that the application is in condition for allowance, and an early indication to this effect is requested. Examiner Siddiquee also is invited to contact the undersigned directly, should he feel that any issue warrants further consideration.

The Commissioner is hereby authorized to charge any additional fees and to credit any overpayment to Deposit Account No. 19-0741. Should no proper payment accompany this response, then the Commissioner is authorized to charge the unpaid amount to the same deposit account. If any extension is needed for timely acceptance of submitted papers, then applicants hereby petition for such extension under 37 C.F.R. §1.136 and authorize payment of the relevant fee(s) from the deposit account.

Respectfully submitted,

Date February 26, 2013

By /Stephen A. Bent/

FOLEY & LARDNER LLP
Customer Number: 22428
Telephone: (202) 672-5404
Facsimile: (202) 672-5399

Stephen A. Bent
Attorney for Applicant
Registration No. 29,768

Electronic Acknowledgement Receipt	
EFS ID:	15050770
Application Number:	12817028
International Application Number:	
Confirmation Number:	4654
Title of Invention:	SECONDARY LITHIUM ION CELL OR BATTERY, AND PROTECTING CIRCUIT, ELECTRONIC DEVICE AND CHARGING DEVICE OF THE SAME
First Named Inventor/Applicant Name:	Xiaoping REN
Customer Number:	22428
Filer:	Stephen A. Bent/Tiawana Lanham
Filer Authorized By:	Stephen A. Bent
Attorney Docket Number:	042787-0109
Receipt Date:	26-FEB-2013
Filing Date:	16-JUN-2010
Time Stamp:	13:00:45
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	no

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1		042787_0109_Amendment.pdf	112342 8d9df3c72e07233bf5562052e496b766696 6b1f1	yes	6

	Multipart Description/PDF files in .zip description		
	Document Description	**Start**	**End**
	Amendment/Req. Reconsideration-After Non-Final Reject	1	1
	Claims	2	3
	Applicant Arguments/Remarks Made in an Amendment	4	6
Warnings:			
Information:			
	Total Files Size (in bytes):	112342	

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

<u>New Applications Under 35 U.S.C. 111</u>
If a new application is being filed and the application includes the necessary components for a filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application.

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

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

PTO/SB/06 (07-06)
Approved for use through 1/31/2007. OMB 0651-0032
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE
Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it displays a valid OMB control number.

PATENT APPLICATION FEE DETERMINATION RECORD Substitute for Form PTO-875	Application or Docket Number 12/817,028	Filing Date 06/16/2010	☐ To be Mailed

APPLICATION AS FILED – PART I

	(Column 1)	(Column 2)	SMALL ENTITY ☒		OR	OTHER THAN SMALL ENTITY	
FOR	NUMBER FILED	NUMBER EXTRA	RATE ($)	FEE ($)		RATE ($)	FEE ($)
☐ BASIC FEE (37 CFR 1.16(a), (b), or (c))	N/A	N/A	N/A			N/A	
☐ SEARCH FEE (37 CFR 1.16(k), (i), or (m))	N/A	N/A	N/A			N/A	
☐ EXAMINATION FEE (37 CFR 1.16(o), (p), or (q))	N/A	N/A	N/A			N/A	
TOTAL CLAIMS (37 CFR 1.16(i))	minus 20 =	*	X $ =		OR	X $ =	
INDEPENDENT CLAIMS (37 CFR 1.16(h))	minus 3 =	*	X $ =			X $ =	
☐ APPLICATION SIZE FEE (37 CFR 1.16(s))	If the specification and drawings exceed 100 sheets of paper, the application size fee due is $250 ($125 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			TOTAL	

APPLICATION AS AMENDED – PART II

		(Column 1)		(Column 2)	(Column 3)	SMALL ENTITY		OR	OTHER THAN SMALL ENTITY	
	02/26/2013	CLAIMS REMAINING AFTER AMENDMENT		HIGHEST NUMBER PREVIOUSLY PAID FOR	PRESENT EXTRA	RATE ($)	ADDITIONAL FEE ($)		RATE ($)	ADDITIONAL FEE ($)
AMENDMENT	Total (37 CFR 1.16(i))	* 9	Minus	** 20	= 0	X $31 =	0	OR	X $ =	
	Independent (37 CFR 1.16(h))	* 3	Minus	***3	= 0	X $125 =	0	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	0	OR	TOTAL ADD'L FEE	

		(Column 1)		(Column 2)	(Column 3)					
		CLAIMS REMAINING AFTER AMENDMENT		HIGHEST NUMBER PREVIOUSLY PAID FOR	PRESENT EXTRA	RATE ($)	ADDITIONAL FEE ($)		RATE ($)	ADDITIONAL FEE ($)
AMENDMENT	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 number found in the appropriate box in column 1.

Legal Instrument Examiner:
/PAMELA YOUNG/

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

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

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www.uspto.gov

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
12/817,028	06/16/2010	Xiaoping REN	042787-0109	4654

22428 7590 11/26/2012

FOLEY AND LARDNER LLP
SUITE 500
3000 K STREET NW
WASHINGTON, DC 20007

EXAMINER	
SIDDIQUEE, MUHAMMAD S	
ART UNIT	PAPER NUMBER
1726	

MAIL DATE	DELIVERY MODE
11/26/2012	PAPER

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.

Office Action Summary	Application No.	Applicant(s)	
	12/817,028	REN ET AL.	
	Examiner	Art Unit	
	MUHAMMAD SIDDIQUEE	1726	

-- 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* MONTH(S) OR THIRTY (30) DAYS, WHICHEVER IS LONGER, 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 *25 August 2011*.

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) *1-9* is/are pending in the application.

5a) Of the above claim(s) *1-3 and 6-8* is/are withdrawn from consideration.

6)☐ Claim(s) _____ is/are allowed.

7)☒ Claim(s) *4,5 and 9* is/are rejected.

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

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

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

Application Papers

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

11)☐ The drawing(s) filed on _____ is/are: a)☐ accepted or b)☐ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).

Priority under 35 U.S.C. § 119

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

a)☐ All b)☐ Some * c)☐ None of:

1.☐ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. _____.

3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

1) ☐ Notice of References Cited (PTO-892)

2) ☐ Information Disclosure Statement(s) (PTO/SB/08) Paper No(s)/Mail Date _____.

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

4) ☐ Other: _____.

DETAILED ACTION

Continued Examination Under 37 CFR 1.114

1. A request for continued examination under 37 CFR 1.114, including the fee set forth in 37 CFR 1.17(e), was filed in this application after final rejection. Since this application is eligible for continued examination under 37 CFR 1.114, and the fee set forth in 37 CFR 1.17(e) has been timely paid, the finality of the previous Office action has been withdrawn pursuant to 37 CFR 1.114. Applicant's submission filed on 8/25/2011 has been entered.

Response to Arguments

2. Applicant's arguments filed 8/25/2011 have been fully considered but they are not persuasive. In response to applicant's argument that using the cut-off voltage above 4.2V is wholly unforeseen by the art is not true. The references WO 93/21665 teaches using cut-off voltage above 4.2V.

Claim Rejections - 35 USC § 103

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

> (a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made.

4. The factual inquiries set forth in *Graham* v. *John Deere Co.*, 383 U.S. 1, 148 USPQ 459 (1966), that are applied for establishing a background for determining obviousness under 35 U.S.C. 103(a) 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. Claims 4-5 and 9 are rejected under 35 U.S.C. 103(a) as being unpatentable over Idota (US 5,260,148) in view of Guyomard et al (WO 93/21665) and Patino et al (US 6,326,770).

Regarding claims 4-5 and 9, Idota discloses a lithium secondary battery comprising an anode and a cathode where the ratio of the equivalent amount of the anode (negative electrode) active material to that of the cathode (positive electrode) active material be larger than 1 (i.e., the amount of the anode active material is more than equivalent to the cathode active material). The ratio thereof is more preferably from 1.1 to 5, most preferably from 1.1 to 3.5. [column 3, lines 14-19]. Idota does not specifically disclose battery is capable of being charged to between 4.2 volts to 5.8 volts. However, it is the position of the examiner that such properties are inherent, given that both Idota and the present application utilize the same ratio of anode active material and cathode active material. A reference which is silent about a claimed invention's features is inherently anticipatory if the missing feature is necessarily present in that which is described in the reference. *In re Robertson, 49 USPQ2d 1949 (1999).* Moreover, Guyomard discloses a battery where cut-off voltage is used up to 5 voltage for increased cycle life and enhanced cell capacity [Pages 1-4]. Idota/Guyomard remains silent about a protection circuit. However, Patino discloses electronic devices comprising battery system where protection circuit is used to limit voltage in the battery [column 1, lines 11-28]. Therefore, it would have been obvious to a person of ordinary

skill in the art at the time the invention was made to a protection circuit as taught by Patino in the battery of Idota/Guyomard in order to have a safer device.

Any inquiry concerning this communication or earlier communications from the examiner should be directed to MUHAMMAD SIDDIQUEE whose telephone number is (571)270-3719. The examiner can normally be reached on Monday-Thursday, 7:30 am to 5:30 pm EST.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Patrick Ryan can be reached on 571-272-1292. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

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/Muhammad Siddiquee/
Examiner, Art Unit 1726

/Patrick Joseph Ryan/
Supervisory Patent Examiner, Art Unit 1726

Index of Claims	Application/Control No.	Applicant(s)/Patent Under Reexamination
	12817028	REN ET AL.
	Examiner	**Art Unit**
	MUHAMMAD SIDDIQUEE	1795

✓	Rejected	-	Cancelled	N	Non-Elected	A	Appeal
=	Allowed	÷	Restricted	I	Interference	O	Objected

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

CLAIM		DATE								
Final	Original	08/11/2010	11/07/2010	04/22/2011	11/21/2012					
	1	÷	N	N	N					
	2	÷	N	N	N					
	3	÷	N	N	N					
	4	÷	✓	✓	✓					
	5	÷	✓	✓	✓					
	6	÷	N	N	N					
	7	÷	N	N	N					
	8	÷	N	N	N					
	9				✓					

EAST Search History

EAST Search History (Prior Art)

Ref #	Hits	Search Query	DBs	Default Operator	Plurals	Time Stamp
S1	6	US-1135103-$.DID. OR US-1185860-$.DID. OR JP-2000270491-$.DID.	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT	NEAR	ON	2008/07/09 11:57
S2	2	"5604418".pn.	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT	NEAR	ON	2008/07/09 11:59
S3	1	"5604418".pn.	US-PGPUB; USPAT; USOCR	NEAR	ON	2008/07/09 11:59
S4	196	US-5743921-$.DID. OR US-5920181-$.DID. OR US-5969502-$.DID. OR US-5648187-$.DID. OR US-5962166-$.DID. OR US-5986430-$.DID. OR US-6194874-$.DID. OR US-5998051-$.DID. OR US-5604057-$.DID. OR US-6025696-$.DID. OR US-5674644-$.DID. OR US-6043629-$.DID. OR US-6137265-$.DID. OR US-6046514-$.DID. OR US-5939864-$.DID. OR US-6046575-$.DID. OR US-6114835-$.DID. OR US-6075343-$.DID. OR US-4888258-$.DID. OR US-6104165-$.DID. OR US-5192629-$.DID. OR US-6127804-$.DID. OR US-5587133-$.DID. OR US-6221531-$.DID. OR US-5631539-$.DID. OR US-5635138-$.DID. OR US-6228528-$.DID. OR US-5705291-$.DID. OR US-6242893-$.DID. OR US-6057670-$.DID. OR US-6245464-$.DID. OR US-6091227-$.DID. OR US-4299890-$.DID. OR US-6143444-$.DID. OR US-4362794-$.DID. OR US-6204634-$.DID. OR US-4414093-$.DID. OR US-4268587-$.DID. OR US-5196279-$.DID. OR US-4419421-$.DID. OR US-5209871-$.DID. OR US-5686808-$.DID. OR US-5215821-$.DID. OR US-5763119-$.DID. OR US-5225056-$.DID. OR US-5783333-$.DID. OR US-5332631-$.DID. OR US-5908715-$.DID. OR US-5376478-$.DID. OR US-5952815-$.DID. OR US-5413883-$.DID. OR US-6007947-$.DID. OR US-5514490-$.DID. OR US-6027836-$.DID. OR US-5518842-$.DID. OR US-6040684-$.DID. OR US-5527644-$.DID. OR US-6048645-$.DID. OR US-5571634-$.DID. OR US-6175213-$.DID.	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT	NEAR	ON	2008/07/09 12:01

		OR US-5591546-$.DID. OR US-6236215-$.DID. OR US-5604415-$.DID. OR US-4336315-$.DID. OR US-5616429-$.DID. OR US-4591538-$.DID. OR US-5645960-$.DID. OR US-4633373-$.DID. OR US-5667914-$.DID. OR US-4960657-$.DID. OR US-5684383-$.DID. OR US-4968393-$.DID. OR US-5703463-$.DID. OR US-5481174-$.DID. OR US-5734253-$.DID. OR US-5496663-$.DID. OR US-5744939-$.DID. OR US-5519563-$.DID. OR US-5780991-$.DID. OR US-5539299-$.DID. OR US-5818203-$.DID. OR US-5610495-$.DID. OR US-5818199-$.DID. OR US-5671375-$.DID. OR US-5825155-$.DID. OR US-5744937-$.DID. OR US-5866279-$.DID. OR US-5764028-$.DID. OR US-5872444-$.DID. OR US-5804944-$.DID. OR US-5903131-$.DID. OR US-5818201-$.DID. OR US-5905362-$.DID. OR US-5831350-$.DID. OR US-5932373-$.DID. OR US-5858573-$.DID. OR US-5945804-$.DID. OR US-5903137-$.DID. OR US-5963019-$.DID.				
S7	1	10/491134	US-PGPUB; USPAT; USOCR	NEAR	ON	2008/07/09 12:04
S18	17537	(charge near5 ((cut-off or cut off) near5 voltage) or ((cut-off or cut off) near5 voltage))	US-PGPUB; USPAT; USOCR	NEAR	ON	2008/07/11 18:21
S19	12169	S18 not (battery or celectrochemical cell)	US-PGPUB; USPAT; USOCR	NEAR	ON	2008/07/11 18:22
S20	5368	S18 not S19	US-PGPUB; USPAT; USOCR	NEAR	ON	2008/07/11 18:22
S21	2857	(positive electrode or negative electrode or anode or cathode) near5 material with ratio	US-PGPUB; USPAT; USOCR	NEAR	ON	2008/07/11 18:23
S22	724	S21 not (battery or celectrochemical cell)	US-PGPUB; USPAT; USOCR	NEAR	ON	2008/07/11 18:23
S23	2133	S21 not S22	US-PGPUB; USPAT; USOCR	NEAR	ON	2008/07/11 18:24
S24	5	S20 same S23	US-PGPUB; USPAT; USOCR	NEAR	ON	2008/07/11 18:24
S25	153	S20 and S23	US-PGPUB; USPAT; USOCR	NEAR	ON	2008/07/11 18:24

S26	62	S25 and @ad<"20020928"	US-PGPUB; USPAT; USOCR	NEAR	ON	2008/07/11 18:25
S27	9	JP-01304664-$.DID. OR WO-03030293-$.DID. OR WO-2004021502-$.DID. OR EP-1189299-$.DID. OR EP-1324418-$.DID.	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT	NEAR	ON	2008/07/11 18:36
S28	9	US-7128998-$.DID. OR US-5464705-$.DID. OR US-20010024757-$.DID. OR US-20040209156-$.DID. OR US-20050196664-$.DID.	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT	NEAR	ON	2008/07/11 18:37
S29	924	(ratio with positive adj electrode with negative adj electrode with material) or (ratio with anode with cathode with material)	US-PGPUB; USPAT; USOCR	NEAR	ON	2008/07/11 19:31
S30	97	(ratio near5 positive adj electrode near5 negative adj electrode near5 material) or (ratio near5 anode near5 cathode near5 material)	US-PGPUB; USPAT; USOCR	NEAR	ON	2008/07/11 19:33
S31	5	S20 and S30	US-PGPUB; USPAT; USOCR	NEAR	ON	2008/07/11 19:38
S32	0	S26 and (overcharg$4 near5 protect$4 near5 voltage)	US-PGPUB; USPAT; USOCR	NEAR	ON	2008/07/11 20:53
S33	228	(overcharg$4 near5 protect$4 near5 voltage)	US-PGPUB; USPAT; USOCR	NEAR	ON	2008/07/11 20:53
S34	0	S30 and (overcharg$4 near5 protect$4 near5 voltage)	US-PGPUB; USPAT; USOCR	NEAR	ON	2008/07/11 20:54
S35	0	S30 and S33	US-PGPUB; USPAT; USOCR	NEAR	ON	2008/07/11 20:54
S36	116	S33 and @ad<"20020928"	US-PGPUB; USPAT; USOCR	NEAR	ON	2008/07/11 20:55
S37	5	S30 and (overcharg$4 near5 voltage)	US-PGPUB; USPAT; USOCR	NEAR	ON	2008/07/11 20:57
S38	4	S26 and (overcharg$4 near5 voltage)	US-PGPUB; USPAT; USOCR	NEAR	ON	2008/07/11 20:57
S39	44	S26 and (charg$4 near5 volt$4) and discharg$4 near5 volt$4	US-PGPUB; USPAT;	NEAR	ON	2008/07/11 21:01

			USOCR			
S40	38	S26 and((charg$4 near5 volt$4) with (discharg$4 near5 volt$4))	US-PGPUB; USPAT; USOCR	NEAR	ON	2008/07/11 21:01
S41	2	09/768298	US-PGPUB; USPAT; USOCR	NEAR	ON	2008/07/12 09:08
S42	1	10/320319	US-PGPUB; USPAT; USOCR	NEAR	ON	2008/07/12 09:13
S43	8	US-6453198-$.DID. OR US-6544689-$.DID. OR US-6617074-$.DID. OR US-6706441-$.DID.	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT	NEAR	ON	2008/07/12 10:10
S44	15	overcharge near5 releas$4 near5 volt$4	US-PGPUB; USPAT; USOCR	NEAR	ON	2008/07/12 12:50
S45	146	429/60.ccls.	US-PGPUB; USPAT; USOCR	NEAR	ON	2008/07/12 13:17
S46	97	S45 and (ratio near5 positive adj electrode near5 negative adj electrode near5 material) or (ratio near5 anode near5 cathode near5 material)	US-PGPUB; USPAT; USOCR	NEAR	ON	2008/07/12 13:18
S48	1737	429/231.95.ccls.	US-PGPUB; USPAT; USOCR	NEAR	ON	2008/07/12 13:20
S49	710	S48 and (charg$4 near5 volt$4) and discharg$4 near5 volt$4	US-PGPUB; USPAT; USOCR	NEAR	ON	2008/07/12 13:22
S50	22	(SUN-JIE or REN-XIAOPING).in.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT	NEAR	ON	2008/07/12 13:23
S51	1	S50 and (charg$4 near5 volt$4) and discharg$4 near5 volt$4	US-PGPUB; USPAT; USOCR	NEAR	ON	2008/07/12 13:24
S52	1	"5654622".pn.	US-PGPUB; USPAT; USOCR	NEAR	ON	2009/01/02 18:23
S53	8	US-1135103-$.DID. OR US-1185860-$.DID. OR US-5604418-$.DID. OR JP-2000270491-$.DID.	US-PGPUB; USPAT; USOCR; EPO; JPO;	NEAR	ON	2009/01/02 18:27

			DERWENT			
S55	1	10/491134	US-PGPUB; USPAT; USOCR	NEAR	ON	2009/01/02 18:33
S56	17919	(charge near5 ((cut-off or cut off) near5 voltage) or ((cut-off or cut off) near5 voltage))	US-PGPUB; USPAT; USOCR	NEAR	ON	2009/01/02 18:36
S57	99	S56 same ("4.3" V or "4.4" V or "4.5" V or "4.6" V)	US-PGPUB; USPAT; USOCR	NEAR	ON	2009/01/02 18:38
S58	129	S56 same ("4.2" V)	US-PGPUB; USPAT; USOCR	NEAR	ON	2009/01/02 18:38
S59	5	"6558848"	US-PGPUB; USPAT; USOCR	NEAR	ON	2009/01/10 16:26
S60	39	(US-20030082448-$ or US-20030049534-$ or US-20040209156-$ or US-20010024757-$ or US-20020098416-$ or US-20020086214-$ or US-20020076612-$ or US-20030113613-$ or US-20010023983-$).did. or (US-5604418-$ or US-5464705-$ or US-7135251-$ or US-6998071-$ or US-6949312-$ or US-6617073-$ or US-6558847-$ or US-6558843-$ or US-6436577-$ or US-5478673-$ or US-7001690-$ or US-6528033-$ or US-6451483-$ or US-6268087-$ or US-5882218-$ or US-5744264-$ or US-5716728-$ or US-5344431-$ or US-5260148-$ or US-6071489-$ or US-6040090-$ or US-5998063-$ or US-5965293-$ or US-6756154-$ or US-6558848-$ or US-6497980-$).did. or (US-5654622-$).did. or (EP-1189299-$).did. or (JP-2000270491-$).did. or (JP-2000270491-$ or US-20010024757-A-$ or EP-1189299-A-$).did.	US-PGPUB; USPAT; EPO; JPO; DERWENT	NEAR	ON	2009/01/10 16:30
S61	18	S60 and cut-off voltage	US-PGPUB; USPAT; USOCR	NEAR	ON	2009/01/10 16:31
S62	9	cut-off voltage with "4.5V"	US-PGPUB; USPAT; USOCR	NEAR	ON	2009/01/10 16:43
S63	46	cut-off voltage with ("4.5V" or "4.4V" or "4.35V" or "4.3" V)	US-PGPUB; USPAT; USOCR	NEAR	ON	2009/01/10 16:45
S64	32	TANAKA-MITSUTOSHI.in.	US-PGPUB; USPAT;	NEAR	ON	2009/01/10 17:07

			USOCR			
S65	171	TANAKA-MITSUTOSHI.in.	JPO	NEAR	ON	2009/01/10 17:08
S68	10	S65 and ratio	JPO	NEAR	ON	2009/01/10 17:09
S69	980	(ratio with positive adj electrode with negative adj electrode with material) or (ratio with anode with cathode with material)	US-PGPUB; USPAT; USOCR	NEAR	ON	2009/01/10 18:28
S70	24	((cut-off or cut off) near3 voltage) with ("4.5V" or "4.4V" or "4.35V" or "4.3V")	US-PGPUB; USPAT; USOCR	NEAR	ON	2009/01/10 18:31
S71	1963	(((cut-off or cut off) near3 voltage) or voltage) with ("4.5V" or "4.4V" or "4.35V" or "4.3V")	US-PGPUB; USPAT; USOCR	NEAR	ON	2009/01/10 18:32
S72	28	S69 and S71	US-PGPUB; USPAT; USOCR	NEAR	ON	2009/01/10 18:32
S73	26	"5487960"	US-PGPUB; USPAT; USOCR	NEAR	ON	2009/08/11 15:50
S74	1	"5487960".pn.	US-PGPUB; USPAT; USOCR	NEAR	ON	2009/08/11 15:50
S75	12	("5213914" | "5464705" | "5693435" | "5763119" | "5885544" | "5989744" | "6022640" | "6153336" | "6453198" | "6544689" | "6617074" | "6706441").PN.	US-PGPUB; USPAT; USOCR	NEAR	ON	2009/09/02 12:21
S76	3	(capacity ratio or specific capacity) with "400" cycle	US-PGPUB; USPAT; USOCR	NEAR	ON	2010/01/14 09:13
S77	859	(capacity ratio or specific capacity) with cycle	US-PGPUB; USPAT; USOCR	NEAR	ON	2010/01/14 09:14
S78	1	"5487960".pn.	US-PGPUB; USPAT; USOCR	NEAR	ON	2010/01/14 09:57
S82	2	US-5604418-$.DID.	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT	NEAR	ON	2010/01/14 18:36
S83	18851	(charge near5 ((cut-off or cut off) near5 voltage) or ((cut-off or cut off) near5 voltage))	US-PGPUB; USPAT; USOCR	NEAR	ON	2010/01/14 18:43
S84	16890	"320"/$.ccls.	US-PGPUB;	NEAR	ON	2010/01/14 18:44

			USPAT; USOCR			
S85	596	S83 and S84	US-PGPUB; USPAT; USOCR	NEAR	ON	2010/01/14 18:44
S86	1	S85 and (capacity ratio or specific capacity) with cycle	US-PGPUB; USPAT; USOCR	NEAR	ON	2010/01/14 18:46
S87	17	S85 and (capacity ratio or specific capacity)	US-PGPUB; USPAT; USOCR	NEAR	ON	2010/01/14 18:46
S88	1109	429/49,50.ccls.	US-PGPUB; USPAT; USOCR	NEAR	ON	2010/01/14 18:47
S89	16	S83 and S88	US-PGPUB; USPAT; USOCR	NEAR	ON	2010/01/14 18:47
S90	51	S88 and (capacity ratio or specific capacity)	US-PGPUB; USPAT; USOCR	NEAR	ON	2010/01/14 18:48
S91	785	"320"/137.ccls.	US-PGPUB; USPAT; USOCR	NEAR	ON	2010/01/14 18:49
S92	21	S83 and S91	US-PGPUB; USPAT; USOCR	NEAR	ON	2010/01/14 18:49
S94	1	12/817028	US-PGPUB; USPAT; USOCR	NEAR	ON	2010/11/07 15:23
S95	44	(US-20030082448-$ or US-20030049534-$ or US-20040209156-$ or US-20010024757-$ or US-20020098416-$ or US-20020086214-$ or US-20020076612-$ or US-20030113613-$ or US-20010023983-$ or US-20100253292-$).did. or (US-5604418-$ or US-5464705-$ or US-7135251-$ or US-6998071-$ or US-6949312-$ or US-6617073-$ or US-6558847-$ or US-6558843-$ or US-6436577-$ or US-5478673-$ or US-7001690-$ or US-6528033-$ or US-6451483-$ or US-6268087-$ or US-5882218-$ or US-5744264-$ or US-5716728-$ or US-5344431-$ or US-5260148-$ or US-6071489-$ or US-6040090-$ or US-5998063-$ or US-5965293-$ or US-6756154-$ or US-6558848-$ or US-6497980-$).did. or (US-5654622-$ or US-5487960-$ or US-6432585-$ or US-6459564-$).did. or	US-PGPUB; USPAT; EPO; JPO; DERWENT	NEAR	ON	2010/11/07 15:24

		(EP-1189299-$).did. or (JP-2000270491-$ or JP-63250566-$).did. or (JP-2000270491-$ or US-20010024757-A-$ or EP-1189299-A-$).did.				
S96	20	S95 and (electronic device or (computer or laptop or phone))	US-PGPUB; USPAT; USOCR	NEAR	ON	2010/11/07 15:25
S97	32	((cut-off or cut off) near3 voltage) with ("4.5V" or "4.4V" or "4.35V" or "4.3V")	US-PGPUB; USPAT; USOCR	NEAR	ON	2010/11/07 15:33
S98	4	S95 and S97	US-PGPUB; USPAT; USOCR	NEAR	ON	2010/11/07 15:34
S99	2	S98 and (electronic device or (computer or laptop or phone))	US-PGPUB; USPAT; USOCR	NEAR	ON	2010/11/07 15:36
S100	0	((cut-off or cut off) near3 voltage) with ("4.5V" or "4.4V" or "4.35V" or "4.3V") same protect$4 near3 circuit	US-PGPUB; USPAT; USOCR	NEAR	ON	2010/11/07 15:41
S101	1	((cut-off or cut off) near3 voltage) with ("4.5V" or "4.4V" or "4.35V" or "4.3V") and protect$4 near3 circuit	US-PGPUB; USPAT; USOCR	NEAR	ON	2010/11/07 15:41
S102	1	((cut-off or cut off) near3 voltage) with ("4.5V" or "4.4V" or "4.35V" or "4.3V" or "4.2V") and protect$4 near3 circuit	US-PGPUB; USPAT; USOCR	NEAR	ON	2010/11/07 15:42
S103	93	((cut-off or cut off) near3 voltage) with ("4.5V" or "4.4V" or "4.35V" or "4.3V" or "4.2V")	US-PGPUB; USPAT; USOCR	NEAR	ON	2010/11/07 15:43
S104	7	((cut-off or cut off) near3 voltage) with ("4.5V" or "4.4V" or "4.35V" or "4.3V" or "4.2V") same circuit	US-PGPUB; USPAT; USOCR	NEAR	ON	2010/11/07 15:43
S105	2	overcharge release voltage with ("4.5V" or "4.4V" or "4.35V" or "4.3V" or "4.2V")	US-PGPUB; USPAT; USOCR	NEAR	ON	2010/11/07 15:49
S106	8	overcharge voltage with ("4.5V" or "4.4V" or "4.35V" or "4.3V" or "4.2V")	US-PGPUB; USPAT; USOCR	NEAR	ON	2010/11/07 15:49
S107	10	overcharge voltage same ("4.5V" or "4.4V" or "4.35V" or "4.3V" or "4.2V")	US-PGPUB; USPAT; USOCR	NEAR	ON	2010/11/07 15:53
S108	2	S107 not S106	US-PGPUB; USPAT; USOCR	NEAR	ON	2010/11/07 15:53
S109	1	"6558848".pn.	US-PGPUB; USPAT;	NEAR	ON	2010/11/07 18:39

			USOCR			
S110	1	S109 and (charge near5 ((cut-off or cut off) near5 voltage))	US-PGPUB; USPAT; USOCR	NEAR	ON	2010/11/07 18:40
S111	1	S109 and (cut-off or cut off)	US-PGPUB; USPAT; USOCR	NEAR	ON	2010/11/07 18:40
S112	152	(Kobayash-Naoya or Kawakami-Soichiro).in.	US-PGPUB; USPAT; USOCR	NEAR	ON	2010/11/07 18:42
S113	5	S112 and (charge near5 ((cut-off or cut off) near5 voltage))	US-PGPUB; USPAT; USOCR	NEAR	ON	2010/11/07 18:42
S114	152	(Kobayash-Naoya or Kawakami-Soichiro).in.	US-PGPUB; USPAT; USOCR	NEAR	ON	2010/11/07 20:51
S115	78	S114 and circuit	US-PGPUB; USPAT; USOCR	NEAR	ON	2010/11/07 20:51
S116	0	S114 and protect$ circuit	US-PGPUB; USPAT; USOCR	NEAR	ON	2010/11/07 20:52
S117	0	S114 and cut-off circuit	US-PGPUB; USPAT; USOCR	NEAR	ON	2010/11/07 20:53
S118	1	S114 and charge circuit	US-PGPUB; USPAT; USOCR	NEAR	ON	2010/11/07 20:54
S119	15896	battery same protect$4 with circuit	US-PGPUB; USPAT; USOCR	NEAR	ON	2010/11/07 20:58
S120	5885	battery with protect$4 near3 circuit	US-PGPUB; USPAT; USOCR	NEAR	ON	2010/11/07 20:59
S121	749	battery with voltage near3 protect$4 near3 circuit	US-PGPUB; USPAT; USOCR	NEAR	ON	2010/11/07 20:59
S124	1	S121 and ((cut-off or cut off) near3 voltage) with ("4.5V" or "4.4V" or "4.35V" or "4.3V")	US-PGPUB; USPAT; USOCR	NEAR	ON	2010/11/07 21:07
S125	39	S121 and ((cut-off or cut off) near3 voltage)	US-PGPUB; USPAT; USOCR	NEAR	ON	2010/11/07 21:07
S126	7	S121 same ((cut-off or cut off) near3	US-	NEAR	ON	2010/11/07

		voltage)	PGPUB; USPAT; USOCR			21:08
S127	7	US-5604418-$.DID. OR US-4185487-$.DID. OR US-5487960-$.DID. OR US-5260148-$.DID. OR US-20030113613-$.DID. OR US-6558848-$.DID. OR US-1135103-$.DID. OR US-1185860-$.DID. OR JP-2000270491-$.DID.	USPAT	NEAR	ON	2010/11/07 22:17
S128	18	US-5604418-$.DID. OR US-4185487-$.DID. OR US-5487960-$.DID. OR US-5260148-$.DID. OR US-20030113613-$.DID. OR US-6558848-$.DID. OR US-1135103-$.DID. OR US-1185860-$.DID. OR JP-2000270491-$.DID.	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT	NEAR	ON	2010/11/07 22:17
S129	18	US-5604418-$.DID. OR US-4185487-$.DID. OR US-5487960-$.DID. OR US-5260148-$.DID. OR US-20030113613-$.DID. OR US-6558848-$.DID. OR US-1135103-$.DID. OR US-1185860-$.DID. OR JP-2000270491-$.DID.	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT	NEAR	ON	2010/11/07 22:17
S130	22	(SUN-JIE or REN-XIAOPING).in.	US-PGPUB; USPAT; USOCR	NEAR	ON	2010/11/07 22:37
S131	3	S130 and ((cut-off or cut off) near3 voltage)	US-PGPUB; USPAT; USOCR	NEAR	ON	2010/11/07 22:38
S132	0	WO-96/24168-$.DID.	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT	NEAR	ON	2011/04/22 10:57
S133	1	WO-9624168-$.DID.	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT	NEAR	ON	2011/04/22 10:57
S134	1	10/320319	US-PGPUB; USPAT; USOCR	NEAR	ON	2012/11/21 11:56

11/21/2012 12:48:14 PM
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Search Notes	Application/Control No.	Applicant(s)/Patent Under Reexamination
	12817028	REN ET AL.
	Examiner	Art Unit
	MUHAMMAD SIDDIQUEE	1726

SEARCHED			
Class	Subclass	Date	Examiner
429	60, 231.95	11/7/2010	MSS

SEARCH NOTES		
Search Notes	Date	Examiner
Consulted with Jonathan Crepeau in Art unit 1795	11/3/2010	MSS
Searched for Inventor in EAST and PALM	11/14/2010	MSS
Class 429/60,231.95 was limited by text, see EAST search history.	11/7/2010	MSS
Searched USPAT, US-PGPUB, USOCR	11/7/2010	MSS
See EAST search results	11/21/2012	MSS

INTERFERENCE SEARCH			
Class	Subclass	Date	Examiner

/MUHAMMAD SIDDIQUEE/ Examiner.Art Unit 1726	

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Applicant:	Xiaoping REN *et al.*
Title:	**SECONDARY LITHIUM ION CELL OR BATTERY, AND PROTECTING CIRCUIT, ELECTRONIC DEVICE AND CHARGING DEVICE OF THE SAME**
Appl. No.:	12/817,028
Appl. Filing Date:	6/16/2010
Examiner:	Muhammad S. Siddiquee
Art Unit:	1726
Confirmation No.:	4654

REQUEST FOR CONTINUED EXAMINATION (RCE) TRANSMITTAL

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

Sir:

This is a Request for Continued Examination (RCE) under 37 C.F.R. § 1.114 of the above-identified application. This RCE and the enclosed items listed below are being filed prior to the earliest of: (1) payment of the issue fee (unless a petition under 37 C.F.R. § 1.313 is granted); (2) abandonment of the application; or (3) the filing of a notice of appeal to the U.S. Court of Appeals for the Federal Circuit under 35 U.S.C. §141, or the commencement of a civil action under 35 U.S.C. §145 or §146 (unless the appeal or civil action is terminated).

1. Submission **required** under 37 C.F.R. §1.114: (check items that apply)

a. Previously submitted:

[ ] Please enter and consider the amendment and/or reply previously filed on __.

[ ] Please consider the Affidavit(s)/Declaration(s) previously filed on __ but not considered.

[ ] Please consider the arguments in the Appeal Brief or Reply previously filed on __.

[ ] Other __.

b. Enclosed are:

[**X**] Amendment/Reply.

[ ] Affidavit(s)/Declaration(s).

[ ] Information Disclosure Statement.

[ ] Form PTO/SB/08 with copies of ___ listed reference(s).

[ ] Other .

Miscellaneous:

[ ] Suspension of action of the above-identified application is requested under 37 C.F.R. § 1.103(c) for a period of __ months.

The filing fee is calculated below:

	Claims as Amended		Previously Paid For		Extra Claims Present		Rate		Fee Totals
RCE Fee 1.17(e):							$810.00	=	$810.00
Total Claims:	8	-	20	=	0	x	$52.00	=	$0.00
Independents	3	-	3	=	0	x	$220.00	=	$0.00
First presentation of any Multiple Dependent Claims:						+	$390.00	=	$0.00
CLAIMS FEE TOTAL:								=	$810.00

[**X**] Applicant hereby petitions for an extension of time under 37 C.F.R. §1.136(a) for the total number of months checked below:

[X]	Extension for response filed within the first month:	$130.00	1	$130.00
[ ]	Extension for response filed within the second month:	$490.00		$0.00
[ ]	Extension for response filed within the third month:	$1,110.00		$0.00
[ ]	Extension for response filed within the fourth month:	$1,730.00		$0.00
[ ]	Extension for response filed within the fifth month:	$2,350.00		$0.00
			EXTENSION FEE SUBTOTAL:	$130.00
			EXTENSION FEE ALREADY PAID: -	$0.00
			EXTENSION FEE TOTAL	$130.00
			CLAIMS AND EXTENSION FEE TOTAL:	$940.00
[X]	Small Entity Fees Apply (subtract ½ of above):			$470.00
[ ]	Suspension of action requested under 37 C.F.R. § 1.103(c)			$0.00
			TOTAL FEE:	$470.00

The above-identified fees of $470.00 are being paid by credit card via EFS-Web.

The Commissioner is hereby authorized to charge any additional fees, which may be required under 37 C.F.R. §§ 1.16-1.17, and to credit any overpayment to Deposit Account No. 19-0741. Should no proper payment accompany this paper, then the Commissioner is authorized to charge the unpaid amount to the same deposit account.

Please direct all correspondence to the undersigned attorney at the indicated address.

Respectfully submitted,

Date August 25, 2011

By /Stephen A. Bent/

FOLEY & LARDNER LLP
Customer Number: 22428
Telephone: (202) 672-5404
Facsimile: (202) 672-5399

Stephen A. Bent
Attorney for Applicant
Registration No. 29,768

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Applicants:	Xiaoping REN *et al.*
Title:	SECONDARY LITHIUM ION CELL OR BATTERY, AND PROTECTING CIRCUIT, ELECTRONIC DEVICE AND CHARGING DEVICE OF THE SAME
Appl. No.:	12/817,028
Filing Date:	6/16/2010
Examiner:	Muhammad S. Siddiquee
Art Unit:	1726
Confirmation Number:	4654

AMENDMENT ACCOMPANYING RCE UNDER 37 CFR § 1.114

Mail Stop RCE
Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450
Sir:

This communication is responsive to a non-final Office Action dated April 28, 2011, concerning the captioned application. The response is timely by virtue of the accompanying petition and payment of the relevant fees.

Amendments to the Claims are reflected in the listing of claims which begins on page 2 of this document.

Remarks/Arguments begin on page 4 of this document.

AMENDMENTS TO THE CLAIMS

This replaces all prior versions and listings of claims in the application.

Listing of Claims

1. (Withdrawn) A secondary lithium ion cell or battery, characterized in that the single secondary lithium ion cell has a charge cut-off voltage of greater than 4.2 V but less than 5.8 V, and the ratio of positive electrode material to negative electrode material of the single cell is from 1:1.0 to 1:2.5, as calculated by the theoretic capacity with the charge cut-off voltage set at 4.2 V.

2. (Withdrawn) A protecting circuit for the secondary lithium ion cell or battery according to claim 1, characterized in that the single lithium ion cell of said protecting circuit has a first overcharge protection voltage of greater than 4.35 V, and an overcharging protection release voltage of greater than 4.15 V.

3. (Withdrawn) A protecting circuit according to claim 2, characterized in that the single lithium ion cell of said protecting circuit has a first overcharge protection voltage of greater than 4.45 V, and an overcharge protection release voltage of greater than 4.25 V.

4. (Previously Presented) An electronic device using a secondary lithium ion cell or battery as energy source, characterized in that said electronic device comprises a protecting circuit, wherein the single lithium ion cell has a first overcharging protection voltage of greater than 4.35 V, and an overcharge protection release voltage of greater than 4.15 V, and wherein the ratio of positive electrode material to negative electrode material of the single lithium ion cell is from 1:1.0 to 1:2.5, as calculated by the theoretic capacity with the charge cut-off voltage set at 4.2V.

5. (Original) An electronic device according to claim 4, characterized in that said electronic device comprises a protecting circuit, wherein the single lithium ion cell has a first overcharging protection voltage of greater than 4.45 V, and an overcharge protection release voltage of greater than 4.25 V.

6. (Withdrawn) A charging device for a secondary lithium ion cell or battery, characterized in that said charging device controls a charge cut-off voltage to the single lithium ion cell within the range of greater than 4.3 V but less than 5.8 V.

7. (Withdrawn) A charging device according to claim 6, characterized in that said charging device controls a charge cut-off voltage to the single lithium ion cell within the range from 4.3 V to 5.2 V.

8. (Withdrawn) A charging device according to claim 6, characterized in that said charging device controls a charge cut-off voltage to the single lithium ion cell within the range from 4.3 V to 4.8 V.

9. (New) An electronic device according to claim 4, wherein the ratio of positive electrode material to negative electrode material of the single lithium ion cell is from 1:1.15 to 1:2.5, as calculated by the theoretic capacity with the charge cut-off voltage set at 4.2V.

REMARKS

Applicants request reconsideration of this application in view of the foregoing amendments and these remarks.

At the time of the present action, claims 1-8 were pending, with non-elected claims 1-3 and 6-8 withdrawn. No claims are amended presently. New claim 9 depends from claim 4. No new matter has been added. Thus, claims 4, 5, and 9 are pending for examination.

A. Background

After the fashion of the Amendment filed February 9, 2011, applicants again provide some prefatory comments to aid the examiner in understanding the claimed invention.

The "Background Art" section of the application states that 4.2V is an accepted charge cut-off voltage for secondary lithium ion batteries. Using a charge cut-off voltage greater than 4.2V results in an improved capacity and improved operating voltage. With that expediency, however, come negative side effects, such as structural changes in the positive and negative electrode materials, decomposition of the electrolyte, and reduced recycle properties, which have kept the battery industry from using a charge cut-off voltage greater than 4.2V. This point is amply evidenced in the documents cited and summarized in the background section.

In contravention of contemporaneous common opinion, applicants discovered an approach for raising the cut-off voltage above 4.2V that substantially avoids changes to the electrode materials and decomposition of the electrolyte. In a manner wholly unforeseen by the art, applicants' approach also does not diminish the recycle property of the secondary lithium ion battery.

Applicants' claimed invention thus comprises using (1) an overcharging protection voltage of greater than 4.35 V and (2) a ratio from 1:1.0 to 1:2.5 for positive electrode material to negative electrode material of the single lithium ion cell, as calculated by the theoretic capacity with the charge cut-off voltage set at 4.2V. Employing such ratio and voltage threshold, as presently recited, cedes properties to a lithium ion battery that, as noted above, would have been unexpected in view of the art of record.

B. Outstanding Claim Rejection

The Office Action rejects claims 4 and 5 under 35 U.S.C. § 103(a) over U.S. patent No. 5,260,148 to Idota in view of WO 96/24168 to Amatucci and U.S. patent No. 6,326,770 to Patino *et al*. Applicants traverse these rejections because the Idota, Amatucci, and Patino references fail to disclose or even to suggest the features of the claimed invention, which uses (1) an overcharging protection voltage of greater than 4.35 V and (2) a ratio from 1:1.0 to 1:2.5 for positive electrode material to negative electrode material of the single lithium ion cell, as calculated by the theoretic capacity with the charge cut-off voltage set at 4.2V.

With respect to feature (1) and the cutoff voltage used, the Office relies on Amatucci, stating on page 3 of the Action that "Amatucci … discloses battery where cut-off voltage is used up to 5.2 voltage for electrolyte stability and enhanced cell capacity [page 1-2; Example 1, page 12]."

Contrary to this assertion, however, Amatucci does ***not*** disclose a lithium ion battery that has a charge cut-off voltage of greater than 4.2 V but less than 5.8 V, as presently recited. Rather, Amatucci discloses applying a voltage of greater than 4.2 volts in the process of preparing the CoO_2 phase and NiO_2 phase for the material of the prior-art cell. During the use of Amatucci's cell, where the voltage is cycled in a range, the cut-off voltage of Amatucci is not greater than 4.2 V.

On this point applicants would direct the examiner to commentary of the reference on page 9, line 25 to page 10, line 21. There Amatucci details of the preparation of the CoO_2 phase and NiO_2 phase for the material of its cell as follows. First, in order to prepare the CoO_2 phase, a voltage of 5.2V is applied to the cell, which will deintercalate substantially all the lithium from the $LiCoO_2$ cathode. Secondly, in order to prepare the NiO_2 phase, a similar process is employed by applying to the cell a voltage of 5.1V. Thirdly, after the complete delithiation, both of the oxides of CoO_2 and NiO_2 are reintercalated so as to be used as the cathode in a finished cell.

Thus, Amatucci merely discloses that the voltages of 5.1V and 5.2V are employed in the preparation of a particular oxide phase, prior to the cell being finished, not that such voltages are used in the practical cycle during operation of the cell. Indeed, while Amatucci does disclose the voltages applied in the cycling of its cell in operation, the voltages are not greater than 4.2V.

For instance, the reference discloses on page 10, lines 18-21: "Following reintercalation, these phases can, for example, be cycled with lithium between 3.0V and 4.2V for CoO_2 phase and 2.8V and 4.1V for NiO_2 phase without loss of cell capacity" (emphasis added). Amatucci's Example 1 further provides, on page 13 at lines 3-6, that "[f]ollowing the attainment of the CoO_2 phase in the cathode and the reintercalation of lithium to form the $LiCoO_2$ phase, this cell was cycled between 3V and 4.2V with little loss of charge capability, as seen in FIG. 3" (emphasis added).

It is apparent, therefore, that Amatucci discloses that its cell is operated so as to be cycled in a voltage range not greater than 4.2V, where voltages greater than 4.2V are merely used in preparation of the cathode. By the same token, the cut-off voltage for Amatucci is not greater than 4.2V.

Idota and Patino also do disclose a cut-off voltage of greater than 4.2V. Even if Amatucci, Idota and Patino were combined as the examiner posits, therefore, the result would not have led the skilled artisan to a battery having a cut-off voltage of greater than 4.2V. With respect to Idota, as discussed during the prosecution of both the parent application and the present application, Idota does not disclose or suggest a high cut-off voltage of more than 4.2V. Patino merely relates to a battery system where a protection circuit is used but is silent regarding the cut-off voltage.

With respect to the ratio recited in claim 4, the Office cites to Idota in column 3, lines 14-19. Yet, Idota fails to disclose the prescribed ratio of from 1:1.0 to 1:2.5 for positive electrode material to negative electrode material of the single lithium ion cell, as calculated by the theoretic capacity with the charge cut-off voltage set at 4.2V. Rather, in the cited section of Idota the ratio of the positive electrode material to negative electrode material is calculated by "ratio of equivalent amount," not "as calculated by the theoretic capacity with the charge cut-off voltage set at 4.2V."

Idota is silent whether its ratio is a weight ratio or a volume ratio. In either case, the ratio is not calculated based on capacity as recited in claim 4. Accordingly, Idota does not disclose the recited capacity ratio of claim 1.

Moreover, neither Amatucci nor Patino implicates the calculation method of capacity-based ratio, as recited in claim 4. Thus, even if Idota, Amatucci and Patino were combined, the combination would not have the feature of the ratio as specifically recited in claim 4 of a ratio from 1:1.0 to 1:2.5 for positive electrode material to negative electrode material of the single lithium ion cell, as calculated by the theoretic capacity with the charge cut-off voltage set at 4.2V.

In summary, no reasonable combination of teachings gleaned from the cited references would have suggested the overcharging protection voltage or the ratio features that claim 4 recites. Moreover, from the posited combination the skilled artisan could not have foreseen the effect where, in raising the cut-off voltage above 4.2V, changes to the electrode materials and decomposition of the electrolyte are substantially avoided without diminishing the recycle property of the secondary lithium ion battery.

CONCLUSION

Applicants therefore submit that the application is in condition for allowance, and they request an early indication to that effect. Examiner Siddiquee also is invited to contact the undersigned directly, should he feel that any issue warrants further consideration.

The Commissioner is hereby authorized to charge any additional fees, which may be required under 37 C.F.R. §§ 1.16-1.17, and to credit any overpayment to Deposit Account No. 19-0741. Should no proper payment accompany this response, then the Commissioner is authorized to charge the unpaid amount to the same deposit account. If any extension is needed for timely acceptance of submitted papers, then applicants hereby petition for such extension under 37 C.F.R. §1.136 and authorize payment of the relevant fee(s) to the deposit account.

Respectfully submitted,

Date August 25, 2011

By /Stephen A. Bent/

FOLEY & LARDNER LLP
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Telephone: (202) 672-5404
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Stephen A. Bent
Attorney for Applicant
Registration No. 29,768

Electronic Patent Application Fee Transmittal	
Application Number:	12817028
Filing Date:	16-Jun-2010
Title of Invention:	SECONDARY LITHIUM ION CELL OR BATTERY, AND PROTECTING CIRCUIT, ELECTRONIC DEVICE AND CHARGING DEVICE OF THE SAME
First Named Inventor/Applicant Name:	Xiaoping REN
Filer:	Stephen A. Bent
Attorney Docket Number:	042787-0109
Filed as Small Entity	

Utility under 35 USC 111(a) Filing Fees

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Basic Filing:				
Pages:				
Claims:				
Miscellaneous-Filing:				
Petition:				
Patent-Appeals-and-Interference:				
Post-Allowance-and-Post-Issuance:				
Extension-of-Time:				
Extension - 1 month with $0 paid	2251	1	65	65

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Miscellaneous:				
Request for continued examination	2801	1	405	405
		Total in USD ($)		**470**

Electronic Acknowledgement Receipt	
EFS ID:	10815973
Application Number:	12817028
International Application Number:	
Confirmation Number:	4654
Title of Invention:	SECONDARY LITHIUM ION CELL OR BATTERY, AND PROTECTING CIRCUIT, ELECTRONIC DEVICE AND CHARGING DEVICE OF THE SAME
First Named Inventor/Applicant Name:	Xiaoping REN
Customer Number:	22428
Filer:	Stephen A. Bent
Filer Authorized By:	
Attorney Docket Number:	042787-0109
Receipt Date:	25-AUG-2011
Filing Date:	16-JUN-2010
Time Stamp:	16:36:40
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	yes
Payment Type	Credit Card
Payment was successfully received in RAM	$470
RAM confirmation Number	3454
Deposit Account	
Authorized User	

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)

1	Request for Continued Examination (RCE)	RCE.pdf	119624 93fd70f1216045b8dad7a9b2142c0e16fdea74aa	no	3
Warnings:					
This is not a USPTO supplied RCE SB30 form.					
Information:					
2	Amendment Submitted/Entered with Filing of CPA/RCE	114AMENDMENT.pdf	113895 544851e3f00ec5cd319698807c69f46dcfca11fb	no	7
Warnings:					
Information:					
3	Fee Worksheet (SB06)	fee-info.pdf	32551 ef5f6d2ded8593140e8f65d7f348e6a15ef34290	no	2
Warnings:					
Information:					
			Total Files Size (in bytes):	266070	

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

<u>New Applications Under 35 U.S.C. 111</u>
If a new application is being filed and the application includes the necessary components for a filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application.

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

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

PTO/SB/06 (07-06)
Approved for use through 1/31/2007. OMB 0651-0032
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE
Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it displays a valid OMB control number.

PATENT APPLICATION FEE DETERMINATION RECORD Substitute for Form PTO-875	Application or Docket Number 12/817,028	Filing Date 06/16/2010	☐ To be Mailed

APPLICATION AS FILED – PART I

	(Column 1)	(Column 2)	SMALL ENTITY ☒		OR	OTHER THAN SMALL ENTITY	
FOR	NUMBER FILED	NUMBER EXTRA	RATE ($)	FEE ($)		RATE ($)	FEE ($)
☐ BASIC FEE (37 CFR 1.16(a), (b), or (c))	N/A	N/A	N/A			N/A	
☐ SEARCH FEE (37 CFR 1.16(k), (i), or (m))	N/A	N/A	N/A			N/A	
☐ EXAMINATION FEE (37 CFR 1.16(o), (p), or (q))	N/A	N/A	N/A			N/A	
TOTAL CLAIMS (37 CFR 1.16(i))	minus 20 =	*	X $ =		OR	X $ =	
INDEPENDENT CLAIMS (37 CFR 1.16(h))	minus 3 =	*	X $ =			X $ =	
☐ APPLICATION SIZE FEE (37 CFR 1.16(s))	If the specification and drawings exceed 100 sheets of paper, the application size fee due is $250 ($125 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			TOTAL	

APPLICATION AS AMENDED – PART II

		(Column 1)		(Column 2)	(Column 3)	SMALL ENTITY		OR	OTHER THAN SMALL ENTITY	
	08/25/2011	CLAIMS REMAINING AFTER AMENDMENT		HIGHEST NUMBER PREVIOUSLY PAID FOR	PRESENT EXTRA	RATE ($)	ADDITIONAL FEE ($)		RATE ($)	ADDITIONAL FEE ($)
AMENDMENT	Total (37 CFR 1.16(i))	* 9	Minus	** 20	= 0	X $26 =	0	OR	X $ =	
	Independent (37 CFR 1.16(h))	* 3	Minus	***3	= 0	X $110 =	0	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	0	OR	TOTAL ADD'L FEE	

		(Column 1)		(Column 2)	(Column 3)					
		CLAIMS REMAINING AFTER AMENDMENT		HIGHEST NUMBER PREVIOUSLY PAID FOR	PRESENT EXTRA	RATE ($)	ADDITIONAL FEE ($)		RATE ($)	ADDITIONAL FEE ($)
AMENDMENT	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 number found in the appropriate box in column 1.

Legal Instrument Examiner:
/VANESSA BARBER/

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

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

UNITED STATES PATENT AND TRADEMARK OFFICE

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

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
12/817,028	06/16/2010	Xiaoping REN	042787-0109	4654

22428 7590 04/28/2011

FOLEY AND LARDNER LLP
SUITE 500
3000 K STREET NW
WASHINGTON, DC 20007

EXAMINER	
SIDDIQUEE, MUHAMMAD S	
ART UNIT	PAPER NUMBER
1726	

MAIL DATE	DELIVERY MODE
04/28/2011	PAPER

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.

Office Action Summary	Application No.	Applicant(s)	
	12/817,028	REN ET AL.	
	Examiner	Art Unit	
	MUHAMMAD SIDDIQUEE	1726	

-- 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* MONTH(S) OR THIRTY (30) DAYS, WHICHEVER IS LONGER, 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 *15 February 2011*.

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

3)☐ 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

4)☒ Claim(s) *1-8* is/are pending in the application.

4a) Of the above claim(s) *1-3 and 6-8* is/are withdrawn from consideration.

5)☐ Claim(s) _____ is/are allowed.

6)☒ Claim(s) *4 and 5* is/are rejected.

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

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

Application Papers

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

10)☐ The drawing(s) filed on _____ is/are: a)☐ accepted or b)☐ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).

11)☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

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).

a)☐ All b)☐ Some * c)☐ None of:

1.☐ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. _____.

3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

1) ☐ Notice of References Cited (PTO-892)
2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
3) ☒ Information Disclosure Statement(s) (PTO/SB/08) Paper No(s)/Mail Date *2/15/2011*.
4) ☐ Interview Summary (PTO-413) Paper No(s)/Mail Date. _____ .
5) ☐ Notice of Informal Patent Application
6) ☐ Other: _____.

DETAILED ACTION

Applicant's amendment filed on 2/15/2011 was received. Claim 4 is amended and claims 1-3, 6-8 are withdrawn.

Response to Arguments

Applicant's arguments filed 2/15/2011 have been fully considered but they are not persuasive. In response to applicant's argument that raising the cut-off voltage above 4.2V that substantially avoids changes to the electrode materials and decomposition of the electrolyte is wholly unforeseen by the art is not true. As the references (WO 96/24168 and WO 93/21665) supplied by the applicant teaches cut-off voltage above 4.2V.

Claim Rejections - 35 USC § 103

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

> (a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made.

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

3. This application currently names joint inventors. In considering patentability of the claims under 35 U.S.C. 103(a), the examiner presumes that the subject matter of the various claims was commonly owned at the time any inventions covered therein were made absent any evidence to the contrary. Applicant is advised of the obligation under 37 CFR 1.56 to point out the inventor and invention dates of each claim that was not commonly owned at the time a later invention was made in order for the examiner to consider the applicability of 35 U.S.C. 103(c) and potential 35 U.S.C. 102(e), (f) or (g) prior art under 35 U.S.C. 103(a).

4. Claims 4-5 are rejected under 35 U.S.C. 103(a) as being unpatentable over Idota (US 5,260,148) in view of Amatucci (WO 96/24168) and Patino et al (US 6,326,770).

Regarding claims 4-5, Idota discloses a lithium secondary battery comprising an anode and a cathode where the ratio of the equivalent amount of the anode (negative electrode) active material to that of the cathode (positive electrode) active material be larger than 1 (i.e., the amount of the anode active material is more than equivalent to the cathode active material). The ratio thereof is more preferably from 1.1 to 5, most preferably from 1.1 to 3.5. [column 3, lines 14-19]. Idota does not specifically disclose battery is capable of being charged to between 4.2 volts to 5.8 volts. However, Amatucci discloses a battery where cut-off voltage is used up to 5.2 voltage for electrolyte stability and enhanced cell capacity [Pages 1-2; Example 1, page 12]. Idota/Amatucci remains silent about a protection circuit. However, Patino discloses electronic devices comprising battery system where protection circuit is used to limit

voltage in the battery [column 1, lines 11-28]. Therefore, it would have been obvious to a person of ordinary skill in the art at the time the invention was made to a protection circuit as taught by Patino in the battery of Idota/Amatucci in order to have a safer device.

Conclusion

5. Applicant's amendment necessitated the new ground(s) of rejection presented in this Office action. Accordingly, **THIS ACTION IS MADE FINAL**. See MPEP § 706.07(a). Applicant is reminded of the extension of time policy as set forth in 37 CFR 1.136(a).

A shortened statutory period for reply to this final action is set to expire THREE MONTHS from the mailing date of this action. In the event a first reply is filed within TWO MONTHS of the mailing date of this final action and the advisory action is not mailed until after the end of the THREE-MONTH shortened statutory period, then the shortened statutory period will expire on the date the advisory action is mailed, and any extension fee pursuant to 37 CFR 1.136(a) will be calculated from the mailing date of the advisory action. In no event, however, will the statutory period for reply expire later than SIX MONTHS from the date of this final action.

Any inquiry concerning this communication or earlier communications from the examiner should be directed to MUHAMMAD SIDDIQUEE whose telephone number is (571) 270-3719. The examiner can normally be reached on Monday-Thursday, 7:30 am to 4:00 pm EST.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Patrick Ryan can be reached on 571-272-1292. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see http://pair-direct.uspto.gov. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free). If you would like assistance from a USPTO Customer Service Representative or access to the automated information system, call 800-786-9199 (IN USA OR CANADA) or 571-272-1000.

/Muhammad Siddiquee/
Examiner, Art Unit 1726

/Patrick Joseph Ryan/
Supervisory Patent Examiner, Art Unit 1726

Index of Claims	Application/Control No.	Applicant(s)/Patent Under Reexamination
	12817028	REN ET AL.
	Examiner	Art Unit
	MUHAMMAD SIDDIQUEE	1795

✓	Rejected	-	Cancelled	N	Non-Elected	A	Appeal
=	Allowed	÷	Restricted	I	Interference	O	Objected

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

CLAIM		DATE								
Final	Original	08/11/2010	11/07/2010	04/22/2011						
	1	÷	N	N						
	2	÷	N	N						
	3	÷	N	N						
	4	÷	✓	✓						
	5	÷	✓	✓						
	6	÷	N	N						
	7	÷	N	N						
	8	÷	N	N						

PTO/SB/08 (09-06)
Approved for use through 03/31/2007. OMB 0651-0031
U.S. Patent and Trademark Office: U.S. DEPARTMENT OF COMMERCE

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Substitute for form 1449/PTO				*Complete if Known*	
INFORMATION DISCLOSURE STATEMENT BY APPLICANT				**Application Number**	12/817,028
Date Submitted: February 15, 2011				**Filing Date**	6/16/2010
				First Named Inventor	Xiaoping REN
(use as many sheets as necessary)				Art Unit	1726
				Examiner Name	Muhammad S. Siddiquee
Sheet	1	of	1	Attorney Docket Number	042787-0109

U.S. PATENT DOCUMENTS

Examiner Initials*	Cite No.[1]	Document Number Number-Kind Code[2] (*if known*)	Publication Date MM-DD-YYYY	Name of Patentee or Applicant of Cited Document	Pages, Columns, Lines, Where Relevant Passages or Relevant Figures Appear

FOREIGN PATENT DOCUMENTS

Examiner Initials*	Cite No.[1]	Foreign Patent Document Country Code[3] Number[4] Kind Code[5] (*if known*)	Publication Date MM-DD-YYYY	Name of Patentee or Applicant of Cited Documents	Pages, Columns, Lines, Where Relevant Passages or Relevant Figures Appear	T[6]
/M.S./	B1	JP 10-503466	3/31/1998	BELL COMMUNICATIONS RESEARCH INC.		✓
/M.S./	B2	WO 96/24168	8/8/1996	BELL COMMUNICATIONS RESEARCH INC.		
/M.S./	B3	WO 93/21665	10/28/1993	BELL COMMUNICATIONS RESEARCH INC.		

NON PATENT LITERATURE DOCUMENTS

Examiner Initials*	Cite No.[1]	Include name of the author (in CAPITAL LETTERS), title of the article (when appropriate), title of the item (book, magazine, journal, serial, symposium, catalog, etc.) date, page(s), volume-issue number(s), publisher, city and/or country where published.	T[6]
/M.S./	B4	Notice of Reasons for Rejection Japanese Application No. 2003-533374 dated October 13, 2010	✓

Examiner Signature	/Muhammad Siddiquee/	Date Considered	04/22/2011

*EXAMINER: Initial if reference considered, whether or not citation is in conformance with MPEP 609. Draw line through citation if not in conformance and not considered. Include copy of this form with next communication to applicant. 1 Applicant's unique citation designation number (optional). 2 See Kinds Codes of USPTO Patent Documents at www.uspto.gov or MPEP 901.04. 3 Enter Office that issued the document, by the two-letter code (WIPO Standard ST.3). 4 For Japanese patent documents, the indication of the year of the reign of the Emperor must precede the serial number of the patent document. 5 Kind of document by the appropriate symbols as indicated on the document under WIPO Standard ST.16 if possible. 6 Applicant is to place a check mark here if English language Translation is attached. 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 2 hours 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, 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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Substitute for form 1449/PTO				***Complete if Known***	
INFORMATION DISCLOSURE STATEMENT BY APPLICANT				**Application Number**	12/817,028
Date Submitted: February 15, 2011				**Filing Date**	6/16/2010
				First Named Inventor	Xiaoping REN
(use as many sheets as necessary)				Art Unit	1726
				Examiner Name	Muhammad S. Siddiquee
Sheet	1	of	1	Attorney Docket Number	042787-0109

U.S. PATENT DOCUMENTS

Examiner Initials*	Cite No.[1]	Document Number Number-Kind Code[2] (*if known*)	Publication Date MM-DD-YYYY	Name of Patentee or Applicant of Cited Document	Pages, Columns, Lines, Where Relevant Passages or Relevant Figures Appear

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	B1	JP 10-503466	3/31/1998	BELL COMMUNICATIONS RESEARCH INC.		✓
	B2	WO 96/24168	8/8/1996	BELL COMMUNICATIONS RESEARCH INC.		
	B3	WO 93/21665	10/28/1993	BELL COMMUNICATIONS RESEARCH INC.		

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	B4	Notice of Reasons for Rejection Japanese Application No. 2003-533374 dated October 13, 2010	✓

Examiner Signature		Date Considered	

*EXAMINER: Initial if reference considered, whether or not citation is in conformance with MPEP 609. Draw line through citation if not in conformance and not considered. Include copy of this form with next communication to applicant. 1 Applicant's unique citation designation number (optional). 2 See Kinds Codes of USPTO Patent Documents at www.uspto.gov or MPEP 901.04. 3 Enter Office that issued the document, by the two-letter code (WIPO Standard ST.3). 4 For Japanese patent documents, the indication of the year of the reign of the Emperor must precede the serial number of the patent document. 5 Kind of document by the appropriate symbols as indicated on the document under WIPO Standard ST.16 if possible. 6 Applicant is to place a check mark here if English language Translation is attached. 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 2 hours 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, 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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DELITHIATED COBALT OXIDE AND NICKEL OXIDE PHASES AND METHOD OF PREPARING SAME

Patent number: JP10503466 (T)

Publication date: 1998-03-31

Inventor(s):

Applicant(s):

Classification:

- international: ***C01G51/00; C01G51/04; C01G53/00; H01M10/0525; H01M10/36; H01M4/52; H01M4/525;*** *H01M10/0568; H01M10/0569;* **C01G51/00; C01G53/00; H01M10/00; H01M10/36; H01M4/52;** (IPC1-7): C01G51/00; C01G53/00; H01M10/40; H01M4/02; H01M4/04; H01M4/58

- european: C01G51/04; C01G53/00; H01M10/0525; H01M4/525; Y02E60/12B

Application number: JP19960523559T 19960116

Priority number(s): WO1996US00556 19960116; US19950383401 19950203

Also published as:

WO9624168 (A1)
US5587133 (A)
MX9705570 (A)
EP0809868 (A1)
CA2210489 (A1)

Abstract not available for JP 10503466 (T)
Abstract of correspondent: **WO 9624168 (A1)**

LiCoO2 and LiNiO2 are fully delithiated electrochemically using solid state electrolytic cells and oxidation-resistant electrolytes to yield new, stable phases of CoO2 and NiO2

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(19)日本国特許庁（ＪＰ）　(12) 公表特許公報（Ａ）　(11)特許出願公表番号

特表平10－503466

(43)公表日　平成10年(1998)３月31日

(51)Int.Cl.[6]	識別記号	庁内整理番号	Ｆ１	
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53/00		9343－4G	53/00	Ａ
Ｈ０１Ｍ　4/02		9351－4K	Ｈ０１Ｍ　4/02	Ｃ
4/04		9351－4K	4/04	Ａ
4/58		9151－4K	4/58	

審査請求　有　　予備審査請求　有　（全 28 頁）　最終頁に続く

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(87)国際公開番号　ＷＯ９６／２４１６８
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(33)優先権主張国　米国（ＵＳ）
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(74)代理人　弁理士　谷　義一　（外１名）

(54)【発明の名称】　脱リチウム化された酸化コバルト相および酸化ニッケル相、およびそれらの製造方法

(57)【要約】
ＬｉＣｏＯ₂およびＬｉＮｉＯ₂は、ソリッド・ステート電解セルおよび耐酸化性電解質を用いて電気化学的に十分に脱リチウム化されて(delithiated)、新規で安定なＣｏＯ₂およびＮｉＯ₂の相を生ずる。

【特許請求の範囲】

１．安定な金属二酸化物相の製造方法であって、

ａ）アノードと、酸化に対して不活性な電解質と、コバルト酸リチウム(lithium cobalt oxide)インターカレーション複合体およびＬｉxＮｉＯ2（式中、ｘは０．８～１．０である）の式を有するニッケル酸リチウム(lithium nickel oxide)インターカレーション複合体からなる群から選ばれる金属酸化物を含有するカソードとを有する電解セル(electrolytic cells)を製造する工程と、

ｂ）前記セルに、実質的に全部の前記金属酸化物からのリチウムをデインターカレートするのに十分に高い電圧をかける工程と

を具えることを特徴とする方法。

２．前記電圧が約５．０Ｖよりも高いことを特徴とする請求項１に記載の方法。

３．前記電解質が、ジメチルカーボネート（ＤＭＣ）とエチレンカーボネート（ＥＣ）との混合物（重量パーセント比が約９５ＤＭＣ：５ＥＣ～２０ＤＭＣ：８０ＥＣ）に添加された、ＬｉＰＦ6、またはおよそ同量以下のＬｉＢＦ4を有するＬｉＰＦ6の０．５Ｍ～２Ｍ溶液を含有することを特徴とする請求項２に記載の方法。

４．さらに、前記安定な金属二酸化物相を、リチウム、ナトリウム、カリウム、ルビジウムおよび水素からなる群から選ばれる元素でインターカレートする工程と具えることを特徴とする請求項１に記載の方法。

５．前記金属が、コバルトおよびニッケルからなる群から選ばれることを特徴とする請求項１の方法により製造される安定な金属二酸化物相。

６．

d (Å)
4.30 ± 0.02
2.44 ± 0.02
2.12 ± 0.02
1.61 ± 0.02
1.41 ± 0.02
1.34 ± 0.02
1.17 ± 0.02

のX線回析パターンを有する、請求項5に記載の安定な二酸化コバルト相。

7．

d (Å)
4.47 ± 0.02
2.40 ± 0.02
2.29 ± 0.02
1.97 ± 0.02
1.51 ± 0.02
1.41 ± 0.02
1.38 ± 0.02

のX線回析パターンを有する、請求項5に記載の安定な二酸化ニッケル相。

8．アノード、電解質およびカソードを含む二次電解セルであって、前記カソードが請求項5の安定な金属二酸化物相を具えることを特徴とする二次電解セル。

9．前記カソードが、さらに、前記安定な金属二酸化物相にインターカレートされたリチウム、ナトリウム、カリウム、ルビジウム、または水素からなる群から選ばれる元素を含有することを特徴とする請求項8に記載の二次電解セル。

【発明の詳細な説明】

脱リチウム化された酸化コバルト相および酸化ニッケル相、
およびそれらの製造方法

発明の技術背景

再充電可能なリチウムイオン電池セル(rechargeable lithium ion battery cells)の商業的重要性の高まりにより、より大きな電圧でリチウムイオンをより良く可逆的にインターカレートおよびデインターカレートすることが可能なカソード材料を同定および製造する要望が促されている。リチウムイオン再充電式電池で用いられる3種の卓越した可逆性リチウム・インターカレーション化合物がある。すなわち、$LiCoO_2$および$LiNiO_2$化合物、さらには$LiMn_2O_4$スピネルである。

$LiCoO_2$セルは特に関心が高い。その理由は、それらが、4Vよりも高い電圧でリチウムを可逆的に挿入/脱挿入する能力を有し、その結果、Ni-Cdよりも3倍大きな出力電圧およびエネルギー密度を有する電池(batteries)が得られることによる。$LiCoO_2$セルの理論上の充電容量は、約275アンペア-時間/キログラム(A-h/kg)と大きいものである。しかし、実際の用途では、$LiCoO_2$セルの最大の獲得可能な容量は、わずか約140A-h/kg(約4.2Vの最大の充電電圧に相当)であった。

$LiCoO_2$セルにおいてこの充電カットオフ電圧を越えようとする従来の試みは、次に行われる充放電サイクルにおける充電容量の厳しい損失として現れる低いセル性能をもたらしている。この$LiCoO_2$セルの4.2Vの充電の限界について一般に考えられている理由は、この電圧以上の$LiCoO_2$の電気化学的な脱リチウム化(delithiation)が、部分的に脱リチウム化された$LiCoO_2$の構造を不安定にし、続いて行われる充放電サイクルにおけるリチウムのインターカレーションを損なっている、ということであった。

コバルト酸リチウム(lithium cobalt oxide)は、ファン・デル・ワールス・

ギャップにより隔てられたCoO_2層から構成される六面構造をとる。ファン・デル・ワールス・ギャップ内の八面体の部位は、Liイオンによって占められる

。このことにより、リチウムの可逆的なインターカレーションが生じる。

そのような化合物において、リチウムは、糊剤またはセメント（接合剤）として作用して、負に帯電したCoO_2層間の斥力的な(repulsive)相互作用を遮蔽(screening)する。該化合物が十分にリチウム化された(lithiated)$LiCoO_2$である場合、その遮蔽は最大になる。リチウムが除去されるにつれて、遮蔽効果は低下し、２つのCoO_2層間の斥力は強化されて、ｃ軸パラメータの拡大が生じる。このリチウムの遮蔽効果により、CoO_2を形成するための完全なリチウムのデインターカレーションは不可能であると考えられた。

Ohzukuら(J. Electrochem. Soc., Vol. 141, No. 11, Nov. 1994, p. 2972)は、約８５％のリチウムを取り除くことに成功している。彼らの努力により、単斜相が明らかになり、CoO_2相の存在が疑問となった。

もう１つの理論において、ReimersおよびDahn(J. Electrochem. Soc., 139, 2091, (1992))は、過剰のCo^{4+}が、コバルト酸リチウム構造の結晶性を破壊する、と述べている。明らかに、それは、低いリチウム含有量における高度に結晶性である相の形成を阻害する。

Wizansky、RauchおよびDi Salvo(Journal of Solid State Chemistry, 81, 203-207(1989))は、強力な酸化剤（NO_2^+およびMoF_6等）の使用により、$LiCoO_2$の脱リチウム化を研究した。彼らの結果は、このアプローチが単に$LiCoO_2$を分解するだけであることを示した。

$LiNiO_2$は、$LiCoO_2$と近親構造であり、二次リチウムイオン電池における使用のために市販されている。従来、誰も、脱リチウム化したNiO_2相を得ることができなかった。Ohzukuら(J. Electrochem. Soc., Vol. 140, No. 7, July 1993)は、酸化ニッケルを使って$Li_{0.06}NiO_2$を報告し、これが末端相(end phase)であると推測した。

リチウム二次電池は一般に認知されており、例えば米国特許第5,296,318号(Gozdzら)に記載されている（この特許は、その全体を、引用することにより、本明細書の一部を構成するものとする）。したがって、リチウム金属を含有

しない「ロッキングチエア」型電池は、リチウムイオン伝導性電解質（非水系溶

剤またはそのような溶剤の混合物に溶解したＬｉ⁺塩を含有）により隔離された２個のリチウムイオン吸収性電極「スポンジ」を具えるものとして考察してもよい。多くのそのような塩および溶剤は、カナダ特許公告第2,022,191 号(1991年１月30日付け)で明らかになっているように、当技術分野で公知である。

これらの予め入手可能な電解質を具えるセルを、４．３Ｖよりもわずかに大きなボルト数にまで循環させる場合、電解質の酸化が起こる。この酸化は、小さいにもかかわらず、電池セルの容量、サイクル寿命および安全性を危険にさらす可能性がある。例えば、電極の酸化反応は、充電電流の一部を消費し、これは、該セルを放電する際に回収不可能である。この結果、後続のサイクルにわたってセル容量の連続的な損失が生じる。さらに、各充電の間に電解質の小さな部分が消費される場合、セルを組み立てる時に過剰の電解質が含まれなければならない。この過剰な電解質は、一定体積の電池本体の活物質の量を低減し、したがって、初期の容量を減少させる。さらに、電解質の酸化は、固形および気体の副生物を生じる場合がある。固形の副生物は、活物質の粒子上に不動態層を構築し、セルの極性を本質的に上昇させ、出力電圧を低下させる。同時に、かつ、さらに重要なことに、この気体の副生物はセルの内部圧力を上昇させ、したがって、爆発の危険性を上昇させ、危険で許容不可能な操作条件を導く。

米国特許第5,192,629 号（その全部を引用することにより本明細書の一部を構成するものとする）は、強力に酸化する陽電極材料を具える二次電池において電解質の分解を最小限に抑えるのに格別に有用な１種類の電解質組成物を提供する。したがって、これらの電解質は、独自的に、サイクル寿命を強化し、かつ実用上の「ロッキングチェア」型セルの温度性能を改善することが可能である。これらの電解質組成物は、５５℃および室温（約２５℃）で約５．０Ｖまでに及ぶ範囲の有効安定性を有する。

酸化に対して実質的に不活性な電解質は、ジメチルカーボネート（ＤＭＣ）および工チレンカーボネート（ＥＣ）との混合物（約９５ＤＭＣ：５ＥＣ～２０ＤＭＣ～８０ＥＣの範囲の重量パーセント比）に溶解した、$LiPF_6$、または添加されたおよそ同量の$LiBF_4$を有する$LiPF_6$の０．５Ｍ～２Ｍ溶

液を含有する。好ましい電解質溶液において、溶媒比は約８０ＤＭＣ：２０ＥＣ～２０ＤＭＣ：８０ＥＣである。室温以下での操作に最適な組成物は、約６７ＤＭＣ：３３ＥＣの溶媒混合物に溶解した約１．５Ｍ　ＬｉＰＦ$_6$溶液である。室温以上（例えば５５℃の範囲）で作動する電池は、最も最適なように、約３３ＤＭＣ：６７ＥＣの溶媒の組合せに溶解した約１．５Ｍ　ＬｉＰＦ$_6$溶液から本質的になる電解質を用いる。さらに有用な電解質は、約５０ＤＭＣ：５０ＥＣの溶媒混合物に溶解した同量部のＬｉＰＦ$_6$とＬｉＢＦ$_4$との約１Ｍ～２Ｍ溶液から本質的になる。

無視できる電流(negligible current)は増加し、可逆的なＬｉのインターカレーションの後、Ｌｉに対する約５Ｖ以下の電圧では、この著しい安定性が、炭素（例えば石油コーク等）の負電極を具える「ロッキング・チェア」型セルだけでなく、Ｌｉ負電極セルにおいても、強化されたセル容量を可能にすることを示す。ＬｉＣｏＯ$_2$陽電極を用いるそのようなリチウム材料セルは、約４．３～５．１Ｖの通常の操作範囲を達成することがかなり期待されるであろう。

酸化に対して実質的に不活性な電解質およびソリッド・ステート電解セルの補助により、ＣｏＯ$_2$およびＮｉＯ$_2$の双方の十分に脱リチウム化された相が得られた。

発明の要旨

したがって、本発明は、準安定なＣｏＯ$_2$およびＮｉＯ$_2$の相、および、それらの、リチウムイオン二次電池において使用するためのインターカレーション化合物としての用途に関する。本発明の特徴および利点は、以下の記載に述べられており、それらは、その記載から明らかであるか、または本発明の実施により知ることが可能である。

１つの形態において、本発明は、安定な二酸化コバルトの相を製造するための電気化学的方法であって、アノードと、酸化に対して不活性な電解質と、コバルト酸リチウム・インターカレーション複合体(complex)を含むカソードとを有する電解セルを調製する工程と；リチウムを上記コバルト酸リチウム・インターカレーション複合体からデインターカレートするのに十分な電圧を上記セルにかけ

、それによって、安定な二酸化コバルト相を上記カソード中に形成する工程とを包含する方法に関する。

もう1つの形態において、本発明は、上述の方法により調製される安定な二酸化コバルト相に関する。

もう1つの形態において、本発明は、

d (Å)
4.30 ± 0.02
2.44 ± 0.02
2.12 ± 0.02
1.61 ± 0.02
1.41 ± 0.02
1.34 ± 0.02
1.17 ± 0.02

のX線回析パターンを有する安定な二酸化コバルト相に関する。

もう1つの形態において、本発明は、安定な二酸化二ッケル相を製造するための電気化学的方法であって、一般式Li_xNiO_2（式中、xは、好ましくは0.8～1.0である）を有するニッケル酸リチウム(lithium nickel oxide)インターカレーション複合体を提供する工程と；上記ニッケル酸リチウム・インターカレーション複合体を含むカソードを有する電解セルを製造する工程と；該セルに、上記ニッケル酸リチウム・インターカレーション複合体を完全に脱リチウム化するのに十分な電圧をかける工程とを包含する方法に関する。

もう1つの形態において、本発明は、上記の方法により製造される安定な二酸化二ッケル相に関する。

もう1つの形態において、本発明は、

d (Å)
4.47 ± 0.02
2.40 ± 0.02
2.29 ± 0.02
1.97 ± 0.02
1.51 ± 0.02
1.41 ± 0.02
1.38 ± 0.02

のX線回析パターンを有する、安定な二酸化ニッケル相に関する。

もう1つに形態において、本発明は、上記の安定なCoO_2またはNiO_2相を含む二次電解セルの製造方法、およびそれによって製造されるセルに関する。

添付の図面(本明細書に組み込まれ、かつ本明細書の部分を構成する)は、本発明の具体例を説明するものであり、詳細な説明と共に、本発明、およびその目的、利点および原理を説明するのに役立つ。

図面の簡単な説明

本発明は、以下の添付の図面を参照しながら説明される。

図1は、CoO_2相を形成するために$LiCoO_2$を電気化学的に脱リチウム化する間にとった一連のX線回析ダイアグラムであり;

図2は、CoO_2相にリチウムを電気化学的にインターカレーションする間にとった一連のX線回析ダイアグラムであり;

図3は、CoO_2相を用いたセルについての、リチウム含有量に対する充放電の電圧をプロットしたものであり;

図4および図5は、本発明による、NiO_2相に脱リチウム化されている$LiNiO_2$カソードを有するセルについての、リチウム含有量に対する充放電の電圧をプロットしたものであり;

図6は、CoO_2およびNiO_2相について、温度に対する分解反応熱をプロットしたものであり;

図7および図8は、CoO_2およびNiO_2相の熱的分解生成物についてのX線

回析ダイアグラムであり；

図９は、ナトリウム・イオンによりインターカレーションされた本発明のＣｏO_2相を用いるセルについて、ナトリウム含有量に対する充放電の電圧をプロットしたものであり；

図１０は、ＮｉO_2相を形成するためにＬｉＮｉO_2を電気化学的に脱リチウム化する間にとったＸ線回析ダイアグラムであり；および

図１１は、ＣｏO_2相についての大気水(atmospheric water)の効果を説明するＸ線回析ダイアグラムである。

発明の詳細な説明

本発明のＣｏO_2およびＮｉO_2相を達成する上での１つの障害は、脱リチウム化されたＣｏO_2相を達成するのに必要と考えられる高電圧において安定な（酸化に対して不活性な）電解質を開発することにより取り除かれた。これらの電解質は、米国特許第5,192,629 号に記載されているものにより例示され、その開示は引用することにより本明細書の一部を構成するものとする。それにもかかわらず、一般に、ＣｉO_2相は達成できない、と考えられた。その理由は、負に帯電したＣｏO_2層間のファン・デル・ワールス・ギャップにリチウム・イオンが完全に存在しない状態において、該層間の斥力はあまりにも大きく、完全に脱リチウム化されたＣｏO_2相は決して安定ではないことによる。

ここにおいて記載されているＬｉＣｏO_2カソード物質および高電圧に対して安定な電解質を組み込んだ電解セルを用いると、該セルに５．２Ｖの電荷電圧をかけることにより、ＣｏO_2相を製造することが可能であり、それは、ＬｉＣｏO_2カソードからの実質的に全てのリチウムをデインターカレートし、ＣｏO_2を形成する。このＣｏO_2相は準安定性であり、２００℃以上で分解する。

同様に、高電圧に対して安定な電解質およびＬｉＮｉO_2カソードを用いる電解セルでは、ＮｉO_2相への実質的に完全な脱リチウム化は、５．１Ｖの充電電圧をかけることにより達成可能である。

本発明のＣｏO_2およびＮｉO_2相は、一度得られたら、リチウムまたは他のイ

オン[水素核(hydrogen nuclei)、ナトリウム(実施例4)、カリウムまたはルビジウム等]により再インターカレートすることが可能である。リチウムまたは他のイオン種による再インターカレーションは、200℃以下の温度での電気化学的挿入または蒸気相移動(vapor phase transport)により達成可能である。蒸気相移動は、Tarasconらによる論文「Synthesis and peculiar properties of InMo6Sx-8Sex, TlMo6Sx-8Sex and HgyMo6Sx-8Sex」(Physical review B, Vol. 31, No. 2, 1985)に記載されている(これは、その全体において引用することにより本明細書の一部を構成する)。

再インターカレーションに続いて、これらの相は、例えば、リチウムを用いて、CoO_2相では3V~4.2Vの間で、NiO_2相では2.8V~4.1Vの間で、セル容量を損失させることもなしに、循環させることが可能である。

CoO_2相が形成された後で、該相を大気水(atmopheric water)に暴露することにより$CoOOH$を形成してもよい。図11からわかるように、CoO_2は、電気化学セル内でin situで形成されてもよい。空気に約30分間にわたって暴露した後で、2つの相が現れる。空気中で$CoOOH$が形成されてから3日後、オープン回路電圧が>4Vなので、以下の反応が起こる。:

$$2H_2O - 4e^- \cdots\cdots\rightarrow O_2 + 4H^+$$

$$CoO_2 + xe^- + XH^+ \cdots\cdots\rightarrow H_xCoO_2$$

この$CoOOH$は、他の電池技術における電子の導体であってもよい。これは、コバルトが既に使用されているNi電極または$NiMeH$、$Ni-H$または$Ni-Cd$電池における用途を含む。

別の方法(alternative)として、これらの相は、一度形成されたら、あらゆる種々の方法で使用可能である。1つの好ましい具体例において、可塑性の(plastic)ソリッドステート・セルのカソードは、下に横たわる電解質/アノード構造体に積層されず、したがって、可塑性マトリックスにおけるCoO_2またはNiO_2相の除去を容易にする。この可塑化した相は、容易に他の環境に移すことが可能である。上記で検討した理由により、純粋なCoO_2相が所望させる場合には、不活性(無水)条件下での移動(handling)が好ましい。

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もう１つの具体例において、この可塑化された相は、例えば、ナトリウム含有電解質や親和性のある(compatible)電解質を含有するセル中に配置され、次いで、酸化コバルト相または酸化ニッケル相をナトリウム・イオンで再インターカレートする。この再インターカレーションは、２番目の、あるいはそれ以後のイオンが再インターカレートされた金属酸化物相に添加されるようにして、完了に達する前に停止してもよい。

さらにもう１つの具体例において、酸化ニッケル相または酸化コバルト相は、有機成分と混合して、例えば、複合ポリマーまたは活性化金属酸化物のキャリアのいずれかを形成してもよい。この相のレドックス潜在性(redox potential)は高く、多くの分野において潜在的に有用である。予想される用途としては、例えば、無機高分子構造の形成において、および生化学的キャリアとして、等が挙げられる。そのような用途は、当業者には明らかに理解できるであろう。

以下の実施例は、従来技術に対して本発明の実施を例示するものである。当業者であれば、これらの実施例が本発明を限定するものと解釈されるべきではないことがわかるであろう。

実施例１

可塑性(plastic)電解セルは、ポリビニリデンフルオライド（ＰＶｄＦ）およびヘキサフルオロプロピレン（ＨＦＰ）のマトリックスを含有して、１部のＤＭＣおよび１Ｍの$LiPF_6$に２部のＥＣを含有する電解質組成物を取り入れて構成されており、このセルは高電圧での酸化に不活性であった。カソードは、活物質として$LiCoO_2$を含んでおり、陽極アノードは炭素を含んでいた。アノードとソリッドステート電解質を互いに積層し、それらの上にカソードを配置

した。

このセルを５．２Ｖに充電し、この時点で$LiCoO_2$は十分に脱リチウム化されて、CoO_2相を形成した。この相の存在は、図１に示したＸ線データによって確認される。図１は、$LiCoO_2$のデインターカレーションの終点での回折パターンを示し、この$LiCoO_2$のデインターカレーションは、およそ従来の文献に開示された最も最近知られた相、つまり、単斜（$Li_{0.15}CoO_2$）で

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始まり、進行して、電圧５．２Ｖで脱リチウム化を完了する。

このＸ線回折パターンを、ベリリウム・ウインドウを腐食することなしに高電圧での使用を可能にするＸ線回折装置を使用してin situで得た。

５．２Ｖで得られた最終的なＸ線回折パターンは、CoO_2相と結合した六面構造である。さらに、CoO_2相は、一度得られると、図２のＸ線回折パターンのシリーズによって示されたようなセルの放電の間、$LiCoO_2$に再転換された。カソードでのCoO_2相が達成され、かつリチウムを再インターカレートして$LiCoO_2$を形成した後、このセルを、実施例３にみられるように、充電容量をほとんど損失せずに、３Ｖと４．２Ｖの間で循環した。

部分的に脱リチウム化された酸化コバルトの充電サイクルの間、リチウムの再挿入によって単斜相が形成される。しかし、十分に脱リチウムされた酸化コバルトへのリチウム再挿入を行ったところ、六面構造になり、これは電解セルにもともと組み込まれている$LiCoO_2$の構造と同じである。

実施例２

可塑性電解セルを、実施例１に記載したように組み立て、高電圧での酸化に対して不活性な電解質組成物を取り入れ、カソードは$LiNiO_2$から製造した。このセルを５．１Ｖに充電した。この電圧で、実質的に全てのリチウムが$LiNiO_2$相から取り除かれて、NiO_2相を形成した。NiO_2相の存在は、図１０に表されたＸ線データによって確認される。

上記セルを２００μＡで放電した。これより高いと、図４に記載したように、リチウムの７０％がNiO_2構造に再びインターカレートした。引き続き該セルを、容量がフエーディングすることなしに、２．８～４．０Ｖの間で循環することにより、このLi_xNiO_2の可逆充電特性がNiO_2相の達成によって破壊されていないことが確認された。放電電流を１５０μＡに低下させると、全てのリチウムがインターカレートして、$LiNiO_2$相が形成された。図５に示したように、引き続き該セルを、２．８～４．１Ｖの間で循環することによって、$LiNiO_2$の最小の分極およびわずかな不可逆特性で高容量（１９０Ａ-ｈ/ｋｇより大きい）が得られた。これらの結果は、$LiNiO_2$からのリチウムの完全

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な除去により、電気化学に活性のままである構造が生じることを示している。

実施例3

CoO_2相およびNiO_2相の熱安定性の研究を行った。それぞれ実施例1および2に記載されたやり方でCoO_2相およびNiO_2相に運ばれた(brought to)$LiCoO_2$および$LiNiO_2$の可塑性電極を、室温で希釈アセトン溶媒に別々に溶解した。該電極の可塑性な部分は溶媒に溶解し、不溶な金属酸化物は、容器の底に沈殿した。この金属酸化物を該溶液から分離し、示差走査熱量計（ＤＳＣ）を用いて１０℃/分で３００℃に昇温(ramped)させて解析した。

図６に見られるように、比較的強い発熱反応が、CoO_2およびNiO_2相の両方について、２００℃で生じた。ＤＳＣの後のＸ線回折による試料の解析から、両方の相が、

$$MO_2 \text{ - - -} \rightarrow MO + 1/2O_2$$

の反応に従って酸素の損失を伴って還元されることが明らかになった。

図７および図８に表されたＸ線回折パターンより、試料がＣｏＯおよびＮｉＯの混成された岩塩構造(ricksalt structures)に変化したことが確認され、この岩塩構造は、リチウムインターカレーションに対して電気化学的に不活性であることがわかっている。

実施例4

セルは、実施例１に記載されたように組み立てた。CoO_2相は、可塑性セルを５．２Ｖで１５時間にわたって脱リチウム化することによって形成した。CoO_2相を形成した後、可塑化されたCoO_2を電解質/アノード構造体から取り除き、次に、ナトリウムを含む同様に組み立てられたセルに組み込んだ。

新しいセルを可塑性CoO_2カソード、$NaClO_4$電解質およびナトリウム金属アノードを用いて組み立てた。該セルを２．２Ｖで放電してナトリウムを挿入することにより、ナトリウムをCoO_2相に導入した。次に、該セルを、図９に示したように、２．２～４．１Ｖの間で循環した。

【図1】

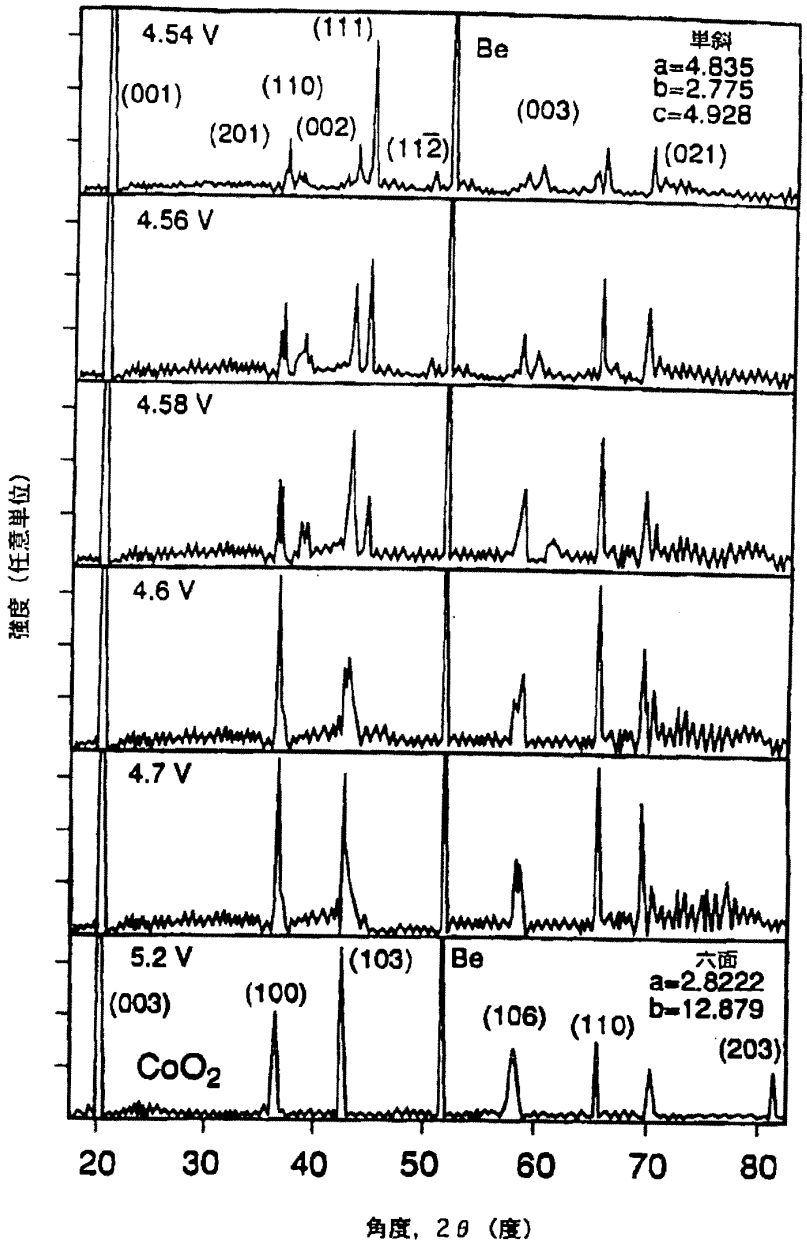
4.54 V
(111)
(001)
(110)
(201)
(002)
(11$\bar{2}$)
Be
単斜
a=4.835
b=2.775
c=4.928
(003)
(021)
4.56 V
4.58 V
4.6 V
4.7 V
5.2 V
(003)
(100)
(103)
CoO_2
Be
六面
a=2.8222
b=12.879
(106)
(110)
(203)
強度（任意単位）
20
30
40
50
60
70
80
角度，2θ（度）

FIG. 1

【図2】

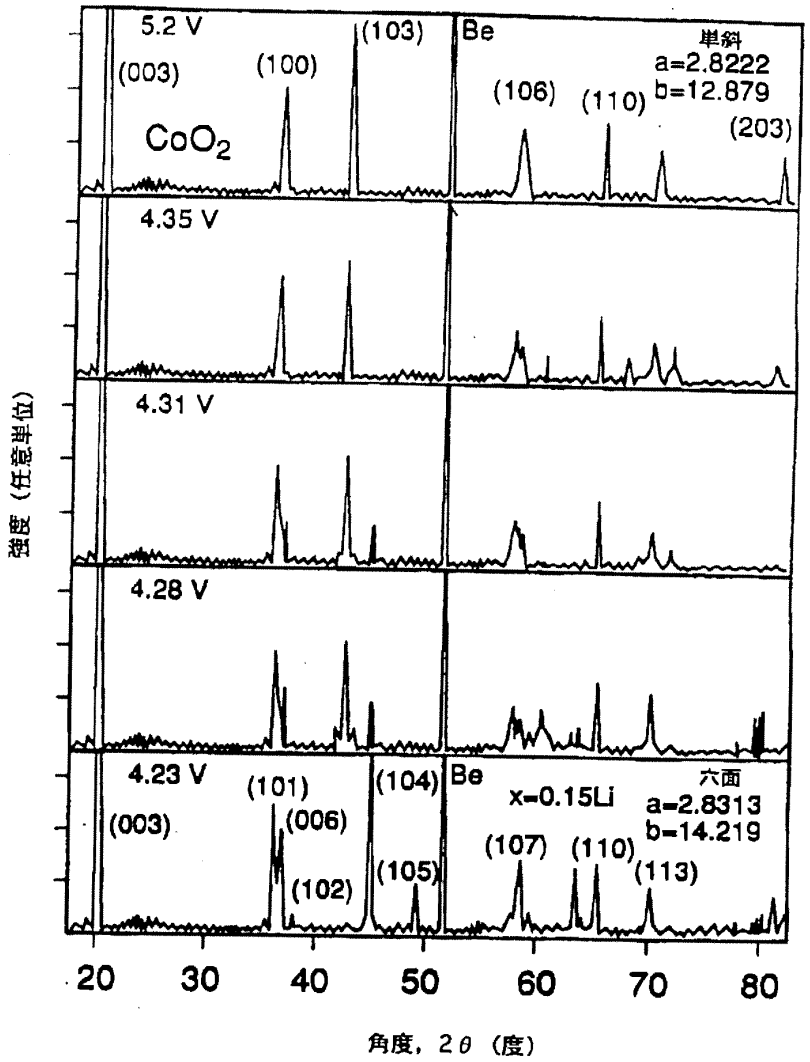
5.2 V
(003)
(100)
(103)
Be
単斜
a=2.8222
b=12.879
(106)
(110)
(203)
CoO_2
4.35 V
4.31 V
4.28 V
4.23 V
(101)
(104)
Be
六面
x=0.15Li
a=2.8313
b=14.219
(003)
(006)
(102)
(105)
(107)
(110)
(113)
強度（任意単位）
20
30
40
50
60
70
80
角度，2θ（度）

FIG. 2

【図3】

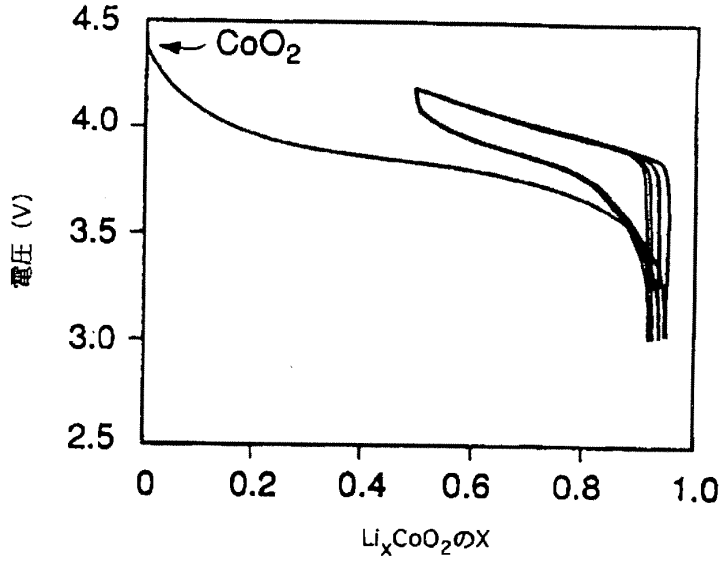

FIG. 3

【図4】

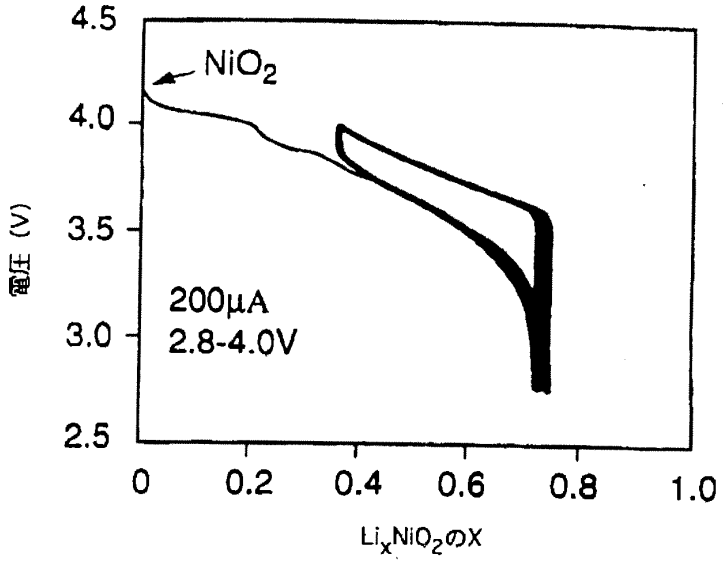

FIG. 4

【図5】

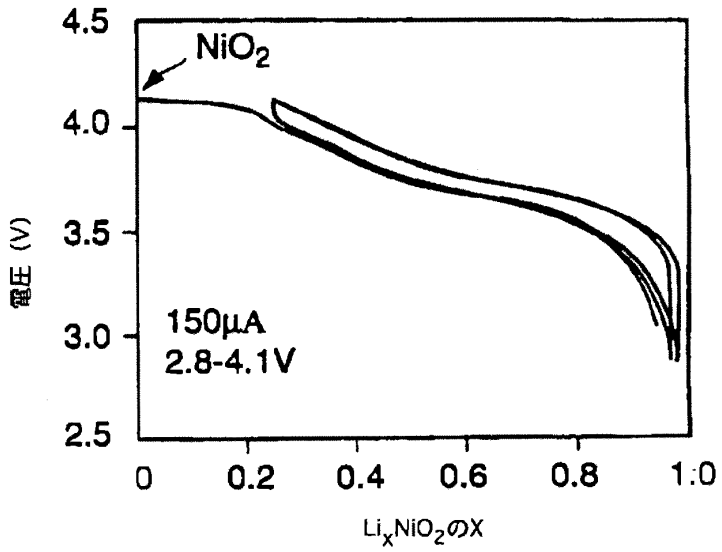

FIG. 5

【図6】

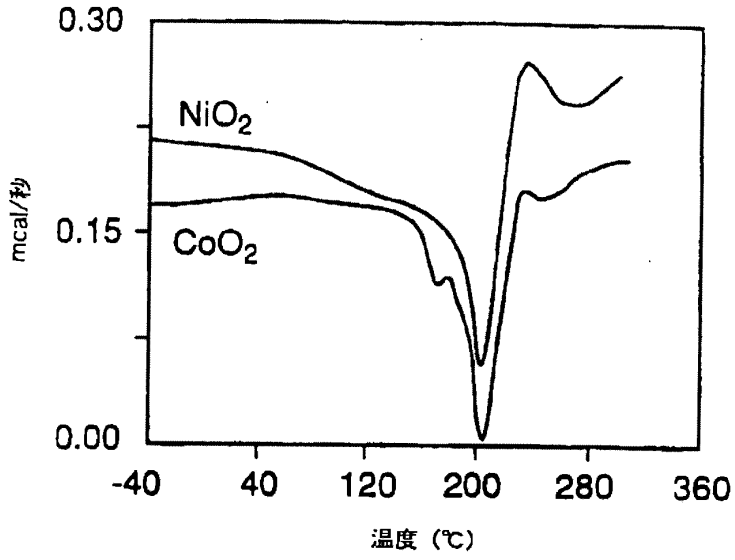

FIG. 6

【図7】

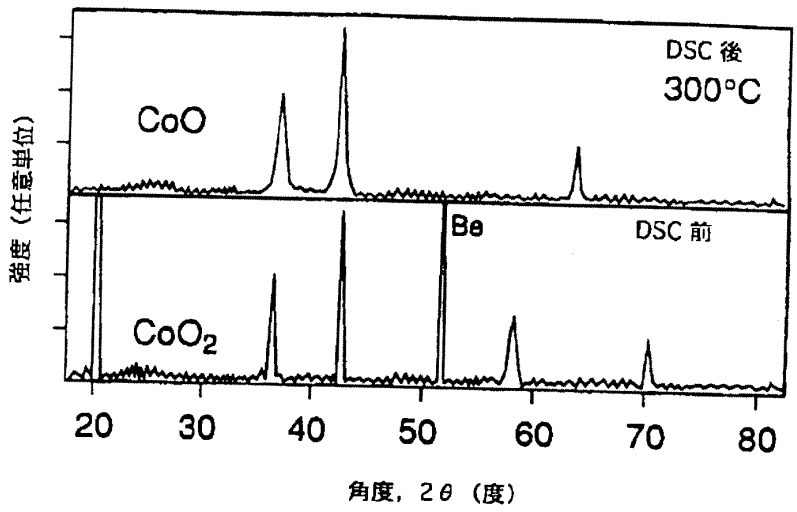

FIG. 7

【図8】

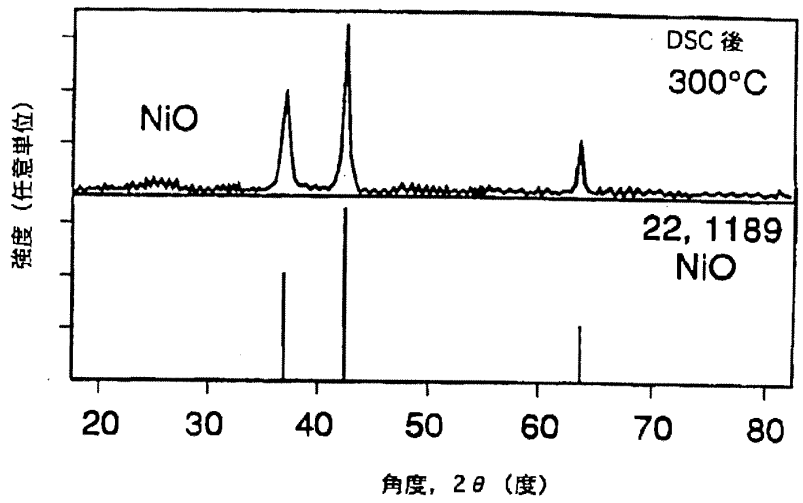

FIG. 8

【図9】

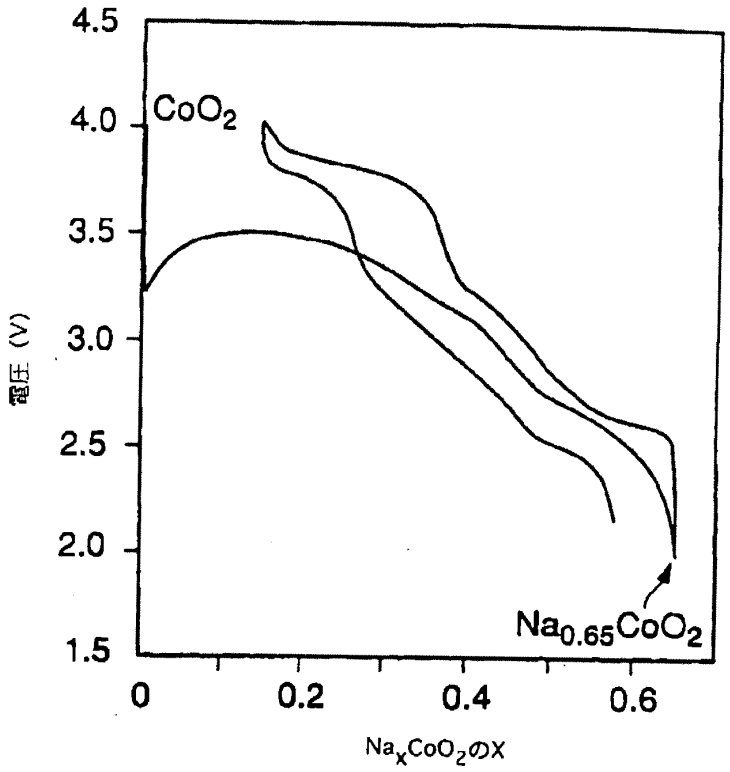

FIG. 9

【図１０】

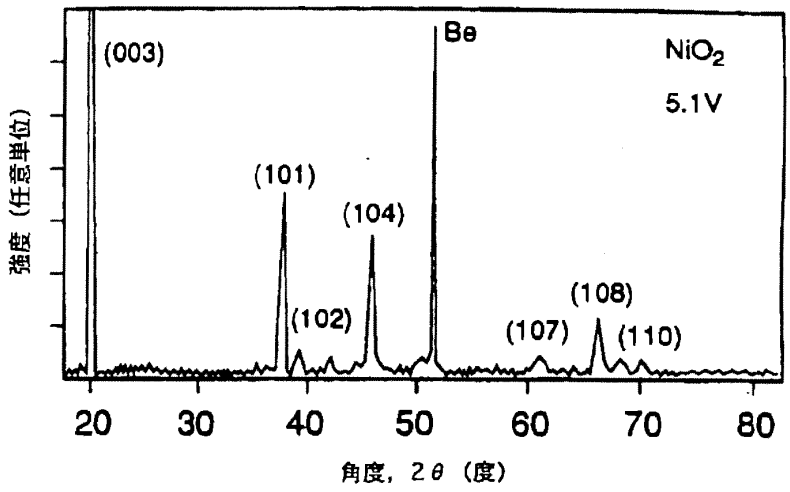
(003)
Be
NiO_2
5.1V
(101)
(104)
(102)
(108)
(107)
(110)
強度（任意単位）
20
30
40
50
60
70
80
角度，2θ（度）

FIG. 10

【図11】

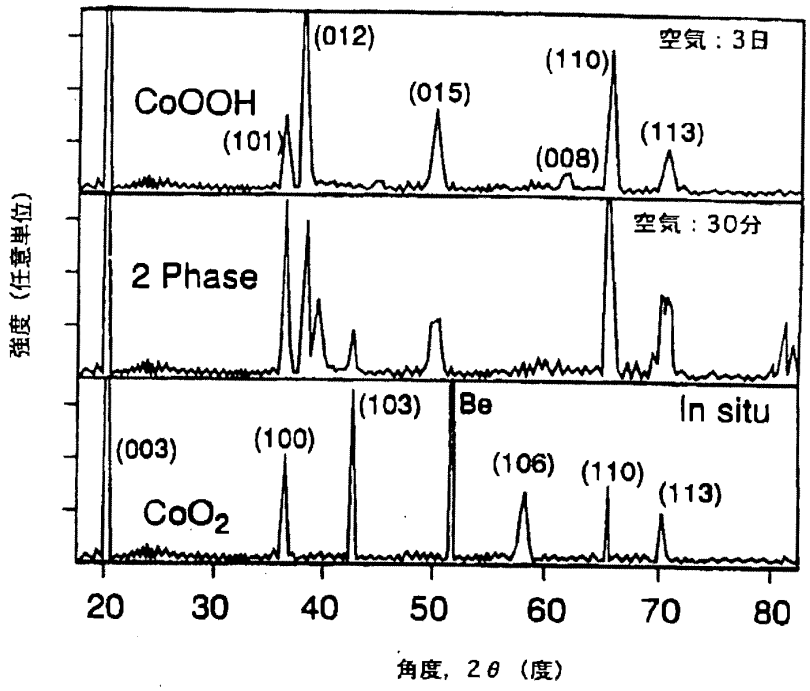
CoOOH
(012)
(101)
(015)
(110)
(008)
(113)
空気：3日
2 Phase
空気：30分
(003)
(100)
(103)
Be
In situ
(106)
(110)
(113)
CoO_2
強度（任意単位）
20
30
40
50
60
70
80
角度，2θ（度）

FIG. 11

【国際調査報告】

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US96/00556

A. CLASSIFICATION OF SUBJECT MATTER
IPC(6) :H01M 6/50, 10/44, 4/58; C25F 1/00; C01G 1/00; C01B 13/14
US CL :429/49, 50, 52, 218; 204/140, 141.5; 423/139, 592
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED
Minimum documentation searched (classification system followed by classification symbols)
U.S. : 429/49, 50, 52, 218; 204/140, 141.5; 423/139, 592

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X -- Y	US, A 4,818,647 (PLICHTA ET AL) 04 APRIL 1989 See Abstract; col. 1, lines 11-14, 50-54; and col.2, lines 6-9.	1, 4, 5, 6, 8, 9
X -- Y	US, A, 5,264,201 (DAHN ET AL) 23 NOVEMBER 1993 See abstract; col. 1, lines 11-14, 50-54; col. 2, lines 31-67; col. 3, lines 3-11; and Example 1.	1, 4, 5, 7, 8, 9
X -- Y	J. ELECTROCHEM. SOC. VOL. 140, NO. 7, JULY 1993, Tsutamu Ohzuku et al, "Electrochemistry and Structural Chemistry of LiNiO (R3m) for 4 Volt Secondary Lithium Cells", pages 1852-1870.	1, 4, 5, 6, 8, 9

[X] Further documents are listed in the continuation of Box C. [ ] See patent family annex.

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Date of the actual completion of the international search 09 APRIL 1996	Date of mailing of the international search report 29 APR 1996
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INTERNATIONAL SEARCH REPORT

International application No.
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C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y,P	US, A, 5,401599 (TAHARA ET AL) 28 MARCH 1995 See abstract; col.1, lines 7-16; col. 6, lines 5-22, 41-44, and 54-61.	2-4
X – Y	US, A, 5,296,319 (BITO ET AL) 22 MARCH 1994 See abstract; col. 1, lines 39-45; col. 2, lines 67-68 and Example 1.	1, 4, 5, 6, 8, 9

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08/383,401 3 February 1995 (03.02.95) US

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(72) Inventors: AMATUCCI, Glenn, G.; 407 Cornell Boulevard, Raritan, NJ 08869 (US). TARASCON, Jean-Marie; 16 Davis Court, Martinsville, NJ 08836 (US).

(74) Agents: WHITE, Lionel, N. et al.; International Coordinator, Room 1G112R, 445 South Street, Morristown, NJ 07960-6438 (US).

(81) Designated States: BR, CA, JP, MX, SG, European patent (AT, BE, CH, DE, DK, ES, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE).

Published
With international search report.

(54) Title: DELITHIATED COBALT OXIDE AND NICKEL OXIDE PHASES AND METHOD OF PREPARING SAME

(57) Abstract

$LiCoO_2$ and $LiNiO_2$ are fully delithiated electrochemically using solid state electrolytic cells and oxidation-resistant electrolytes to yield new, stable phases of CoO_2 and NiO_2

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DELITHIATED COBALT OXIDE AND NICKEL OXIDE PHASES AND METHOD OF PREPARING SAME

BACKGROUND OF THE INVENTION

The increasing commercial importance of rechargeable lithium ion battery cells has prompted a desire to identify and to prepare cathode materials better able to reversibly intercalate and deintercalate lithium ions at greater voltages. There are three prominent reversible lithium intercalation compounds used for lithium ion rechargeable batteries: $LiCoO_2$ and $LiNiO_2$ compounds, as well as $LiMn_2O_4$ spinel.

$LiCoO_2$ cells are of particular interest because of their ability to insert/deinsert lithium reversibly at voltages greater than 4V resulting in batteries that have an output voltage and an energy density 3 times greater than Ni-Cd. The theoretical charge capacity of $LiCoO_2$ cells is large at about 275 Amp-hours/kilogram (A-h/kg). In practical application, however, the maximum obtainable capacity for $LiCoO_2$ cells has been only about 140 A-h/kg, corresponding to a maximum charge voltage of about 4.2 V.

Previous attempts to exceed this charge cutoff voltage in $LiCoO_2$ cells have caused poor cell performance manifested by severe loss of charge capacity in subsequent charge-discharge cycles. The commonly-held reason for the 4.2 volt charge limitation for $LiCoO_2$ cells was that electrochemical delithiation of $LiCoO_2$ above this voltage destabilized the

structure of the partially delithiated $LiCoO_2$ phase, impairing intercalation of lithium in subsequent charge-discharge cycles.

Lithium cobalt oxide adopts a hexagonal structure consisting of CoO_2 layers separated by a Van der Waals gap. The octahedral sites within the Van der Waals gap are occupied by the Li^+ ions. This results in the reversible intercalation of lithium.

In such compounds, lithium acts as a glue or cement, screening the repulsive interactions between the negatively charged CoO_2 layers. When the compound is fully lithiated $LiCoO_2$, the screening effect is greatest. As lithium is removed, the screening effect is decreased and the repulsions between the two CoO_2 layers are enhanced resulting in an expansion of the c-axis parameter. Due to the screening effect of lithium, it was believed that complete lithium deintercalation to form CoO_2 was not possible.

Ohzuku et al., *J. Electrochem. Soc.*, Vol. 141, No. 11, Nov. 1994, p. 2972, have succeeded in removing approximately 85% of the lithium. Their efforts revealed a monoclinic phase and questioned the existence of a CoO_2 phase.

In another theory, Reimers and Dahn, *J. Electrochem. Soc.*, 139, 2091, (1992), states that excess Co^{4+} destroys the crystallinity of the lithium cobalt oxide structure. Apparently, it inhibits the formation of highly crystalline phases at low lithium contents.

Wizansky, Rauch, and DiSalvo, *Journal of Solid State Chemistry*, 81, 203-207 (1989), investigated the delithiation of

$LiCoO_2$ through the use of powerful oxidizing agents such as NO_2^+ and MoF_6. Their results showed that this approach merely decomposes the $LiCoO_2$.

$LiNiO_2$ is isostructural with $LiCoO_2$ and is commercially viable for use in secondary lithium ion batteries. Heretofore, no one has been capable of obtaining the delithiated NiO_2 phase. Ohzuku et al., J. Electrochem. Soc., Vol. 140, No. 7, July 1993, working with the nickel oxide reported $Li_{0.06}NiO_2$ and approximated that this was the end phase.

Lithium secondary batteries are generally recognized and are described for instance in U.S. Patent No. 5,296,318 to Gozdz et al., which is incorporated in its entirety herein by reference. Lithium metal-free "rocking-chair" batteries may thus be viewed as comprising two lithium-ion-absorbing electrode "sponges" separated by a lithium-ion-conducting electrolyte, usually comprising a Li^+ salt dissolved in a non-aqueous solvent or mixture of such solvents. Numerous such salts and solvents are known in the arts, as evidence in Canadian Patent Publication No. 2,022,191, dated 30 January 1991.

When cells comprising these previously-available electrolytes are cycled to a voltage even slightly greater than 4.3 V, electrolyte oxidation occurs. Although small, this oxidation can jeopardize the capacity, cycle life, and safety of the battery cell. For example, the electrode oxidation reaction consumes part of the charging current, which cannot be recovered when discharging the cell. The result is a continuous loss in the cell capacity over subsequent cycles. Further, if

during each charge a small part of the electrolyte is consumed, excess electrolyte must be included when the cell is assembled. The excess electrolyte reduces the amount of active material for a constant volume battery body, thereby decreasing initial capacity. In addition, the oxidation of the electrolyte often generates solid and gaseous by-products. The solid by-products build up a passivating layer on the particles of the active material, essentially increasing the polarization of the cell and lowering the output voltage. Simultaneously, and more importantly, the gaseous by-products increase the internal pressure of the cell, thereby increasing the risk of explosion and leading to unsafe and unacceptable operating conditions.

U.S. Patent No. 5,192,629, which is herein incorporated by reference in its entirety, provides a class of electrolyte compositions that are exceptionally useful for minimizing electrolyte decomposition in secondary batteries comprising strongly oxidizing positive electrode materials. These electrolytes are thus uniquely capable of enhancing the cycle life and improving the temperature performance of practical "rocking chair" cells. These electrolyte compositions have a range of effective stability extending up to about 5.0 V at 55°C, as well as at room temperature (about 25°C).

Electrolytes that are substantially inert to oxidation include a 0.5M to 2M solution of $LiPF_6$, or $LiPF_6$ with up to about an equal amount of $LiBF_4$ added, in a mixture of dimethylcarbonate (DMC) and ethylene carbonate (EC) within the weight percent ratio range from about 95 DMC:5 EC to 20 DMC:80 EC. In a preferred electrolyte solution, the solvent ratio range is about 80 DMC:20 EC to 20 DMC:80 EC. An optimum

composition for operation at room temperature and below is an approximately 1.5M $LiPF_6$ solution in a solvent mixture of about 67 DMC:33 EC. A battery operating at room temperature and higher, e.g., in the range of 55°C, optimally utilizes an electrolyte consisting essentially of an approximately 1.5M $LiPF_6$ solution in a solvent combination of about 33 DMC:67 EC. An additionally useful electrolyte consists essentially of an approximately 1M to 2M solution of equal parts of $LiPF_6$ and $LiBF_4$ in a solvent mixture of about 50 DMC:50 EC.

Negligible current increases, after the reversible Li intercalations, at voltages up to about 5 V vs. Li indicates this remarkable stability that enables enhanced cell capacity not only in the "rocking chair" cells comprising negative electrodes of carbon, e.g., petroleum coke, but also in Li negative electrode cells. Such a lithium metal cell utilizing a $LiCoO_2$ positive electrode may be reasonably expected to achieve normal operating ranges of about 4.3 to 5.1 V.

With the aid of electrolytes which are substantially inert to oxidation and solid state electrolytic cells, fully delithiated phases of both CoO_2 and NiO_2 were obtained.

SUMMARY OF THE INVENTION

Accordingly, the present invention is directed to metastable CoO_2 and NiO_2 phases and their use as intercalation compounds for use in lithium ion secondary batteries. Features and advantages of this invention are set forth in the

description that follows, and they will be apparent from that description or can be learned by practice of the invention.

In one aspect, this invention relates to an electrochemical method for preparing a stable cobalt dioxide phase that includes preparing an electrolytic cell having an anode, an electrolyte substantially inert to oxidation, and a cathode including a lithium cobalt oxide intercalation complex; and applying a voltage to the cell sufficient to completely deintercalate lithium from the lithium cobalt oxide intercalation complex, thereby forming a stable cobalt dioxide phase in the cathode.

In a further aspect, this invention relates to a stable cobalt dioxide phase prepared by the foregoing method.

In a further aspect, this invention relates to a stable cobalt dioxide phase having the x-ray diffraction pattern:

d(Å)
4.30 ± 0.02
2.44 ± 0.02
2.12 ± 0.02
1.61 ± 0.02
1.41 ± 0.02
1.34 ± 0.02
1.17 ± 0.02

In a further aspect, this invention relates to an electrochemical method for preparing a stable nickel dioxide

phase that includes providing a lithium nickel oxide intercalation complex having the formula Li_xNiO_2 wherein x is preferably 0.8 to 1.0, preparing an electrolytic cell having a cathode including the lithium nickel oxide intercalation complex, and applying a voltage to the cell sufficient to delithiate completely the lithium nickel oxide intercalation complex.

In a further aspect, this invention relates to a stable nickel dioxide phase prepared by the above described process. In a further aspect, this invention relates to a stable nickel dioxide phase having the x-ray diffraction pattern:

d(Å)
4.47 ± 0.02
2.40 ± 0.02
2.29 ± 0.02
1.97 ± 0.02
1.51 ± 0.02
1.41 ± 0.02
1.38 ± 0.02

In a further aspect, the invention relates to the a method of making a secondary electrolytic cell including the stable CoO_2 or NiO_2 phase and the cell formed thereby.

The accompanying drawings, which are incorporated in and constitute a part of this specification, illustrate embodiments of the invention and with the description serve to explain the invention and its objects, advantages, and principles.

BRIEF DESCRIPTION OF THE DRAWING

The present invention will be described with reference to the accompanying drawing of which:

FIG. 1 is a series of x-ray diffraction diagrams taken during electrochemical delithiation of $LiCoO_2$ to form the CoO_2 phase;

FIG. 2 is a series of x-ray diffraction diagrams taken during electrochemical intercalation of lithium into the CoO_2 phase;

FIG. 3 plots charge and discharge voltage versus lithium content for a cell utilizing the CoO_2 phase;

FIGs. 4 and 5 plot charge and discharge voltage versus lithium content for a cell having a $LiNiO_2$ cathode that has been delithiated to the NiO_2 phase according to the invention;

FIG. 6 plots decomposition reaction heat versus temperature for the CoO_2 and NiO_2 phase;

FIGs. 7 and 8 are x-ray diffraction diagrams for the thermal decomposition products of the CoO_2 and NiO_2 phases;

FIG. 9 plots charge and discharge voltages versus sodium content for a cell using the CoO_2 phase of this invention intercalated with sodium ions;

FIG. 10 is an x-ray diffraction diagram taken during electrochemical delithiation of $LiNiO_2$ to form the NiO_2 phase; and

FIG. 11 is an x-ray diffraction diagram illustrating the effect of atmospheric water on the CoO_2 phase.

DESCRIPTION OF THE INVENTION

One hindrance to the achievement of the CoO_2 and NiO_2 phases of the present invention, was removed by the development of electrolytes that are stable (inert to oxidation) at the high voltages thought necessary to achieve the delithiated CoO_2 phase. These electrolytes are exemplified by those described in U.S. Patent No. 5,192,629, the disclosure of which is incorporated herein by reference. Nonetheless, it was commonly held that the CoO_2 phase was unattainable because in the complete absence of lithium ions in the Van der Waals gap between the negatively-charged CoO_2 layers, the repulsive force between the layers would be too great and a completely delithiated CoO_2 phase would never be stable.

Using an electrolytic cell incorporating an $LiCoO_2$ cathode material described herein and a high voltage-stable electrolyte, the CoO_2 phase can be prepared by applying to the cell a charge voltage of 5.2 V, which will deintercalate substantially all the lithium from the $LiCoO_2$ cathode, forming the CoO_2 phase. The CoO_2 phase is metastable and decomposes above 200°C.

Similarly, in an electrolytic cell using a high voltage-stable electrolyte and a $LiNiO_2$ cathode, a substantially complete delithiation to a NiO_2 phase can be achieved by applying a charge voltage of 5.1 V.

Once obtained, the CoO_2 and NiO_2 phases of the present invention can be reintercalated with lithium, or by other ions such as hydrogen nuclei, sodium (Example 4), potassium, or rubidium. Reintercalation of lithium or other ionic species into the CoO_2 or NiO_2 phases can be accomplished by electrochemical insertion or by vapor phase transport at temperatures below 200°C. Vapor phase transport is described in a paper by Tarascon et al., "Synthesis and peculiar properties of $InMo_6S_{x-8}Se_x$, $TlMo_6S_{x-8}Se_x$ and $Hg_yMo_6S_{x-8}Se_x$", *Physical Review B*, Vol. 31, NO. 2, 1985, which is incorporated herein by reference in its entirety.

Following reintercalation, these phases can, for example, be cycled with lithium between 3 V and 4.2 V for the CoO_2 phase and 2.8 V and 4.1 V for the NiO_2 phase without loss of cell capacity.

After formation of the CoO_2 phase, CoOOH may be formed by exposure of the phase to atmospheric water. As can be seen from FIG. 11, CoO_2 may be formed in situ in an electrochemical cell. After exposure to air for approximately 30 minutes, two phases are present. After 3 days in air CoOOH was formed, because at an open circuit voltage >4 V the following reaction occurs:

$$2\ H_2O - 4\ e^- \text{-----> } O_2 + 4\ H^+$$

$$CoO_2 + x\ e^- + x\ H^+ \text{-----> } H_xCoO_2$$

The CoOOH may be used as an electronic conductor in other battery technology. This includes application in the Ni electrode or NiMeH, Ni-H or Ni-Cd batteries in which cobalt is already used.

As an alternative, once formed, these phases can be used in any variety of manners. In one preferred embodiment, the cathode of a plastic solid state cell is not laminated to the underlying electrolyte/anode structure, thus allowing ease of removal of the CoO_2 or NiO_2 phase in a plastic matrix. This plasticized phase can then easily be transported to other environments. For the reasons discussed above, if the pure CoO_2 phase is desired, handling under inert (anhydrous) conditions is preferred.

In another embodiment, this plasticized phase is placed into a cell containing, for example, a sodium containing electrolyte and a compatible electrolyte and then the cobalt or nickel oxide phase is reintercalated with the sodium ions. This reintercalation may be stopped short of completion and, in that way, a second or subsequent ion may be added to the reintercalated metal oxide phase.

In yet another embodiment, the nickel or cobalt oxide phase may be combined with an organic component to form, for example, either a composite polymer or an activated metal oxide carrier. The redox potential of this phase is high making it potentially useful in many areas. Anticipated applications include, for example, forming inorganic polymer structures and as a biochemical carrier. Such applications would be clearly recognizable to the skilled artisan.

The following examples exemplify the practice of the present invention to the prior art. It will be appreciated by those skilled in the art that these examples are not to be construed as limiting the present invention.

Example 1

A plastic electrolytic cell was constructed comprising a matrix of polyvinylidene fluoride (PVdF) and hexafluoro-propylene (HFP), incorporating an electrolyte composition of 2 parts EC to one part DMC and 1M $LiPF_6$, which was inert to oxidation at high voltages. The cathode contained $LiCoO_2$ as an active material and the anode contained carbon. The anode and the solid state electrolyte were laminated to one another and the cathode was placed thereover.

This cell was charged to 5.2 V, at which point the $LiCoO_2$ was fully delithiate to form the CoO_2 phase. The existence of this phase is confirmed by the x-ray data depicted in FIG. 1. FIG. 1 depicts the diffraction pattern at the end of deintercalation of $LiCoO_2$ beginning at approximately the last known phase disclosed in the prior literature, i.e., monoclinic ($Li_{0.15}CoO_2$) and proceeding to complete delithiation at a voltage of 5.2V.

The x-ray diffraction patterns were obtained in-situ through the use of an X-ray diffraction apparatus that allows the use of high voltages without corrosion of the beryllium window.

The final x-ray diffraction pattern obtained at 5.2 V is the hexagonal structure associated with the CoO_2 phase.

Moreover, once obtained, the CoO_2 phase reconverted to the $LiCoO_2$ phase during discharge of the cell as shown by the series of x-ray diffraction patterns in FIG. 2. Following attainment of the CoO_2 phase in the cathode and reintercalation of lithium to form the $LiCoO_2$ phase, this cell was cycled between 3 V and 4.2 V with little loss of charge capacity, as seen in FIG. 3.

During the charge cycle of a partially delithiated cobalt oxide, reinsertion of the lithium forms a monoclinic phase; however, reinsertion of lithium into the fully delithiated cobalt oxide resulted in a hexagonal structure, which is the same as the structure of the $LiCoO_2$ originally incorporated into the electrolytic cell.

Example 2

A plastic electrolytic cell was constructed as in Example 1, incorporating an electrolyte composition inert to oxidation at high voltages and a cathode made from $LiNiO_2$. This cell was charged to 5.1 V, at which voltage substantially all of the lithium was removed from the $LiNiO_2$ phase to form the NiO_2 phase. The existence of the NiO_2 phase is confirmed by the x-ray data depicted in FIG. 10.

The cell was discharged at 200 μA, whereupon 70% of the lithium intercalated back into the NiO_2 structure, as seen in FIG. 4. Subsequent cycling this cell between 2.8 V and 4.0 V without capacity fading confirmed that the reversible charge characteristics of the Li_xNiO_2 were not destroyed by the attainment of the NiO_2 phase. Reducing the discharge current to 150 μA resulted in intercalation of all of the lithium to form

the $LiNiO_2$ phase. As shown in FIG. 5, subsequent cycling of this cell between 2.8 V and 4.1 V resulted in a high capacity (greater than 190 A-h/kg) with minimal polarization and slight irreversibility characteristic of $LiNiO_2$. These results show that total removal of lithium from $LiNiO_2$ produces a structure that remains electrochemically active.

Example 3

A study of the thermal stability of the CoO_2 phase and NiO_2 phase was undertaken. Plastic electrodes of $LiCoO_2$ and $LiNiO_2$ brought to the CoO_2 phase and the NiO_2 phase in the manners described in Examples 1 and 2, respectively, were dissolved separately in a dilute acetone solvent at room temperature. The plastic portions of the electrodes dissolved in the solvent, and the insoluble metal oxides settled to the bottom of the vessels. The metal oxides were separated from the solution and analyzed using differential scanning calorimetry (DSC) ramped to 300°C at 10°C/min.

As seen in FIG. 6, a relatively strong exothermic reaction occurred at 200°C for both the CoO_2 and NiO_2 phases. Analysis of the samples by x-ray diffraction after DSC revealed that both phases reduced with attendant oxygen loss according to the reaction

$$MO_2 \text{ --> } MO + 1/2\ O_2.$$

The x-ray diffraction patterns depicted in FIGs. 7 and 8 confirm that the samples transformed into the mixed rocksalt structures of CoO and NiO, which are known to be electrochemically inactive to lithium intercalation.

Example 4

A cell was constructed as in Example 1. The CoO_2 phase was formed by delithiating the plastic cell at 5.2 V for 15 hours. After the CoO_2 phase was formed, the plasticized CoO_2 was removed from the electrolyte/anode structure and then incorporated into a similarly constructed cell contained sodium.

The new cell was constructed using the plastic CoO_2 cathode, an $NaClO_4$ electrolyte and a sodium metal anode. Sodium was introduced into the CoO_2 phase by discharging the cell at 2.2 V to insert the sodium. The cell was then cycled between 2.2 V and 4.1 V, as shown in FIG. 9.

What is claimed is:

1. A method of preparing a stable metal dioxide phase c h a r a c t e r i z e d i n t h a t said method comprises:

a) preparing an electrolytic cell having an anode, an electrolyte inert to oxidation, and a cathode comprising a metal oxide selected from the group consisting of a lithium cobalt oxide intercalation complex and a lithium nickel oxide intercalation complex having the formula Li_xNiO_2 wherein x is 0.8 to 1.0; and

b) applying to said cell a voltage sufficiently high to deintercalate substantially all lithium from said metal oxide.

2. A method according to claim 1 wherein said voltage is in excess of about 5.0 V.

3. A method according to claim 2 wherein said electrolyte comprises a 0.5M to 2M solution of $LiPF_6$, or $LiPF_6$ with up to about an equal amount of $LiBF_4$ added, in a mixture of dimethyl-carbonate (DMC) and ethylene carbonate (EC) within the weight percent ratio range from about 95 DMC:5 EC to 20 DMC:80 EC.

4. A method according to claim 1 which further comprises intercalating said stable metal dioxide phase with an element selected from the group consisting of lithium, sodium, potassium, rubidium, and hydrogen.

5. A stable metal dioxide phase prepared according to the method of claim 1

characterized in that

the metal is selected from the group consisting of cobalt and nickel.

6. A stable cobalt dioxide phase according to claim 5 having the X-ray diffraction pattern:

d(Å)
4.30 ± 0.02
2.44 ± 0.02
2.12 ± 0.02
1.61 ± 0.02
1.41 ± 0.02
1.34 ± 0.02
1.17 ± 0.02

7. A stable nickel dioxide phase according to claim 5 having the X-ray diffraction pattern:

d(Å)
4.47 ± 0.02
2.40 ± 0.02
2.29 ± 0.02
1.97 ± 0.02
1.51 ± 0.02
1.41 ± 0.02
1.38 ± 0.02

8. A secondary electrolytic cell including an anode, an electrolyte, and a cathode

c h a r a c t e r i z e d i n t h a t

said cathode comprises a stable metal dioxide phase of claim 5.

9. A secondary electrolytic cell according to claim 8

c h a r a c t e r i z e d i n t h a t

said cathode further comprises an element selected from the group consisting of lithium, sodium, potassium, rubidium, or hydrogen intercalated into said stable metal dioxide phase.

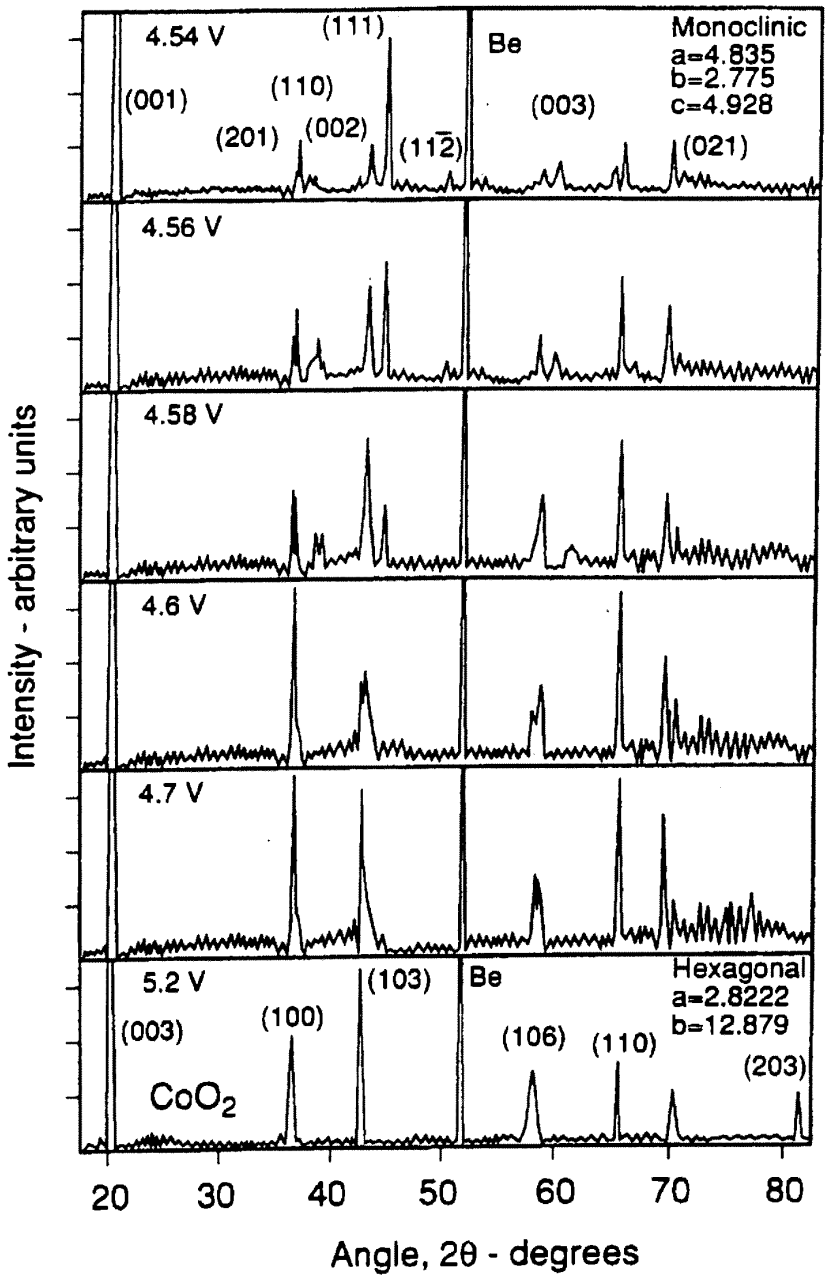
4.54 V
(111)
(001)
(110)
(201)
(002)
(11$\bar{2}$)
Be
Monoclinic
a=4.835
b=2.775
c=4.928
(003)
(021)
4.56 V
4.58 V
4.6 V
4.7 V
5.2 V
(003)
(100)
(103)
CoO_2
Be
Hexagonal
a=2.8222
b=12.879
(106)
(110)
(203)
Intensity - arbitrary units
20
30
40
50
60
70
80
Angle, 2θ - degrees

FIG. 1

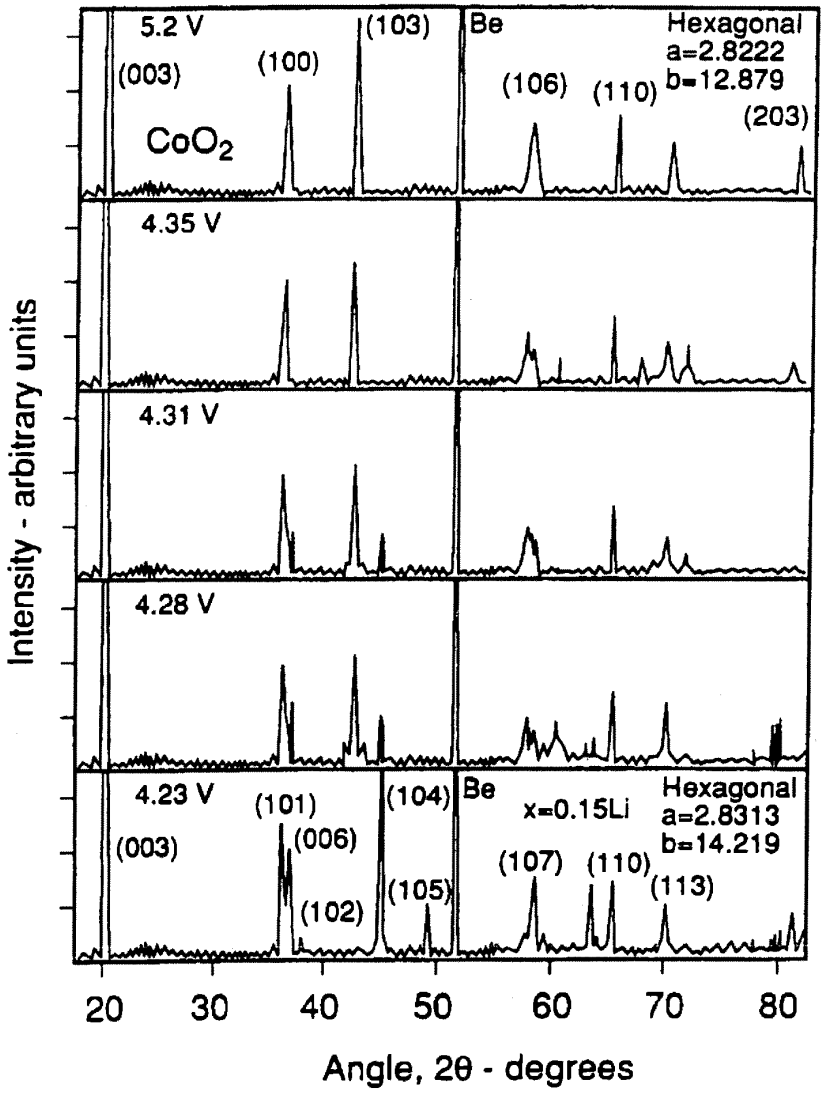
5.2 V
(003)
(100)
(103)
CoO_2
Be
Hexagonal
a=2.8222
b=12.879
(106)
(110)
(203)
4.35 V
4.31 V
4.28 V
4.23 V
(003)
(101)
(006)
(102)
(104)
(105)
Be
x=0.15Li
Hexagonal
a=2.8313
b=14.219
(107)
(110)
(113)
Intensity - arbitrary units
20
30
40
50
60
70
80
Angle, 2θ - degrees

FIG. 2

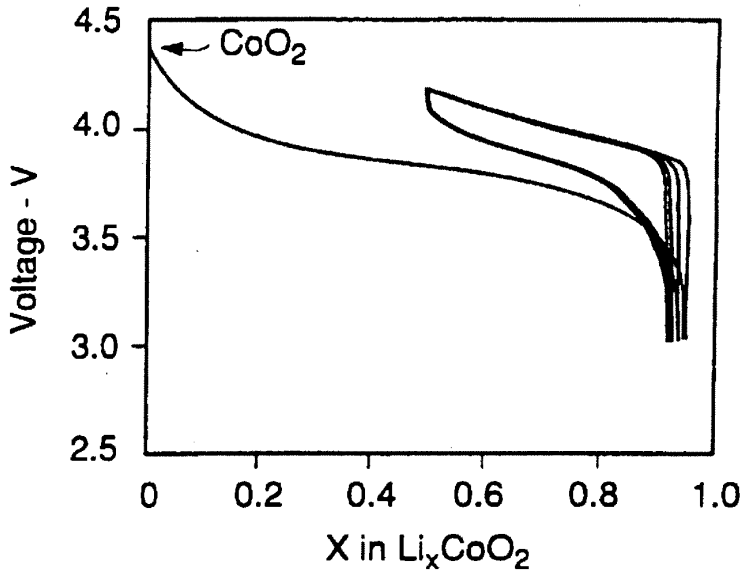

FIG. 3

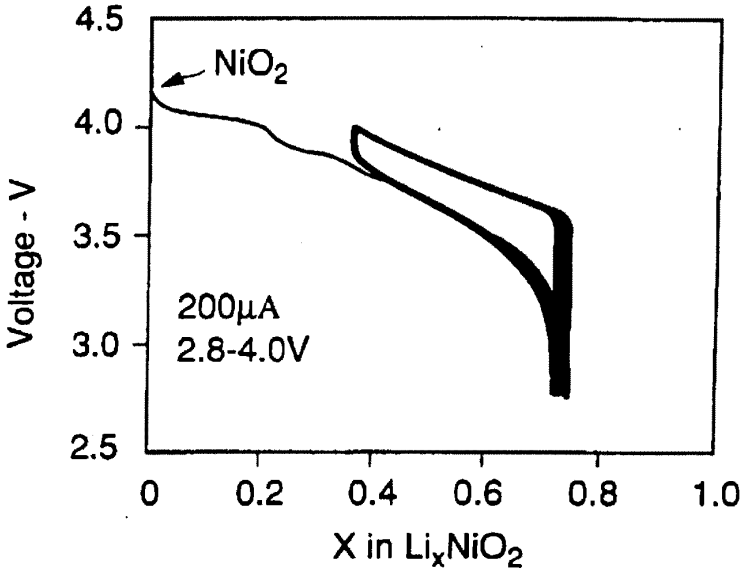
4.5
4.0
3.5
3.0
2.5
Voltage - V
NiO2
200μA
2.8-4.0V
0
0.2
0.4
0.6
0.8
1.0
X in LixNiO2

FIG. 4

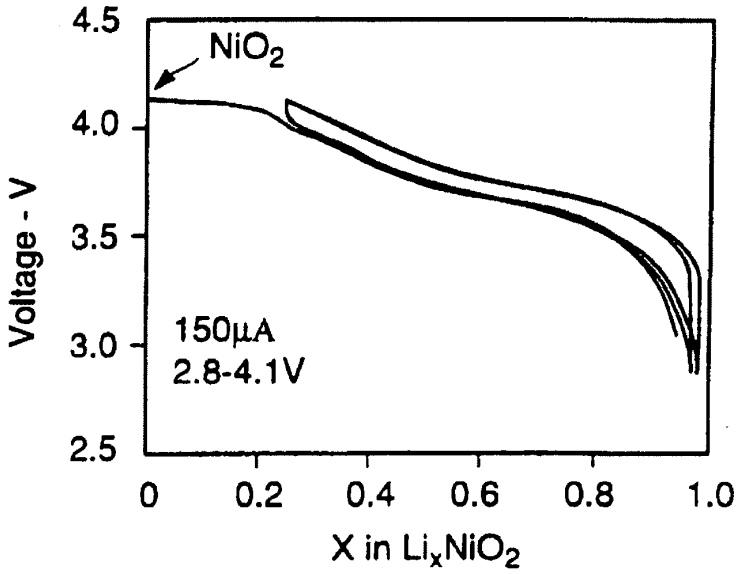
4.5
4.0
3.5
3.0
2.5
Voltage - V
NiO2
150μA
2.8-4.1V
0
0.2
0.4
0.6
0.8
1.0
X in LixNiO2

FIG. 5

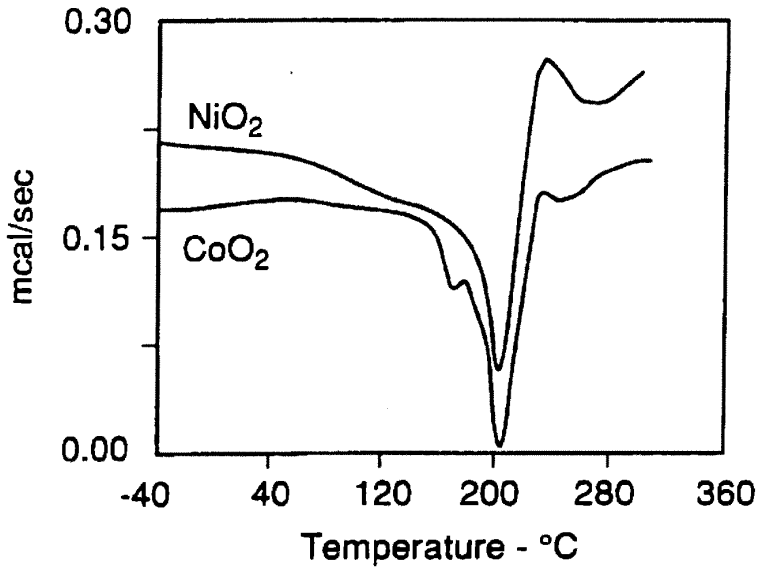
0.30
0.15
0.00
mcal/sec
NiO2
CoO2
-40
40
120
200
280
360
Temperature - °C

FIG. 6

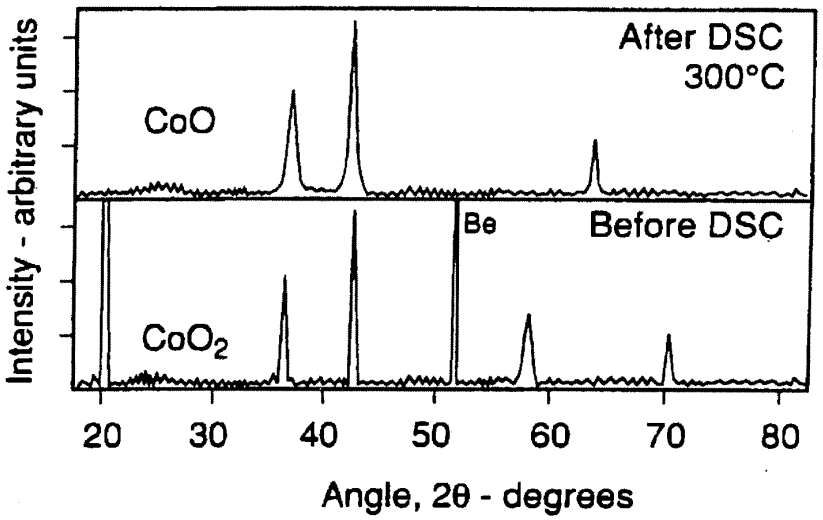
After DSC
300°C
CoO
Be
Before DSC
CoO_2
Intensity - arbitrary units
20
30
40
50
60
70
80
Angle, 2θ - degrees

FIG. 7

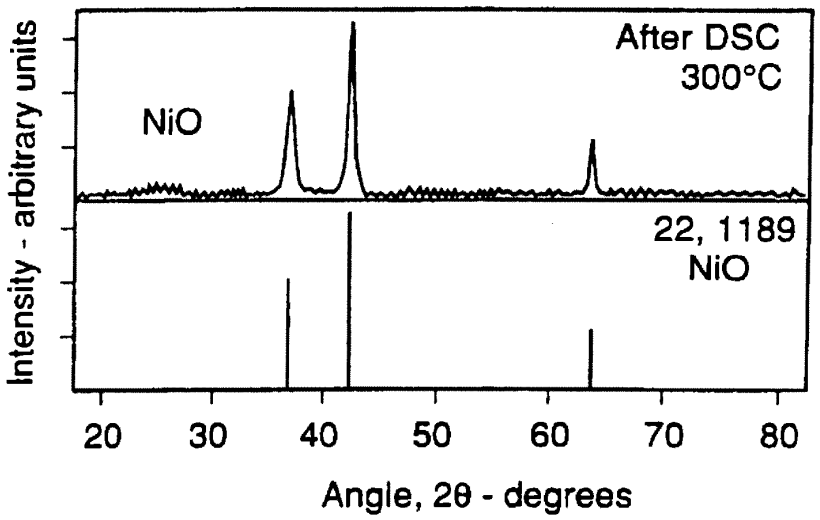
After DSC
300°C
NiO
22, 1189
NiO
Intensity - arbitrary units
20
30
40
50
60
70
80
Angle, 2θ - degrees

FIG. 8

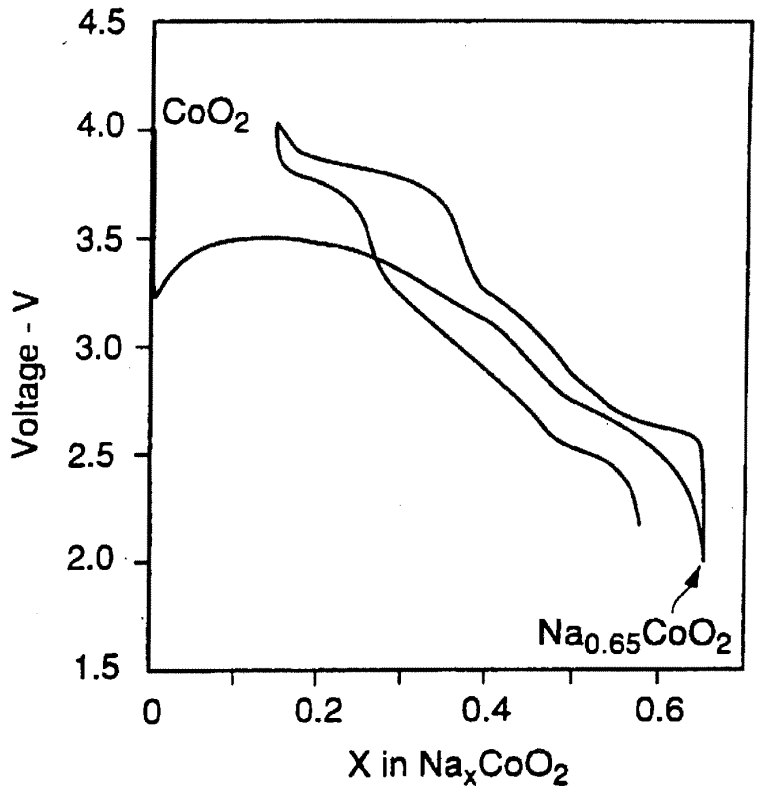
4.5
4.0
3.5
3.0
2.5
2.0
1.5
Voltage - V
CoO_2
$Na_{0.65}CoO_2$
0
0.2
0.4
0.6
X in Na_xCoO_2

FIG. 9

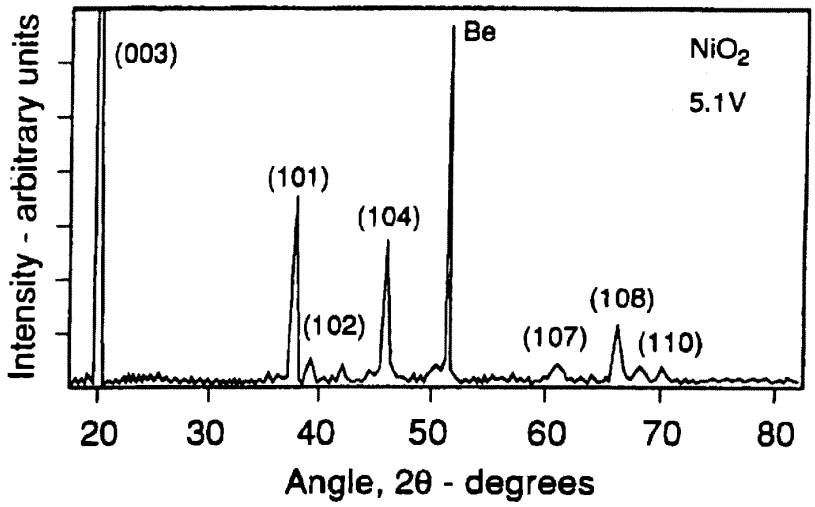
Intensity - arbitrary units
(003)
Be
NiO_2
5.1V
(101)
(104)
(102)
(108)
(107)
(110)
20
30
40
50
60
70
80
Angle, 2θ - degrees

FIG. 10

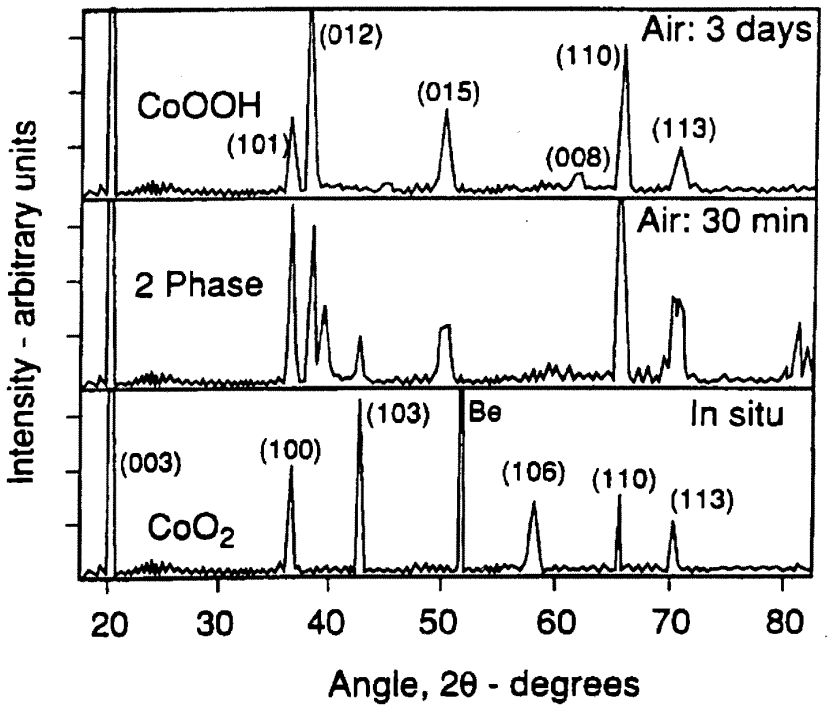
Air: 3 days
(012)
(110)
(015)
CoOOH
(101)
(008)
(113)
Air: 30 min
2 Phase
(103)
Be
In situ
(003)
(100)
(106)
(110)
(113)
CoO_2
Intensity - arbitrary units
20
30
40
50
60
70
80
Angle, 2θ - degrees

FIG. 11

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特表平7－505740

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4/02	Ｃ	7603－4Ｋ	

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(87)国際公開番号　ＷＯ９３／２１６６５
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(31)優先権主張番号　８７１，８５５
(32)優先日　1992年４月21日
(33)優先権主張国　米国（ＵＳ）
(81)指定国　ＥＰ(ＡＴ，ＢＥ，ＣＨ，ＤＥ，ＤＫ，ＥＳ，ＦＲ，ＧＢ，ＧＲ，ＩＥ，ＩＴ，ＬＵ，ＭＣ，ＮＬ，ＰＴ，ＳＥ)，ＣＡ，ＪＰ

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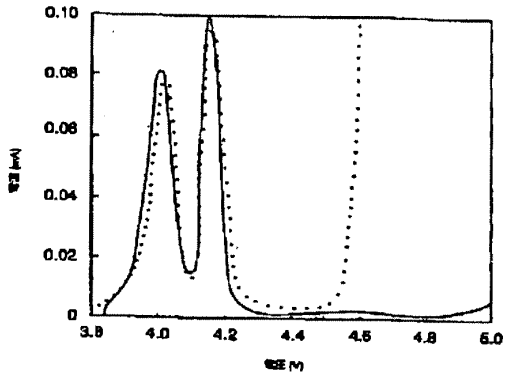
(54)【発明の名称】　$Li_{1+x}Mn_2O_4$ 炭素二次電池用高圧安定電解質

(57)【要約】
二次電池の高電圧充電の結果起こる酸化に耐性のある電解質で、この二次電池は非水炭酸ジメチル（ＤＭＣ）と炭酸エチレン（ＥＣ）溶媒の混合物に溶解した$LiPF_6$の０．５Ｍ～２Ｍ溶液$Li_{1+x}Mn_2O_4$挿入陽極を含み、該溶媒は約９５ＤＭＣ：５ＥＣから２０ＤＭＣ：８０ＥＣまでの重量％の範囲であるもの。



特許請求の範囲

請求項1　リチウム化挿入二次電池の高電圧安定電解質で、非水溶媒中のリチウム化合物の溶液を含み、下記の特性を含むもの

該電解質が本質的に

a) $LiPF_6$；および

b) $LiPF_6$の混合物で、その混合物はモル単位で$LiBF_4$と同等量を有するもの

を含む範囲から選択された約0.5から2Mの溶質の溶液で、

これは非水炭酸ジメチル溶媒（DMC）と炭酸エチレン溶媒（EC）の混合物に溶解したもので、該溶媒は約95 DMC:5 ECから20 DMC:80 ECの重量%の範囲のもの。

請求項2　請求項1記載の電解質で、下記の特性を含むもの

該溶媒は約80 DMC:20 ECから20 DMC:80 ECの重量%の範囲のもの。

請求項3　請求項1記載の電解質で、下記の特性を含むもの

該電解質溶液は下記のグループから選択されるもの：

a) 約33 DMC:67 ECの溶媒混合物中の$LiPF_6$の約1M溶液；

b) 約67 DMC:33 ECの溶媒混合物中の$LiPF_6$の約1.5M溶液；

c) 約50 DMC:50 ECの溶媒混合物中の1Mから2Mの溶液で、この溶液は$LiPF_6$と$LiBF_4$が約同等量であるもの。

請求項4　陰極と陽極からなる二次電池、および非水溶媒中のリチウム化合物の溶液からなる電解質で、下記の特性を含むもの

該電解質が本質的に

a) $LiPF_6$；および

b) $LiPF_6$の混合物で、その混合物はモル単位で$LiBF_4$と同等量を有するもの

を含む範囲から選択された約0.5から2Mの溶質の溶液で、

これは非水炭酸ジメチル溶媒（DMC）と炭酸エチレン溶媒（EC）の混合物に溶解したもので、該溶媒は約95 DMC:5 ECから20 DMC:80 ECの重量%の範囲のもの。

請求項5　請求項4記載の電池で、下記の特性を含むもの

該陽極が、約3～10重量%のカーボンブラックと約1～5重量%の不活性結合剤を混み合わせた挿入化合物からなるもの。

請求項6　請求項4記載の電池で、下記の特性を含むもの

該陽極挿入化合物が、本質的に$Li_xMn_2O_4$からなるもので、式中xは0から1の範囲にあるもの。

請求項7　請求項5記載の電池で、該溶媒は約80 DMC:20 ECから20 DMC:80 ECの重量%の範囲のもの。

請求項8　請求項4記載の電池で、下記の特性を含むもの

該電解質は下記のグループから選択されるもの：

a) 約33 DMC:67 ECの溶媒混合物中の$LiPF_6$の約1M溶液；

b) 約67 DMC:33 ECの溶媒混合物中の$LiPF_6$の約1.5M溶液；

c) 約50 DMC:50 ECの溶媒混合物中の1Mから2Mの溶液で、この溶媒は$LiPF_6$と$LiBF_4$が約同等量であるもの。

請求項9　請求項4記載の電池で、下記の特性を含むもの

該陰極が、本質的に炭素とリチウム金属からなるグループから選択された素材からなるもの。

請求項10　請求項4記載の電池で、下記の特性を含むもの

該陰極が、本質的に炭素からなり、該電解質は本質的に約67 DMC:33 ECから約33 DMC:67 ECの溶媒混合物中における約1Mから1.5Mの$LiPF_6$溶液からなるもの。

明　細　書

発明の名称　$Li_xMn_2O_4$炭素二次電池用高圧安定電解質

発明の背景

本発明は、二次（再充電可能）リチウム電池の非水電解質組成物に関し、さらに詳しくは、一般的に、4.3 Vまたは35℃以上の状況下の充電中、$Li_xMn_2O_4$炭素セル内の酸化によって起こる分解に対して耐性のある電解質組成物に関する。

一般的に再充電可能リチウム電池が有する利点は、リチウム金属を陰極として使用するセル内のリチウムの反応によってかき消されているところがある。再充電可能リチウム電池を操作するためのより確度で本質的に安全な方法として、リチウムイオンを可逆的に挿入できる素材とリチウム金属を取り替え、これによって充電／再充電サイクルの間に挿入電極間でリチウムイオンが「ロッタ」するいわゆる「ロッキングチェア」電池を提供するというものがある。このようなLi金属を含まない「ロッキングチェア」電池は、非水溶媒またはそのような溶媒の混合物に溶解した適当なLi塩からなるリチウム・イオン伝導電解質によって分離された2つのリチウム・イオン吸収電極「スポンジ」からなると考えられる。このような塩と溶媒は技術分野において数多く知られており、その例としてカナダ特許No. 2,022,191（1991年1月30日）などがある。

この種の再充電可能リチウム電池の出力電圧は、セルの2つの挿入電極内のLiの電気化学ポテンシャル間の差によって決定される。故に、効果的なセルでは、陽極と陰極の素材は、それぞれに高電圧と低電圧でリチウムを挿入することができるはずである。陰極として使用されるリチウム金属の代用となる効果的な素材の中で、炭素は大きな比容量と優れた可逆性サイクルとの間での最良の妥協点を提供するものと言える。しかしながら、このような炭素の使用はリチウム金属と比較して、平均出力電圧やエネルギー密度の損失などの短所がいくつか認められ、これはLi_xC炭素の電圧が純粋のリチウム陰極の電圧よりも常に大きいため起こるものである。

陰極と関連する電圧損失を償うために、強い酸化作用の挿入素材を陰極として使用することが望ましい。そのような電極素材はスピネル位相$Li_xMn_2O_4$であり（通常少量のカーボンブラックと組合せて伝導性を向上させ、実用的な複合電極となる）、これは4.1 V vs. Liの電圧でリチウムを可逆的に挿入するものである。しかしながら、このように強度の酸化挿入素材を陰極として使用すると、高い動作電圧、つまり約4 V以上の電圧での酸化による電解質の分解が起こるという危険性がさらに出てくる。例えば、$Li_xMn_2O_4$/Li組合の電圧は約4.1 Vであるため、このレドックスシステムを有効に使用するためには約4.3 Vの電圧まで充電するべきである。その結果、このようなセルの電解質は、約4.3 Vから約5.0 Vまで延長する電圧範囲で安定する必要がある。また、上述した「ロッキングチェア」セルで使用する場合、電解質組成物は複合炭素陰極（例えば、カーボンブラック（スーパーS）および不活性結合剤のそれぞれの約1～5%と組合わせた石油コークス）に関して約0 Vまで安定していなければならない。

現在使用されている挿入電解質（例えば米国特許No. 5,110,696に記載されたような炭酸エチレン（EC）とジエトキシエタン（EDD）の50:50混合物におけるLiClO$_4$の1M溶液）は、$Li_xMn_2O_4$/Cセルで使用された場合、室温のとき約4.3 Vで酸化を始め、また最低約55℃の温度のとき約4.3 Vで酸化を始める。従って、より高い周囲温度でのセルを動作させるには、充電カットオフ電圧を約4.3 V以下のレベルに絞らし、電解質の酸化を避けなければならない。この低いカットオフ電圧のため、約55℃でのセルの利用可能容量は室温の場合のわずか75%になってしまう。

これらの既存電解質からなるセルが、4.3 Vよりほんのわずかにでも大きくサイクリングされると電解質の酸化が起こる。わずかとは言え、この酸化は電池セルの容量、サイクル寿命、安全性を危険にさらす可能性がある。例えば、電極酸化反応は充電電流の一部を消費し、これは後に回復できないものであるため、後段のサイクルで最終的なセル容量損失を招く結果になる。さらに、充電中、電解質の少量が消費されるのであれば、セルを組み立てるときに余分の電解質を含めなければならない。これによって定容電池体の活性度のより低い素材になり、その結果、初期の容量も少なくなる。さらに、電解質の酸化は固体および気体の副産物を生成することがよくある。この固体の副産物は、活性素材の粒子上のパッシベーション層を作り出すもので、セルの極性を増加し、出力電圧を低下させてしまう。同時に、そしてさらに重要なことであるが、気体の副産物はセルの内部圧を上昇させるため爆発の危険性が高くなり、安全性を保つことができず、容認することのできない動作状態となってしまう。

発明のまとめ

本発明は、強い酸化陽極素材からなる二次電池において電解質の分解を最小化するこ

とに非常に有用な電解質組成物の一組を提供するものである。これによって、電解質はサイクル寿命を独自に強化することができ、実用的な「ロッキングチェア」セルの温度性能を向上させる。このように効果的な電解質を個しだすため、望ましい陽極素材の施設作用は予想することができないため、文字通り何百という組成物を調査した。この広範囲にわたる調査の結果、有効な安定性が55℃および室温（約25℃）で約5.0 Vまで達する一群の電解質組成物を発見するに至った。

より優れた電解質を選ぶために、基本的で不可欠な要因のいくつかを考慮した。理想的には、流動性の範囲が広く、電解質酸化を避ける充電カットオフ電圧が高いものが望ましい。選択過程において、組成物の流体温度、つまり融点と沸点の間は、それぞれ差動走査熱量計（Perkin-Elmer社製DSC-4型）と通常の研究所用遠流装置で測定した。次に、異なる電解質組成物のイオン伝導率は、高周波インピーダンスアナライザ（Hewlett Packard社製HP4129A型、5 Hz～10 MHz）を用いて実際的な広い温度範囲（－25℃～65℃）で測定した。最後に、酸化に対する電解質の安定性は、実際のセルで起こると予想される活動を模擬実験するために$Li_{1-x}Mn_2O_4$電極を使用し、定電位モード電量計（CNRS社製（フランス、グレノーブル市）"Mac-Pile"型、バージョンA-3.01e/881）で、さまざまな温度と充電電圧において測定した。これらの測定から、上述の優れた電解質の結果は、$LiPF_6$、またはほぼ同等量までの$LiBF_4$を加えた$LiPF_6$の約0.5Mから2M溶液を、炭酸ジメチル（DMC）および炭酸エチレン（EC）の混合物に溶かした組成物から得られることを発見した。これらの溶媒組成の重量%率は、約95 DMC:5 ECから33 DMC:67 ECの範囲にあったが、できれば約80 DMC:20 EC～20 DMC:80 ECの範囲が望ましい。

図面の簡単な説明

本発明は、次の添付図面を参照しながら説明する。

図1は、陽極Li挿入電極および50:50 EC:DEEの$LiClO_4$の電解質からなる二次セルの室温における充電電圧に対するセル電流を示したプロット図。

図2は、陽極Li挿入電極および50:50 EC:DEEの$LiClO_4$の電解質からなる二次セルの室温および55℃における充電電圧に対するセル電流の比較を示したプロット図。

図3は、陽極Li挿入電極、および50:50 EC:DEEの$LiClO_4$および67:33 DMC:ECの$LiPF_6$の電解質からなる二次セルの室温における充電電圧に対するセル電流の比較を示したプロット図。

図4は、陽極Li挿入電極、および50:50 EC:DEEの$LiClO_4$および67:33 DMC:ECの$LiPF_6$の各電解質からなる二次セルの55℃における充電電圧に対するセル電流の比較を示したプロット図。

発明の詳細な説明

現在知られているLi生成電解質塩や非水溶媒、およびもっと一般的に使用されている陽極挿入素材など、広範囲にわたる組合せを調査した。塩としては$LiAsF_6$、$LiBF_4$、$LiCF_3SO_3$、$LiClO_4$、$LiN(CF_3SO_2)_2$、$LiPF_6$、また溶媒としては炭酸ジエチル、ジエトキシエタン、炭酸ジメチル、炭酸エチレン、炭酸プロピレンなどを調査した。さらに検査電極の組成物には、$KiCoO_2$、$Li_{1-x}Mn_2O_4$、$LiNiO_2$、MnO_2、V_2O_5を調査した。

溶媒中のさまざまな塩の溶液、およびその混合物溶液の融点から沸点の範囲の初期走査によると、1Mから2Mの溶液が一般的に約－40℃から130℃で有用であることを示した。続いて、電池セルの予想「動作範囲」約－25℃から65℃において、これらの溶液で有効電極のテストを行った。

候補の電極の重要なイオン伝導特性の選考は、1 cm当り約3から12 mS（milliSiemensまたはmillimhos）と大きく異なる範囲を示した。炭酸エチレンとジエトキシエタンを50:50の割合にした混合物中の$LiClO_4$の1M溶液からなる従来の理想的「ロッキングチェア」電池電解質組成物の効能評価から、この選択過程の伝導性の最低しきい値は約10 mS/cmに設定した。この基準をもとにして、予期される候補組成物のリストは、炭酸ジメチルと炭酸エチレンの組合せの溶媒を含むものへと急速に縮小していった。さらに塩の組成物は、$LiPF_6$および$LiPF_6$と$LiBF_4$の混合物のいくつかに限定された。

約4.5 Vの過剰再充電電圧下の酸化（分解）に耐える能力を測定するため、これらの残った組成物で最終的な一連の検査が行われた。CNRS "Mac-Pile"データ入手システムを走査速度40 mV/hr、定電位モードで動作させ、選択された電極素材の試料10 mg、1 cm^2に対する候補電解質組成物を検査した。これによってセル電流に対する充電電圧の電量測定の連続プロットが可能となった。この曲線から、電解質酸化の開始を容易に確認することができる。この手順を図1に示したが、これは上述した25℃での$LiClO_4$/EC+DEE電解質の特性曲線をプロットしたものである。約4.05 Vおよび4.15 V vs. Liでのピークは、$Li_{1-x}Mn_2O_4$のセル陽極のシビネル構造からのLiの可逆性除去に対応し、約4.5 V vs. Liで開始する電流の高速度可逆性増加は、その充電レベルで電解質酸化の開始を示している。

また、このようなプロットはセル動作温度の作用も示し、図2は約55℃の高い範囲の周囲温度における従来の$LiClO_4$電解質溶液の検査結果を示したものである。図1の点線で示した室温曲線を参照すると、温度上昇の結果として電解質酸化反応を決定する運動が低い電解質破壊電圧を起こすことが明白に分かる。約4.3 V vs. Li、また後の再充電サイクル中のより低い電圧での電解質酸化の開始は、高い温度で実用的な動作を行うため、充電カットオフ電圧を約4.1 V vs. Liまでに限定しなければならないことを示している。この限定の結果、利用可能なセル容量は、最高でも室温の場合のわずか約75%となってしまう。

この電解質酸化の選考検査により、$LiMn_2O_4$陽極挿入電池セルのための広い温度範囲を有する優れた酸化耐性電解質を発見した。これは、特に$Li_{1-x}Mn_2O_4$（$0<x<1$）電極を使用することが望ましく、炭酸ジメチル（DMC）と炭酸エチレン（EC）の混合物（約95 DMC:5 ECから20 DMC:80 ECの範囲の重量%内）中で、$LiPF_6$の0.5Mから2Mの溶液、または約同等量までの$LiBF_4$を添加した$LiPF_6$で実現することが可能である。できれば、このような電荷溶液において、溶媒の割合は約80 DMC:20 ECから20 DMC:80 ECであることが望ましい。室温またはそれ以下での最適組成物は、溶媒の混合が約33 DMC:67 ECの1M $LiPF_6$溶液であるが、これに対して約55℃の範囲の高い温度で動作する電池は、本質的に約67 DMC:33 ECの組合せの溶媒中の約1.5 M $LiPF_6$溶液からなる電解質を最適に利用する。さらに、有用な電解質は、本質的に約50 DMC:50 ECで混合した溶媒中の$LiPF_6$および$LiBF_4$の同等量の約1Mから2M溶液からなる。

前述した$LiClO_4$の組成物を参照し、図3では室温、図4では55℃での望ましい電解質組成物の優れた酸化耐性特性を示した。可逆性Li挿入後の、Liに対して約5 Vまでの電圧でのわずかな電流増加は優れた安定性を示しており、これによって例えば石油コークスなどの炭素の陰極を含む「ロッキングチェア」セルのセル容量を増加できるばかりでなく、Li陰極セルでも同様のことが可能となる。$Li_{1-x}Mn_2O_4$陽極を使用するこのようなリチウム金属セルは、約4.3 Vから5.1 Vの通常の範囲で動作することが期待できる。

新しい電解質組成物の効能は、一般的なスウェイジロック（Swagelock）セル再増殖検査で確認された。例えば、検査セルは$Li_{1-x}Mn_2O_4$を含む陽極と共に組み立てたが、これは慣例に従って、電気伝導性を向上させるために約3～10%の炭素（スーパーS黒鉛）、またポリテトラフルオロエチレンなどの不活性結合剤を約1～5%含むものだった。これらの検査中、約4～7%の範囲の低い炭素含有量の方が電解質酸化の傾向をさらに減少するため、低い炭素含有量の使用が望ましいことが分かった。95 DMC:5 ECでの1M $LiPF_6$の電極および炭素（黒鉛または石油コークス）陽極からなるセパレータ要素を含むこのような検査セルの一組は、約25℃と55℃、および充電カットオフ電圧のそれぞれ4.9 Cと4.5 Vにおいて2時間のサイクルで充電／放電を繰り返した。このサイクル速度および高い充電電圧でさえ電圧成極は非常に小さく、これは電解質の高いイオン伝導性を確認するものであり、セル容量の大きな損失はなく、これは電解質の高い電圧安定性を示すものだった。電池のサイクル寿命を延ばす電解質の能力は、500サイクル後のセル容量が5サイクル後の場合よりもわずかに約10%少なかっただけという注目すべき事実によって十分証明された。

私どもが発見した電極溶液は、従来のセルに使われたさまざまな固定方法で実用的電池に使用することができる。通常セル電極間に配置される多孔セパレータを充満させることに加え、これらの新しい電解質溶液はゲル化や膜厚化した組成物の形態として含むことや、二次可能剤として重合体構造に使用することも可能である。このような応用法や他の変形は、熟練した技術者には明白なものであり、添付の特許請求の範囲に含まれるものである。

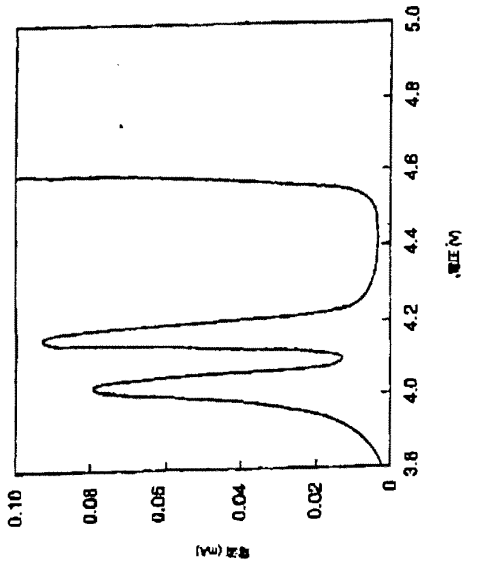

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图 1

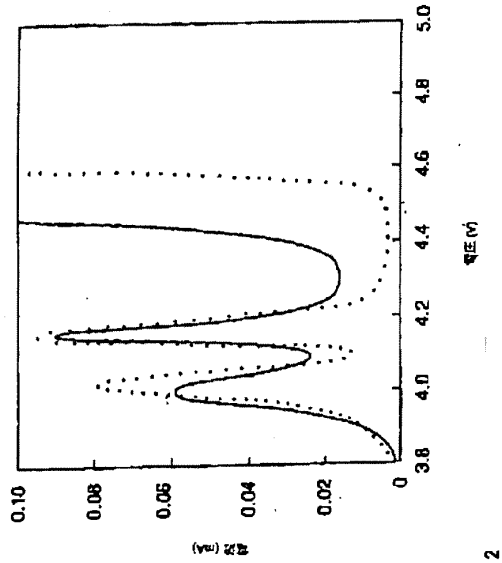
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图 2

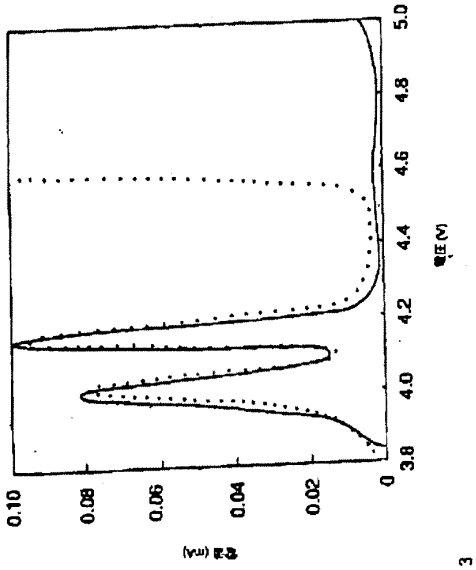
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图 3

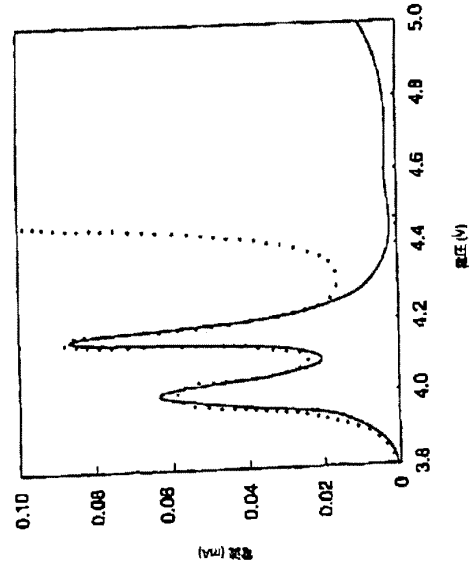
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图 4

国 際 調 査 報 告

International Application No.
PCT/US93/[illegible]

A. CLASSIFICATION OF SUBJECT MATTER
IPC(5): [illegible]
US CL: [illegible]
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED
Minimum documentation searched (classification system followed by classification symbols)
U.S.: [illegible]

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US, A, 4,419,423 (LEGER) 06 December 1983.	
A	US, A, 4,874,680 (KOSHIBA) 17 October 1989.	
A	US, A, 4,904,252 (FURUKAWA ET AL.) 27 February 1990.	
A	US, A, 5,079,109 (TAKAMI ET AL.) 07 January 1992.	
A,P	US, A, 5,110,696 (SHOKOOHI ET AL.) 05 May 1992.	

☐ Further documents are listed in the continuation of Box C. ☐ See patent family annex.

*	Special categories of cited documents:	"T"	[illegible]
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"B"	[illegible]	"X"	[illegible]
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"E"	[illegible]		

Date of the actual completion of the international search: 19 MAY 1993

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Name and mailing address of the ISA/US
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INTERNATIONAL SEARCH REPORT

International application No.
PCT/US96/00556

A. CLASSIFICATION OF SUBJECT MATTER

IPC(6) :H01M 6/50, 10/44, 4/58; C25F 1/00; C01G 1/00; C01B 13/14
US CL :429/49, 50, 52, 218; 204/140, 141.5; 423/139, 592
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

U.S. : 429/49, 50, 52, 218; 204/140, 141.5; 423/139, 592

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X -- Y	US, A 4,818,647 (PLICHTA ET AL) 04 APRIL 1989 See Abstract; col. 1, lines 11-14, 50-54; and col.2, lines 6-9.	1, 4, 5, 6, 8, 9
X -- Y	US, A, 5,264,201 (DAHN ET AL) 23 NOVEMBER 1993 See abstract; col. 1, lines 11-14, 50-54; col. 2, lines 31-67; col. 3, lines 3-11; and Example 1.	1, 4, 5, 7, 8, 9
X -- Y	J. ELECTROCHEM. SOC. VOL. 140, NO. 7, JULY 1993, Tsutamu Ohzuku et al, "Electrochemistry and Structural Chemistry of LiNiO (R3m) for 4 Volt Secondary Lithium Cells", pages 1852-1870.	1, 4, 5, 6, 8, 9

[X] Further documents are listed in the continuation of Box C. [ ] See patent family annex.

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INTERNATIONAL SEARCH REPORT

International application No.
PCT/US96/00556

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y,P	US, A, 5,401599 (TAHARA ET AL) 28 MARCH 1995 See abstract; col.1, lines 7-16; col. 6, lines 5-22, 41-44, and 54-61.	2-4
X – Y	US, A, 5,296,319 (BITO ET AL) 22 MARCH 1994 See abstract; col. 1, lines 39-45; col. 2, lines 67-68 and Example 1.	1, 4, 5, 6, 8, 9

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INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

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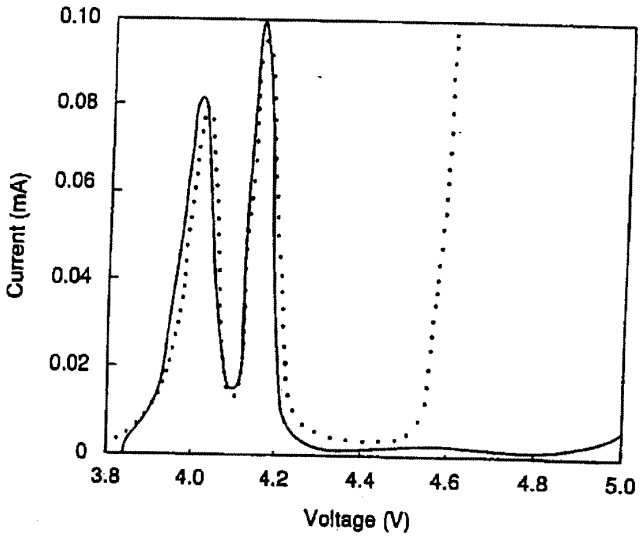
(54) Title: HIGH-VOLTAGE STABLE ELECTROLYTES FOR $Li_{1+x}MN_2O_4$/CARBON SECONDARY BATTERIES



(57) Abstract

An electrolyte resistant to oxidation normally resulting from high voltage charging of a secondary battery comprising an $Li_{1+x}Mn_2O_4$ intercalation positive electrode comprises a 0.5 M to 2 M solution of $LiPF_6$ dissolved in a mixture of non-aqueous dimethylcarbonate (DMC) and ethylene carbonate (EC) solvents wherein said solvents are present in a weight percent ratio range from about 95 DMC : 5 EC to 20 DMC : 80 EC.

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HIGH-VOLTAGE-STABLE ELECTROLYTES FOR $Li_{1+x}Mn_2O_4$/CARBON SECONDARY BATTERIES

BACKGROUND OF THE INVENTION

This invention relates to non-aqueous electrolyte compositions for secondary (rechargeable) lithium battery cells and, more particularly, to electrolyte compositions that are capable of resisting decomposition normally resulting from oxidation which occurs in $Li_{1+x}Mn_2O_4$ / carbon cells during recharging under conditions of greater than about 4.5 V or 55° C.

The advantages generally provided by rechargeable lithium batteries are often significantly overshadowed by dangers of the reactivity of lithium in cells which comprise lithium metal as the negative electrode. A more advanced and inherently safer approach to rechargeable lithium batteries is to replace lithium metal with a material capable of reversibly intercalating lithium ions, thereby providing the so-called "rocking-chair" battery in which lithium ions "rock" between the intercalation electrodes during the charging/recharging cycles. Such a Li metal-free "rocking-chair" battery may thus be viewed as comprising two lithium-ion-absorbing electrode "sponges" separated by a lithium-ion conducting electrolyte usually comprising a Li^+ salt dissolved in a non-aqueous solvent or mixture of such solvents. Numerous such salts and solvents are known in the art, as evidenced in Canadian Patent Publication No. 2,022,191, dated 30 January 1991.

The output voltage of a rechargeable lithium battery cell of this type is determined by the difference between the electrochemical potential of Li within the two intercalation electrodes of the cell. Therefore, in an effective cell the

positive and negative electrode materials should be able to intercalate lithium at high and low voltages, respectively. Among the alternative materials that can effectively replace lithium metal as the negative electrode, carbon provides the best compromise between large specific capacity and good reversible cycling behavior. Such use of carbon, however, presents some detractions, such as loss of average output voltage and energy density, as compared to lithium metal, since the voltage of a Li_xC_6 negative electrode is always greater than that of a pure lithium negative electrode.

To compensate for the loss of voltage associated with the negative electrode, a strongly oxidizing intercalation material is preferably used as the positive electrode. Such an electrode material is the spinel phase $Li_{1+x}Mn_2O_4$, usually combined with a small amount of carbon black to improve electrical conductivity and provide the practical composite electrode, that can reversibly intercalate lithium at a voltage of 4.1 V vs. Li. Use of such a strongly oxidizing intercalation material as positive electrode, however, introduces a further concern, namely, the risk of electrolyte decomposition from oxidation at the higher operating voltages, i.e. greater than about 4 V. For instance, since the voltage of the $Li_{1+x}Mn_2O_4$ / Li couple is about 4.1 V, one should charge the cell up to a voltage of about 4.5 V in order to take full advantage of this redox system. As a result, the electrolyte in such a cell must be stable over a voltage window extending above 4.5 V to about 5.0 V. Also, when used in the noted "rocking chair" cells, the electrolyte compositions must be stable down to about 0 V with respect to a composite carbon negative electrode, e.g., petroleum coke combined with about 1-5% of each of carbon black (Super-S) and an inert binder.

Presently-used intercalation electrolytes, e.g., a 1M solution of $LiClO_4$ in a 50:50 mixture of ethylene carbonate (EC) and diethoxyethane (DEE) such as described in U.S. Pat. No. 5,110,696, when employed in a $Li_{1+x}Mn_2O_4$ / C cell, will begin to

oxidize at about 4.5 V at room temperature and as low as about 4.3 V at temperatures in the range of 55° C. Thus, to operate such a cell in the higher temperature ambient, one must reduce the charging cut-off voltage to a level below about 4.3 V in order to avoid electrolyte oxidation. Because of this lower cut-off voltage, the available capacity of the cell at about 55° C is only 75% of that at room temperature.

When cells comprising these previously-available electrolytes are cycled to a voltage even slightly greater than 4.3 V, electrolyte oxidation occurs. Although small, this oxidation can jeopardize the capacity, cycle life, and safety of the battery cell. For example, the electrode oxidation reaction consumes part of the charging current which is then not recovered when discharging the cell, resulting in a continuous loss in the cell capacity over subsequent cycles. Further, if during each charge a small part of the electrolyte is consumed, excess electrolyte must be included when the cell is assembled. This in turn results in less active material for a constant volume battery body and consequently less initial capacity. In addition, the oxidation of the electrolyte often generates solid and gaseous byproducts, the solid of which build up a passivating layer on the particles of the active material, increasing the polarization of the cell and lowering the output voltage. Simultaneously, and more importantly, the gaseous byproducts increase the internal pressure of the cell, thereby increasing the risk of explosion and leading to unsafe and unacceptable operating conditions.

SUMMARY OF THE INVENTION

The present invention provides a class of electrolyte compositions that is exceptionally useful for minimizing electrolyte decomposition in secondary batteries comprising strongly oxidizing positive electrode materials. These

electrolytes are thereby uniquely capable of enhancing the cycle life and improving the temperature performance of practical "rocking chair" cells. In our search for such an effective electrolyte, we examined literally hundreds of compositions, since the catalytic activity of the desirable positive electrode materials can not be predicted. As a result of these extensive investigations, we have discovered a group of electrolyte compositions whose range of effective stability extends up to about 5.0 V at 55° C, as well as at room temperature (about 25° C).

In selecting an improved electrolyte, a number of basic essential factors are considered. Ideally, the temperature range of fluidity should be broad, the ionic conductivity should be high, and the charging cut-off voltage which avoids electrolyte oxidation should be high. In our selection process, the fluid temperature ranges of the compositions, i.e., between the melting and boiling points, were determined, respectively, with a differential scanning calorimeter (Perkin-Elmer Model DSC-4) and by thermometry in a common laboratory reflux apparatus. Next, the ionic conductivity of the different electrolyte compositions was measured over a wide practical temperature range (-25° C to 65° C) using a high frequency impedance analyzer (Hewlett Packard Model HP4129A, 5 Hz - 10 MHz). Finally, the stability of the electrolytes against oxidation was determined over varying temperature and charging voltage ranges by means of a potentiostatic mode coulometer (CNRS, Grenoble, France, Model "Mac-Pile", version A-3.01e/881) using a $Li_{1+x}Mn_2O_4$ electrode to simulate activity to be expected in a practical cell. From these determinations, we have discovered that the above-noted exceptional electrolyte results are obtained from a composition of about a 0.5M to 2M solution of $LiPF_6$, or $LiPF_6$ to which up to about an equal amount of $LiBF_4$ has been added, dissolved in a mixture of dimethylcarbonate (DMC) and ethylene carbonate (EC) wherein these solvent components are present in the weight percent ratio range from about 95 DMC:5 EC to 33 DMC:67 EC. A preferred ratio of these

solvents is from about 80 DMC:20 EC to 20 DMC:80 EC.

THE DRAWING

The present invention will be described with reference to the accompanying drawing of which:

FIG. 1 depicts a plot of cell current against charging voltage at room temperature for a secondary cell comprising a positive Li intercalation electrode and an electrolyte of $LiClO_4$ in 50:50 EC:DEE;

FIG. 2 depicts comparative plots of cell current against charging voltage at room temperature and at 55° C for secondary cells comprising a positive Li intercalation electrode and an electrolyte of $LiClO_4$ in 50:50 EC:DEE;

FIG. 3 depicts comparative plots of cell current against charging voltage at room temperature for secondary cells comprising a positive Li intercalation electrode and respective electrolytes of $LiClO_4$ in 50:50 EC:DEE and $LiPF_6$ in 67:33 DMC:EC; and

FIG. 4 depicts comparative plots of cell current against charging voltage at 55° C for secondary cells comprising a positive Li intercalation electrode and respective electrolytes of $LiClO_4$ in 50:50 EC:DEE and $LiPF_6$ in 67:33 DMC:EC.

DESCRIPTION OF THE INVENTION

Our investigations covered the vast range of combinations of currently known Li-bearing electrolyte salts and non-aqueous solvents, and the more commonly employed positive intercalation

electrode materials. The salts included $LiAsF_6$, $LiBF_4$, $LiCF_3SO_3$, $LiClO_4$, $LiN(CF_3SO_2)_2$, and $LiPF_6$. The solvents included diethylcarbonate, diethoxyethane, dimethylcarbonate, ethylene carbonate, and propylene carbonate. The test electrode compositions comprised $LiCoO_2$, $Li_{1+x}Mn_2O_4$, $LiNiO_2$, MnO_2, and V_2O_5.

The initial scanning of melting to boiling ranges of solutions of the various salts in the solvents and mixtures thereof indicated that 1M to 2M solutions provided generally good utility from about -40° C to 130° C. Subsequent testing for effective electrolytes was conducted with these solutions in the projected battery cell "working range" of about -25° C to 65° C.

Screening of the important ionic conductivity property of the candidate electrolytes indicated a widely disparate range of about 3 to 12 mS (milliSiemens or millimhos) per cm. From an evaluation of the efficacy of a prior functional "rocking chair" battery electrolyte composition comprising a 1M solution of $LiClO_4$ in a 50:50 percent ratio mixture of ethylene carbonate and diethoxyethane, a minimum threshold conductivity for this selection process was set at about 10 mS/cm. Upon this criterion, the list of prospective candidate compositions rapidly narrowed to those comprising the solvent combination of dimethylcarbonate and ethylene carbonate. Further, the salt components were limited to $LiPF_6$ and some mixtures of $LiPF_6$ and $LiBF_4$.

The ultimate series of tests was conducted on these remaining compositions to determine their ability to withstand oxidation (decomposition) under recharging voltages in excess of about 4.5 V. The CNRS "Mac-Pile" data acquisition system was operated in the potentiostatic mode at a scan rate of 40 mV/hr to test candidate electrolyte compositions against 10mg, 1 cm^2 samples of selected electrode material. This enabled the continuous plotting of coulometric measurements of charging

voltage against cell current. From such curves the onset of electrolyte oxidation can be readily identified. This procedure can be seen with reference to FIG. 1 which plots the characteristic curve for the mentioned prior $LiClO_4$ / EC + DEE electrolyte at 25° C. The peaking at about 4.05 and 4.15 V vs. Li corresponds to the reversible removal of Li from the spinel structure of a $Li_{1+x}Mn_2O_4$ positive cell electrode, while the rapid non-reversing increase in current beginning at about 4.5 V vs. Li heralds the onset of electrolyte oxidation at that charging level.

The effect of cell operating temperature is also indicated from such plots, as can be observed from FIG. 2 which depicts results of a test of the prior $LiClO_4$ electrolyte solution at the higher end of the ambient temperature range, about 55° C. With the dotted room temperature curve of FIG. 1 as a reference, one may readily see that the kinetics governing the electrolyte oxidation reaction lead to a lower electrolyte breakdown voltage as a result of increased temperature. The initiation of electrolyte oxidation at about 4.3 V vs. Li, and at even lower voltage during later recharge cycles, indicates that the charging cut-off voltage must be limited to about 4.1 V vs. Li for practical operation at the higher temperature. As a result of this limitation, the available cell capacity is, at best, only about 75% of that at room temperature.

From this electrolyte oxidation screening, we have discovered that an exceptional, wide temperature range, oxidation resistant electrolyte for a $LiMn_2O_4$ positive electrode intercalation battery cell, particularly one utilizing the preferred $Li_{1+x}Mn_2O_4$ ($0 < x < 1$) electrode, may be realized in a 0.5M to 2M solution of $LiPF_6$, or $LiPF_6$ with up to about an equal amount of $LiBF_4$ added, in a mixture of dimethylcarbonate (DMC) and ethylene carbonate (EC) within the weight percent ratio range from about 95 DMC:5 EC to 20 DMC:80 EC. In a preferred such electrolyte solution the solvent ratio range is about 80 DMC:20 EC to 20 DMC:80 EC. An optimum composition for

operation at room temperature and below is an approximately 1M $LiPF_6$ solution in a solvent mixture of about 33 DMC:67 EC, while a battery operating at higher temperatures in the range of 55° C optimally utilizes an electrolyte consisting essentially of an approximately 1.5M $LiPF_6$ solution in a solvent combination of about 67 DMC:33 EC. An additionally useful electrolyte consists essentially of an approximately 1M to 2M solution of equal parts of $LiPF_6$ and $LiBF_4$ in a solvent mixture of about 50 DMC:50 EC.

The outstanding oxidation resistant characteristics of the preferred electrolyte compositions may be observed, with reference to the earlier-noted $LiClO_4$ composition, in FIG. 3 at room temperature and in FIG. 4 at 55° C. The negligible current increase, after the reversible Li intercalations, at voltages up to about 5 V vs. Li indicates this remarkable stability which enables enhanced cell capacity not only in the "rocking chair" cells comprising negative electrodes of carbon, e.g., petroleum coke, but also in Li negative electrode cells. Such a lithium metal cell utilizing a $Li_{1+x}Mn_2O_4$ positive electrode may be reasonably expected to achieve normal operating ranges of about 4.3 to 5.1 V.

The efficacy of the new electrolyte compositions was confirmed in common Swagelock cell recycling tests. For example, test cells were assembled with positive electrodes comprising $Li_{1+x}Mn_2O_4$ which, according to usual practice, typically included about 3-10% carbon (Super-S graphite) to improve electrical conductivity and about 1-5% of an inert binder, such as polytetrafluoroethylene. In the course of these test we noted that it was preferable to favor lower carbon content in the range of about 4-7%, since the electrolyte oxidation tendency was additionally reduced. A set of such test cells with the separator element comprising an electrolyte of 1 M $LiPF_6$ in 95 DMC:5 EC and a carbon (graphite or petroleum coke) negative electrode were repeatedly charged and discharge over two hours cycles at about 25° C and 55° C and at charging cut-off voltages of 4.9 V and 4.5 V, respectively. Even at this

cycling rate and high charging voltage, the voltage polarization was unusually small, confirming the high ionic conductivity of the electrolyte, and there was no significant loss of cell capacity, verifying the high voltage stability of the electrolyte. The ability of the electrolyte to extend the cycle life of the batteries was amply demonstrated by the remarkable fact that the cell capacities after 500 cycles was only about 10% less than after 5 cycles.

The electrolyte solutions we have discovered may be employed in practical batteries with any of the various immobilizing means that have found utility in prior cells. In addition to being used to saturate the porous separator elements normally disposed between the cell electrodes, these new electrolytes solutions may be included in the form of gelled or thickened compositions or they may be introduced into polymeric matrices as a secondary plasticizer. Such applications and other variants of this type will be apparent to the skilled artisan and are intended to be nonetheless included within the scope of the present invention as recited in the appended claims.

What is claimed is:

1. A high-voltage-stable electrolyte for a lithiated intercalation secondary battery comprising a solution of a lithium compound in a non-aqueous solvent

c h a r a c t e r i z e d i n t h a t

said electrolyte consists essentially of an approximately 0.5 to 2M solution of a solute selected from the class consisting of:

a) $LiPF_6$; and

b) mixtures of $LiPF_6$ with up to about equal mole parts of $LIBF_4$,

dissolved in a mixture of non-aqueous dimethylcarbonate (DMC) and ethylene carbonate (EC) solvents wherein said solvents are present in a weight percent ratio range from about 95 DMC:5 EC to 20 DMC:80 EC.

2. An electrolyte according to claim 1

c h a r a c t e r i z e d i n t h a t

said solvents are present in a weight percent ratio range from about 80 DMC:20 EC to 20 DMC:80 EC.

3. An electrolyte according to claim 1

c h a r a c t e r i z e d i n t h a t

said electrolyte solution is selected from the group consisting of:

a) an approximately 1M solution of $LiPF_6$ in a solvent mixture of about 33 DMC:67 EC;

b) an approximately 1.5M solution of $LiPF_6$ in a solvent mixture of about 67 DMC:33 EC; and

c) 1M to 2M solutions of approximately equal parts of $LiPF_6$ and $LiBF_4$ in a solvent mixture of about 50 DMC:50 EC.

4. A secondary battery comprising a negative electrode, a positive electrode, and an electrolyte comprising a solution of a lithium compound in a non-aqueous solvent

c h a r a c t e r i z e d i n t h a t

said electrolyte consists essentially of an approximately 0.5 to 2M solution of a solute selected from the class consisting of:

a) $LiPF_6$; and

b) mixtures of $LiPF_6$ with up to about equal mole parts of $LIBF_4$,

dissolved in a mixture of non-aqueous dimethylcarbonate (DMC) and ethylene carbonate (EC) solvents wherein said solvents are present in a weight percent ratio range from about 95 DMC:5 EC to 20 DMC:80 EC.

5. A battery according to claim 4

c h a r a c t e r i z e d i n t h a t

said positive electrode comprises an intercalation compound combined with about 3-10 weight percent carbon black and about 1-5 weight percent inert binder.

6. A battery according to claim 4

c h a r a c t e r i z e d i n t h a t

said positive electrode intercalation compound consists essentially of $Li_{1+x}Mn_2O_4$ wherein x is in the range of 0 to about 1.

7. A battery according to claim 6 wherein said solvents are present in a weight percent ratio range from about 80 DMC:20 EC to 20 DMC:80 EC.

8. A battery according to claim 4
c h a r a c t e r i z e d i n t h a t
said electrolyte is selected from the group consisting of:
a) an approximately 1M solution of $LiPF_6$ in a solvent mixture of about 33 DMC:67 EC;
b) an approximately 1.5M solution of $LiPF_6$ in a solvent mixture of about 67 DMC:33 EC; and
c) 1M to 2M solutions of approximately equal parts of $LiPF_6$ and $LiBF_4$ in a solvent mixture of about 50 DMC:50 EC.

9. A battery according to claim 4
c h a r a c t e r i z e d i n t h a t
said negative electrode consists essentially of a material selected from the group consisting of carbon and lithium metal.

10. A battery according to claim 4
c h a r a c t e r i z e d i n t h a t
said negative electrode consists essentially of carbon and said electrolyte consists essentially of an approximately 1M to 1.5M solution of $LiPF_6$ in a solvent mixture of about 67 DMC:33 EC to about 33 DMC:67 EC.

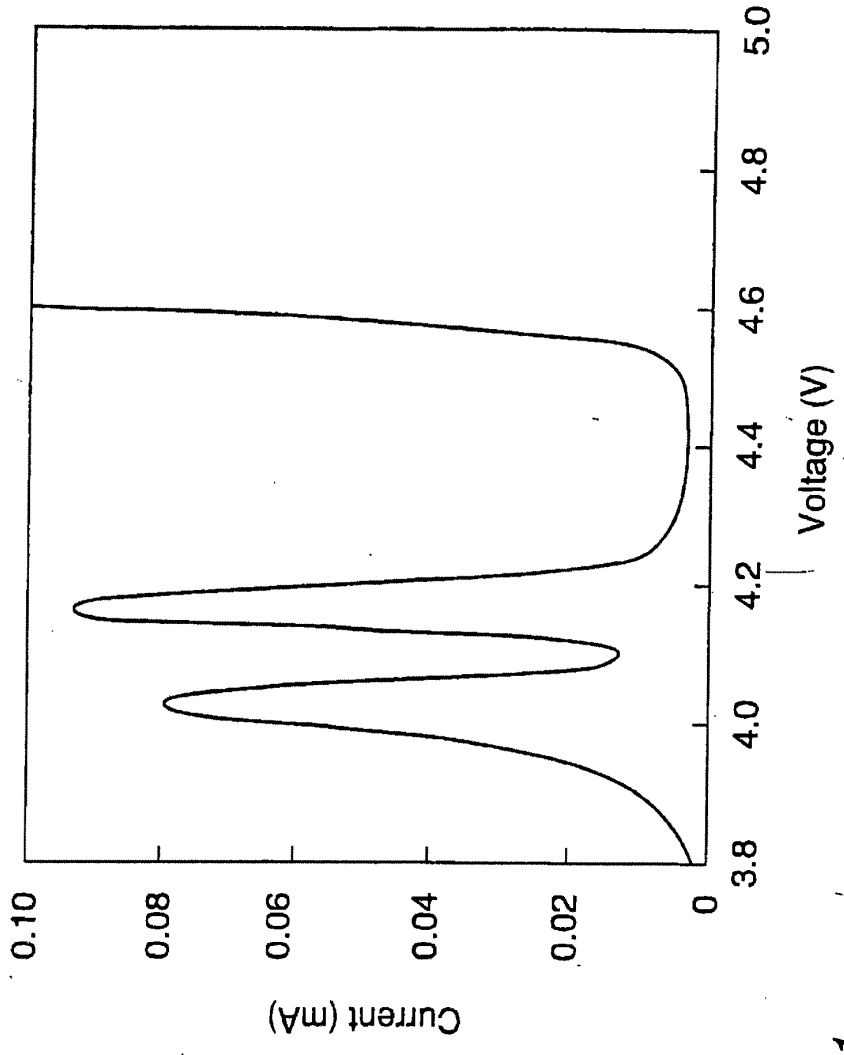

FIG. 1

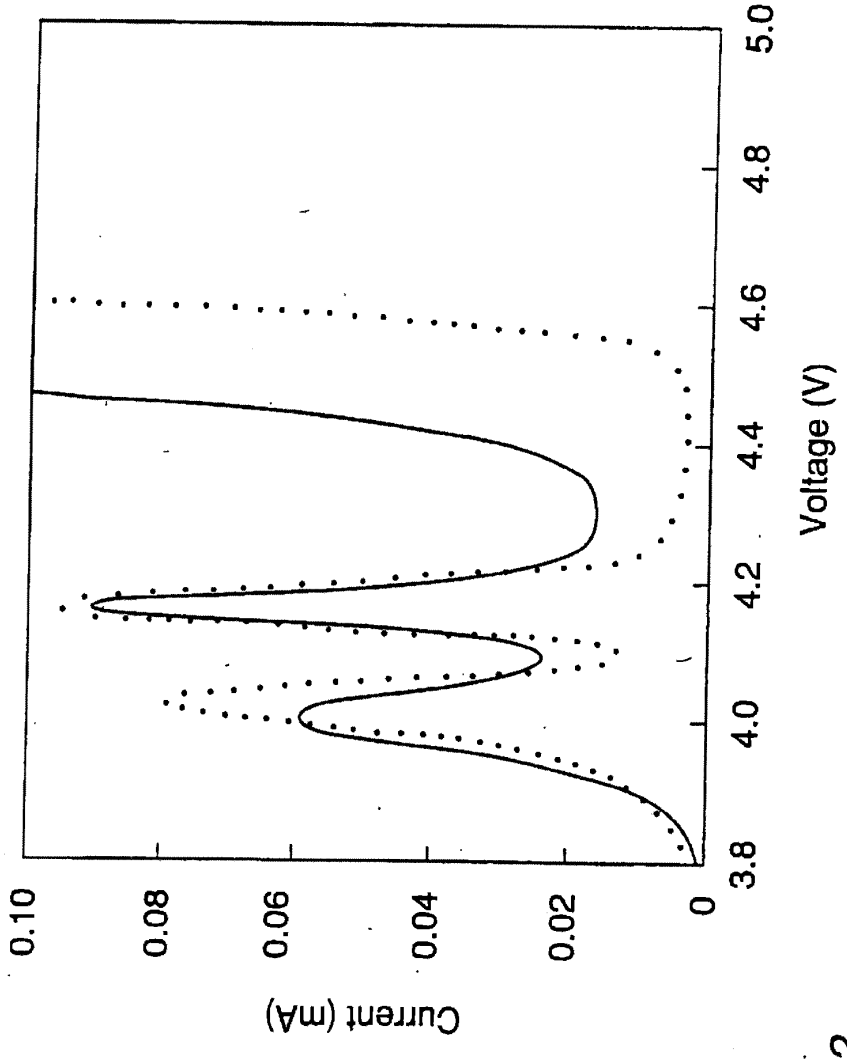

FIG. 2

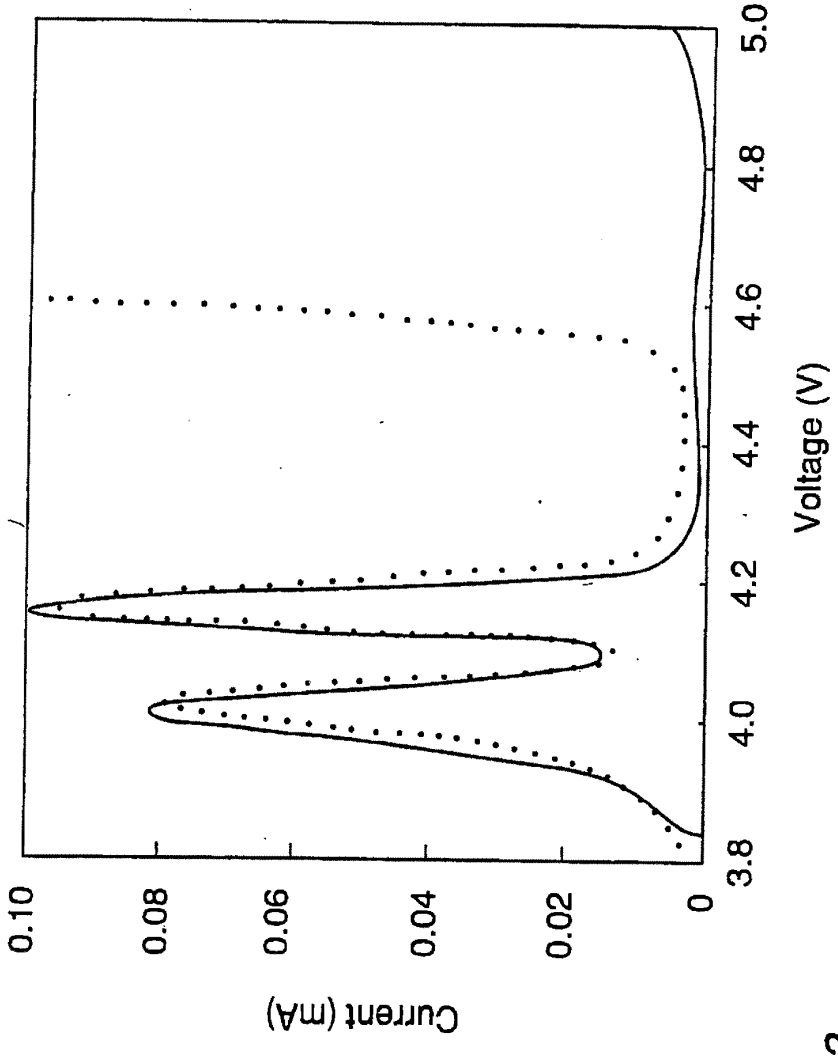

FIG. 3

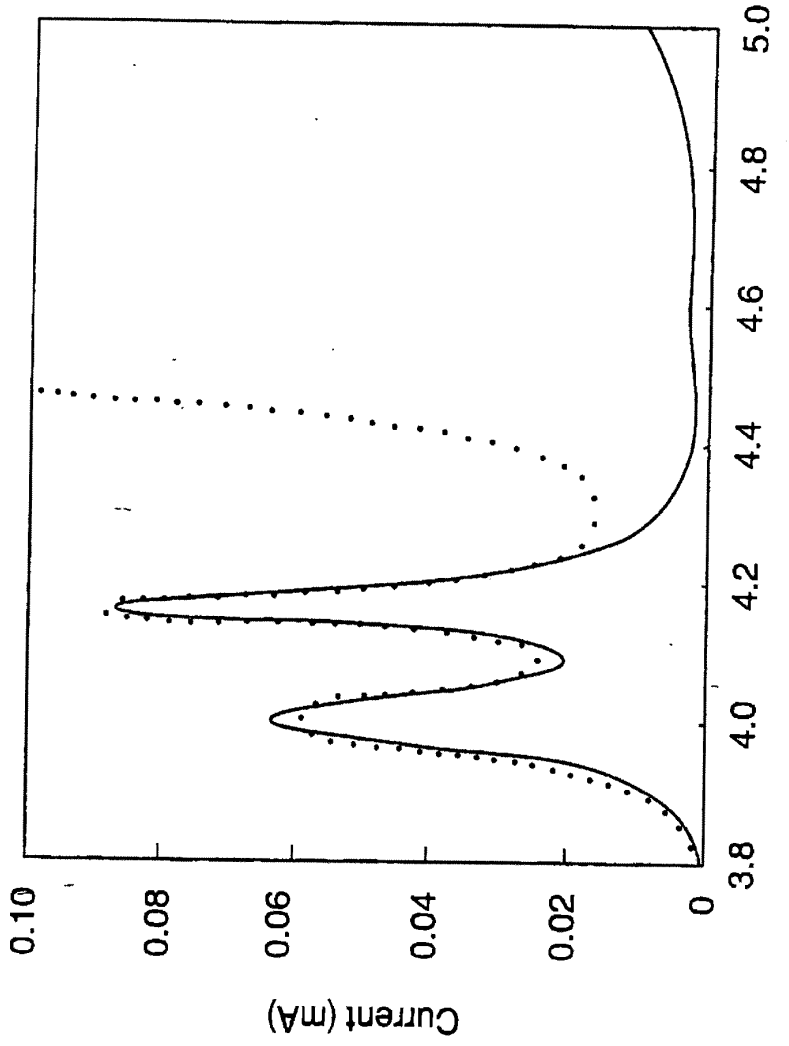

FIG. 4

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US93/02368

A. CLASSIFICATION OF SUBJECT MATTER

IPC(5) :H01M 10/40
US CL :429/197, 224

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

U.S. : 429/197, 224; 429/194, 196, 199, 218

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Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
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A	US, A, 4,874,680 (KOSHIBA) 17 October 1989.	
A	US, A, 4,904,552 (FURUKAWA ET AL.) 27 February 1990.	
A	US, A, 5,079,109 (TAKAMI ET AL.) 07 January 1992.	
A,P	US, A, 5,110,696 (SHOKOOHI ET AL.) 05 May 1992.	

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"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search
18 MAY 1993

Date of mailing of the international search report
09 JUN 1993

Name and mailing address of the ISA/US
Commissioner of Patents and Trademarks
Box PCT
Washington, D.C. 20231
Facsimile No. NOT APPLICABLE

Authorized officer
ANTHONY SKAPARS
Telephone No. (703) 308-2773

Form PCT/ISA/210 (second sheet)(July 1992)*

Electronic Patent Application Fee Transmittal	
Application Number:	12817028
Filing Date:	16-Jun-2010
Title of Invention:	SECONDARY LITHIUM ION CELL OR BATTERY, AND PROTECTING CIRCUIT, ELECTRONIC DEVICE AND CHARGING DEVICE OF THE SAME
First Named Inventor/Applicant Name:	Xiaoping REN
Filer:	Stephen A. Bent
Attorney Docket Number:	042787-0109
Filed as Large Entity	

Utility under 35 USC 111(a) Filing Fees

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

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Miscellaneous:				
Submission- Information Disclosure Stmt	1806	1	180	180
		Total in USD ($)		**180**

Electronic Acknowledgement Receipt	
EFS ID:	9450767
Application Number:	12817028
International Application Number:	
Confirmation Number:	4654
Title of Invention:	SECONDARY LITHIUM ION CELL OR BATTERY, AND PROTECTING CIRCUIT, ELECTRONIC DEVICE AND CHARGING DEVICE OF THE SAME
First Named Inventor/Applicant Name:	Xiaoping REN
Customer Number:	22428
Filer:	Stephen A. Bent/barbie beavers
Filer Authorized By:	Stephen A. Bent
Attorney Docket Number:	042787-0109
Receipt Date:	15-FEB-2011
Filing Date:	16-JUN-2010
Time Stamp:	17:20:18
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	yes
Payment Type	Credit Card
Payment was successfully received in RAM	$180
RAM confirmation Number	4105
Deposit Account	
Authorized User	

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)

1	Transmittal Letter	supplementalids.pdf	117555 38cc2ad459f40719b04badff5177e6d6649cb477	no	3
Warnings:					
Information:					
2	Information Disclosure Statement (IDS) Filed (SB/08)	PTOSB08FORM.pdf	173043 f5d82924e0ba135dda4de7c09869c9f392f03dec	no	1
Warnings:					
Information:					
This is not an USPTO supplied IDS fillable form					
3	Foreign Reference	B1REF.pdf	824467 cea224daf66706542a534d3f37dc53e6446d2ca0	no	29
Warnings:					
Information:					
4	Foreign Reference	B2REF.pdf	1044249 039963e3c3f1001d0d039830d55bcce8f6dda5ba	no	37
Warnings:					
Information:					
5	Foreign Reference	B3REF.pdf	610190 8ce67deb8a893571d9be2542ab00526750e53f32	no	19
Warnings:					
Information:					
6	NPL Documents	B4REF.pdf	449204 03eafb076e23ecce4b522e4e388aefc4e86490bd	no	14
Warnings:					
Information:					
7	Fee Worksheet (PTO-875)	fee-info.pdf	30594 830f897f2172417cb7a005f1aff6436fd927b847	no	2
Warnings:					
Information:					
		Total Files Size (in bytes):	3249302		

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New Applications Under 35 U.S.C. 111
If a new application is being filed and the application includes the necessary components for a filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application.

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

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

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Applicant: Xiaoping REN *et al.*

Title: **SECONDARY LITHIUM ION CELL OR BATTERY, AND PROTECTING CIRCUIT, ELECTRONIC DEVICE AND CHARGING DEVICE OF THE SAME**

Appl. No.: 12/817,028

Filing Date: 6/16/2010

Examiner: Muhammad S. Siddiquee

Art Unit: 1726

Confirmation Number: 4654

SUPPLEMENTAL INFORMATION DISCLOSURE STATEMENT UNDER 37 CFR §1.56

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

Sir:

Submitted herewith on Form PTO/SB/08 is a listing of documents known to Applicants in order to comply with Applicants' duty of disclosure pursuant to 37 CFR §1.56.

A copy of each non-U.S. patent document and each non-patent document is being submitted to comply with the provisions of 37 CFR §1.97 and §1.98.

The submission of any document herewith, which is not a statutory bar, is not intended as an admission that such document constitutes prior art against the claims of the present application or that such document is considered material to patentability as defined in 37 CFR

§1.56(b). Applicants do not waive any rights to take any action which would be appropriate to antedate or otherwise remove as a competent reference any document which is determined to be a *prima facie* art reference against the claims of the present application.

TIMING OF THE DISCLOSURE

The listed documents are being submitted in compliance with 37 CFR §1.97(c), before the mailing date of any of a final action under 37 CFR §1.113, a notice of allowance under 37 CFR §1.311, or an action that otherwise closes prosecution in the application.

RELEVANCE OF EACH DOCUMENT

Foreign language reference JP 10-503466 corresponds to WO 96/24168 submitted herewith.

A full English translation of the Japanese office action is attached.

Applicants respectfully request that each listed document be considered by the Examiner and be made of record in the present application and that an initialed copy of Form PTO/SB/08 be returned in accordance with MPEP §609.

FEE

Fees in the amount of $180.00 to cover the fee associated with an information disclosure statement under 37 CFR §1.97(c) are being paid by credit card via EFS-Web.

The Commissioner is hereby authorized to charge any additional fees, which may be required under 37 C.F.R. §§ 1.16-1.17, and to credit any overpayment to Deposit Account No. 19-0741. Should no proper payment accompany this paper, then the Commissioner is authorized to charge the unpaid amount to the same deposit account.

Respectfully submitted,

Date February 15, 2011

By /Stephen A. Bent/

FOLEY & LARDNER LLP
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Telephone: (202) 672-5404
Facsimile: (202) 672-5399

Stephen A. Bent
Attorney for Applicant
Registration No. 29,768

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Applicant: Xiaoping REN *et al.*

Title: **SECONDARY LITHIUM ION CELL OR BATTERY, AND PROTECTING CIRCUIT, ELECTRONIC DEVICE AND CHARGING DEVICE OF THE SAME**

Appl. No.: 12/817,028

Filing Date: 06/16/2010

Examiner: Muhammad S. Siddiquee

Art Unit: 1726

Confirmation Number: 4654

AMENDMENT AND REPLY UNDER 37 CFR § 1.111

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

Sir:

This communication is responsive to the Non-Final Office Action dated November 9, 2010, concerning the above-referenced patent application, making February 9, 2011 three-months from the mailing date. Accordingly, this response is timely filed.

Amendments to the Claims are reflected in the listing of claims which begins on page 2 of this document.

Remarks/Arguments begin on page 4 of this document.

AMENDMENTS TO THE CLAIMS

This listing of replaces all prior versions and listings of claims in the application.

Listing of Claims

1. (Withdrawn) A secondary lithium ion cell or battery, characterized in that the single secondary lithium ion cell has a charge cut-off voltage of greater than 4.2 V but less than 5.8 V, and the ratio of positive electrode material to negative electrode material of the single cell is from 1:1.0 to 1:2.5, as calculated by the theoretic capacity with the charge cut-off voltage set at 4.2 V.

2. (Withdrawn) A protecting circuit for the secondary lithium ion cell or battery according to claim 1, characterized in that the single lithium ion cell of said protecting circuit has a first overcharge protection voltage of greater than 4.35 V, and an overcharging protection release voltage of greater than 4.15 V.

3. (Withdrawn) A protecting circuit according to claim 2, characterized in that the single lithium ion cell of said protecting circuit has a first overcharge protection voltage of greater than 4.45 V, and an overcharge protection release voltage of greater than 4.25 V.

4. (Currently Amended) An electronic device using a secondary lithium ion cell or battery as energy source, characterized in that said electronic device comprises a protecting circuit, wherein the single lithium ion cell has a first overcharging protection voltage of greater than 4.35 V, and an overcharge protection release voltage of greater than 4.15 V, and wherein the ratio of positive electrode material to negative electrode material of the single lithium ion cell is from 1:1.0 to 1:2.5, as calculated by the theoretic capacity with the charge cut-off voltage set at 4.2V.

5. (Original) An electronic device according to claim 4, characterized in that said electronic device comprises a protecting circuit, wherein the single lithium ion cell has a first overcharging protection voltage of greater than 4.45 V, and an overcharge protection release voltage of greater than 4.25 V.

6. (Withdrawn) A charging device for a secondary lithium ion cell or battery, characterized in that said charging device controls a charge cut-off voltage to the single lithium ion cell within the range of greater than 4.3 V but less than 5.8 V.

7. (Withdrawn) A charging device according to claim 6, characterized in that said charging device controls a charge cut-off voltage to the single lithium ion cell within the range from 4.3 V to 5.2 V.

8. (Withdrawn) A charging device according to claim 6, characterized in that said charging device controls a charge cut-off voltage to the single lithium ion cell within the range from 4.3 V to 4.8 V.

REMARKS

Applicant requests reconsideration of the present application in view of the foregoing amendments and in view of the reasons that follow. At the time of the present action, claims 1-8 were pending, with non-elected claims 1-3 and 6-8 withdrawn. Claim 4 is revised here. Thus, claims 4 and 5 remain pending for examination.

A. Background

As the present application states in the "Background Art" section, 4.2V is an accepted charge cut-off voltage for secondary lithium ion batteries. By contrast, although using a charge cut-off voltage greater than 4.2V results in an improved capacity and improved operating voltage, negative side effects pertain, such as structural changes in the positive and negative electrode materials, decomposition of the electrolyte, and reduced recycle properties, which have kept the battery industry from using a charge cut-off voltage greater than 4.2V. This point is amply evidenced in the documents cited and summarized in the background section of this application.

In contravention of contemporaneous common opinion, Applicant discovered an approach for raising the cut-off voltage above 4.2V that substantially avoids changes to the electrode materials and decomposition of the electrolyte. In a manner wholly unforeseen by the art, Applicant's approach also does not diminish the recycle property of the secondary lithium ion battery.

Applicant's claimed invention comprises using (1) an overcharging protection voltage of greater than 4.35 V and (2) a ratio from 1:1.0 to 1:2.5 for positive electrode material to negative electrode material of the single lithium ion cell, as calculated by the theoretic capacity with the charge cut-off voltage set at 4.2V. Use of such ratio and voltage threshold, as presently recited, cedes to a lithium ion battery the properties of which, as noted above, would have been unexpected in view of the art of record.

B. Outstanding Claim Rejection

The Office Action rejects claims 4 and 5 under 35 U.S.C. § 103(a) over U.S. patent No. 6,558,848 to Kobayashi *et al.* in view of U.S. patent No. 6,326,770 to Patino *et al.*

Without acquiescing to this rationale for rejection, Applicant has sought to advance prosecution by amending claim 4 so as to describe aspects of the subject invention with greater particularity. Thus, revised claim 4 prescribes a "ratio of positive electrode material to negative electrode material [that] is from 1:1.0 to 1:2.5, as calculated by the theoretic capacity with the charge cut-off voltage set at 4.2V." This claim language tracks that of the claims allowed in parent application, serial No. 10/491,134 (now U.S. patent No. 7,749,641). As discussed in detail below, these recited features are neither disclosed nor suggested by any reasonable permutation the Kobayashi and Patino references.

Kobayashi describes "lithium secondary cells" where "the charge cut-off voltage was set at 4.5V, and the discharge cut-off voltage at 4.5V" (reference at 20:24-26). Although this portion of Kobayashi briefly relates a protection voltage greater than 4.35V, there is no hint that the ratio of positive to negative electrode materials should be in the range from 1:1.0 to 1:2.5.

Kobayashi cannot be reasonably interpreted, therefore, as suggesting the aforementioned features recited in independent claim 4. Furthermore, no principled reading of Patino could cast the secondary reference in the role of curing this deficiency. Patino merely describes "a safety circuit that has an associated voltage cutoff value (V_{cutoff})" (reference at 1:14-16), which says nothing about positive and negative electrode ratios.

It necessarily follows the present claim 4 is distinguishable over the cited combination of references. Withdrawal of the rejection of claims 4 and 5 over Kobayashi and Patino is warranted, therefore.

C. Further Comments on Patentability

The commentary above amply substantiates the patentability of the present claims over the art of record. Applicant would add that, at the time of Applicant's invention, it would not have been obvious to modify Kobayashi to include the ratio of positive to negative electrode materials specified in the claims. This point was underscored during Applicant's prosecution of the '134 parent application, *e.g.*, in responses dated May 15 and November 13, 2009.

During that prosecution the PTO properly determined that the prior art of record, which included Kobayashi, would not have suggested creating a battery characterized by the recited voltage and ratio ranges:

> ... While US '260 and US '960 teaches a battery with electrode material capacity ratio and charge cut-off voltage, neither US '960 nor the remaining prior art of record would reasonably lead one of ordinary skill in the art to arrive at the invention as currently claimed. For example, the prior art of record does not reasonably teach or suggest of the claimed battery/method for improving the capacity, average operating voltage and specific energy of a secondary lithium ion cell or battery, characterized in that the charge cut-off voltage of the secondary lithium ion cell or battery is greater than 4.2 V but less than 5.8 V; and a ratio of positive electrode material to negative electrode material of the secondary lithium ion cell or battery is from 1:1.0 to 1:2.5, as calculated by a specific capacity with a charge voltage limited to 4.2 V. And there is nothing taught by the prior art of record to reasonably arrive at the claimed configuration. Moreover, JP '559 teaches that life cycle property of a cell drastically decreases when the charging voltage increases beyond 4.2V. Accordingly, one of ordinary skill at the time of invention would not have predicted that the resulting cell would have high capacity.

Notice of Allowance in U.S. application serial No. 10/491,134 (emphasis supplied).

The PTO's conclusion was founded in part on the teachings from JP 2001-176559,[1] the Zou publication,[2] the Mizushima publication[3], and the Postoia publication,[4] the combination of which clearly established that the claimed invention was unobvious. More precisely, these references

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[1] JP 2001-176559, Yamamoto et al., December 15, 1999 (filing date).

[2] Zou *et al.*, "Synthesis of High-Voltage (4.5V) Cycling Doped $LiCoO_2$ for Use in Lithium Rechargeable Cells," *Chemistry of Materials*, Vol. 15, No. 25 (2003).

[3] Mizushima *et al*, "A New Cathode Material for Batteries of High Energy Density," *Material Research Bulletin*, 783-89 (1980).

[4] Posita *et al.*, "Synthesis of Mn spinels from different polymorphs of MnO_2," *Journal of Power Sources*, 37-43 (1995).

evidenced that the result achieved with the claimed invention contravened the understanding and expectations of the art; hence, that it would have been surprising to one of ordinary skill.

By the same token, it would not have been obvious at the time of invention to modify Kobayashi to include a ratio of positive to negative electrode materials from 1:1.0 to 1:2.5, thereby to achieve the surprising results previously discussed. Accordingly, a rejection to the contrary would be ill-conceived and lacking in substantial foundation.

CONCLUSION

Applicant submits that this application is in condition for allowance, and an early indication to this effect is requested. Examiner Siddiquee is invited to contact the undersigned directly, should he feel that any other point requires consideration.

Respectfully submitted,

Date February 9, 2011

By /Stephen A. Bent/

FOLEY & LARDNER LLP
Customer Number: 22428
Telephone: (202) 672-5404
Facsimile: (202) 672-5399

Stephen A. Bent
Attorney for Applicant
Registration No. 29,768

The Commissioner is hereby authorized to charge any additional fees, which may be required under 37 C.F.R. §§ 1.16-1.17, and to credit any overpayment to Deposit Account No. 19-0741. Should no proper payment accompany this response, then the Commissioner is authorized to charge the unpaid amount to the same deposit account. If any extension is needed for timely acceptance of submitted papers, then applicant hereby petitions for such extension under 37 C.F.R. §1.136 and authorizes payment of the relevant fee(s) from the deposit account.

Electronic Acknowledgement Receipt	
EFS ID:	9405434
Application Number:	12817028
International Application Number:	
Confirmation Number:	4654
Title of Invention:	SECONDARY LITHIUM ION CELL OR BATTERY, AND PROTECTING CIRCUIT, ELECTRONIC DEVICE AND CHARGING DEVICE OF THE SAME
First Named Inventor/Applicant Name:	Xiaoping REN
Customer Number:	22428
Filer:	Stephen A. Bent/Linda Novak
Filer Authorized By:	Stephen A. Bent
Attorney Docket Number:	042787-0109
Receipt Date:	09-FEB-2011
Filing Date:	16-JUN-2010
Time Stamp:	11:42:30
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	no

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1	Amendment/Req. Reconsideration-After Non-Final Reject	Response.pdf	95014 56ec238b6e8e370d273074d73926224332827a31	no	7
Warnings:					
Information:					

Total Files Size (in bytes):	95014

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New Applications Under 35 U.S.C. 111
If a new application is being filed and the application includes the necessary components for a filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application.

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

PTO/SB/06 (07-06)
Approved for use through 1/31/2007. OMB 0651-0032
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE
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PATENT APPLICATION FEE DETERMINATION RECORD Substitute for Form PTO-875	Application or Docket Number 12/817,028	Filing Date 06/16/2010	☐ To be Mailed

APPLICATION AS FILED – PART I

	(Column 1)	(Column 2)	SMALL ENTITY ☒		OR	OTHER THAN SMALL ENTITY	
FOR	NUMBER FILED	NUMBER EXTRA	RATE ($)	FEE ($)		RATE ($)	FEE ($)
☒ BASIC FEE (37 CFR 1.16(a), (b), or (c))	N/A	N/A	N/A	82		N/A	
☐ SEARCH FEE (37 CFR 1.16(k), (i), or (m))	N/A	N/A	N/A			N/A	
☐ EXAMINATION FEE (37 CFR 1.16(o), (p), or (q))	N/A	N/A	N/A			N/A	
TOTAL CLAIMS (37 CFR 1.16(i))	minus 20 =	*	X $ =		OR	X $ =	
INDEPENDENT CLAIMS (37 CFR 1.16(h))	minus 3 =	*	X $ =			X $ =	
☐ APPLICATION SIZE FEE (37 CFR 1.16(s))	If the specification and drawings exceed 100 sheets of paper, the application size fee due is $250 ($125 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	82		TOTAL	

APPLICATION AS AMENDED – PART II

		(Column 1)		(Column 2)	(Column 3)	SMALL ENTITY		OR	OTHER THAN SMALL ENTITY	
	02/09/2011	CLAIMS REMAINING AFTER AMENDMENT		HIGHEST NUMBER PREVIOUSLY PAID FOR	PRESENT EXTRA	RATE ($)	ADDITIONAL FEE ($)		RATE ($)	ADDITIONAL FEE ($)
AMENDMENT	Total (37 CFR 1.16(i))	* 8	Minus	** 20	= 0	X $26 =	0	OR	X $ =	
	Independent (37 CFR 1.16(h))	* 3	Minus	***3	= 0	X $110 =	0	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	0	OR	TOTAL ADD'L FEE	

		(Column 1)		(Column 2)	(Column 3)					
		CLAIMS REMAINING AFTER AMENDMENT		HIGHEST NUMBER PREVIOUSLY PAID FOR	PRESENT EXTRA	RATE ($)	ADDITIONAL FEE ($)		RATE ($)	ADDITIONAL FEE ($)
AMENDMENT	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 number found in the appropriate box in column 1.

Legal Instrument Examiner:
/TER J. JACKSON WOODRUFF/

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.
12/817,028	06/16/2010	Xiaoping REN	042787-0109	4654

22428 7590 11/09/2010

FOLEY AND LARDNER LLP
SUITE 500
3000 K STREET NW
WASHINGTON, DC 20007

EXAMINER	
SIDDIQUEE, MUHAMMAD S	
ART UNIT	PAPER NUMBER
1726	

MAIL DATE	DELIVERY MODE
11/09/2010	PAPER

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.

Office Action Summary	Application No.	Applicant(s)	
	12/817,028	REN ET AL.	
	Examiner	Art Unit	
	MUHAMMAD SIDDIQUEE	1726	

-- 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* MONTH(S) OR THIRTY (30) DAYS, WHICHEVER IS LONGER, 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 *16 June 2010*.

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

3)☐ 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

4)☒ Claim(s) *1-8* is/are pending in the application.

4a) Of the above claim(s) *1-3 and 6-8* is/are withdrawn from consideration.

5)☐ Claim(s) _____ is/are allowed.

6)☒ Claim(s) *4 and 5* is/are rejected.

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

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

Application Papers

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

10)☐ The drawing(s) filed on _____ is/are: a)☐ accepted or b)☐ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).

11)☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

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).

a)☒ All b)☐ Some * c)☐ None of:

1.☐ Certified copies of the priority documents have been received.

2.☒ Certified copies of the priority documents have been received in Application No. 10/491,134.

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) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
3) ☒ Information Disclosure Statement(s) (PTO/SB/08) Paper No(s)/Mail Date *8/18/2010*.
4) ☐ Interview Summary (PTO-413) Paper No(s)/Mail Date. _____ .
5) ☐ Notice of Informal Patent Application
6) ☐ Other: _____.

DETAILED ACTION

Election/Restrictions

1. Applicant's election with traverse of Group III (claims 4-5) in the reply filed on 9/13/2010 is acknowledged. The traversal is on the ground(s) that there are other special technical features in the invention than the one identified by the examiner. This is not found persuasive because there could be more than one special technical features in the invention, however, if that is known in the art, the invention lacks the unity of invention. In this case, if the applicant asserts that a charge cut-off voltage greater than 4.2 V is special technical feature, it is known in the art as evidenced by US 5,487,960 [column 1, lines 39-43; column 3, lines 21-49].

The requirement is still deemed proper and is therefore made FINAL.

Claim Rejections - 35 USC § 103

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

> (a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made.

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

4. This application currently names joint inventors. In considering patentability of the claims under 35 U.S.C. 103(a), the examiner presumes that the subject matter of the various claims was commonly owned at the time any inventions covered therein were made absent any evidence to the contrary. Applicant is advised of the obligation under 37 CFR 1.56 to point out the inventor and invention dates of each claim that was not commonly owned at the time a later invention was made in order for the examiner to consider the applicability of 35 U.S.C. 103(c) and potential 35 U.S.C. 102(e), (f) or (g) prior art under 35 U.S.C. 103(a).

5. Claims 4-5 are rejected under 35 U.S.C. 103(a) as being unpatentable over Kobayashi et al (US 6,558,848 B1) in view of Patino et al (US 6,326,770).

Regarding claim 4-5, Kobayashi discloses a battery for using in electronic devices like personal computers and portable telephones comprising electrodes where the charge cut-off voltage is set at 4.5 volts and the discharge cut-off voltage at 4.5 volts. Kobayashi remains silent about a protection circuit. However, Patino discloses electronic devices comprising battery system where protection circuit is used to limit voltage in the battery [column 1, lines 11-28]. Therefore, it would have been obvious to a person of ordinary skill in the art at the time the invention was made to a protection circuit as taught by Patino in the electronic device of Kobayashi in order to have a safer device.

Any inquiry concerning this communication or earlier communications from the examiner should be directed to MUHAMMAD SIDDIQUEE whose telephone number is

(571) 270-3719. The examiner can normally be reached on Monday-Thursday, 7:30 am to 4:00 pm EST.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Patrick Ryan can be reached on 571-272-1292. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see http://pair-direct.uspto.gov. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free). If you would like assistance from a USPTO Customer Service Representative or access to the automated information system, call 800-786-9199 (IN USA OR CANADA) or 571-272-1000.

/Muhammad Siddiquee/
Examiner, Art Unit 1726

/Patrick Joseph Ryan/
Supervisory Patent Examiner, Art Unit 1726

Notice of References Cited	Application/Control No. 12/817,028	Applicant(s)/Patent Under Reexamination REN ET AL.	
	Examiner MUHAMMAD SIDDIQUEE	Art Unit 1726	Page 1 of 1

U.S. PATENT DOCUMENTS

*		Document Number Country Code-Number-Kind Code	Date MM-YYYY	Name	Classification
*	A	US-6,558,848	05-2003	Kobayashi et al.	429/241
*	B	US-6,326,770	12-2001	Patino et al.	320/132
	C	US-			
	D	US-			
	E	US-			
	F	US-			
	G	US-			
	H	US-			
	I	US-			
	J	US-			
	K	US-			
	L	US-			
	M	US-			

FOREIGN PATENT DOCUMENTS

*		Document Number Country Code-Number-Kind Code	Date MM-YYYY	Country	Name	Classification
	N					
	O					
	P					
	Q					
	R					
	S					
	T					

NON-PATENT DOCUMENTS

*		Include as applicable: Author, Title Date, Publisher, Edition or Volume, Pertinent Pages)
	U	
	V	
	W	
	X	

*A copy of this reference is not being furnished with this Office action. (See MPEP § 707.05(a).)
Dates in MM-YYYY format are publication dates. Classifications may be US or foreign.

UNITED STATES PATENT AND TRADEMARK OFFICE

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www.uspto.gov

BIB DATA SHEET

CONFIRMATION NO. 4654

SERIAL NUMBER	FILING or 371(c) DATE RULE	CLASS	GROUP ART UNIT	ATTORNEY DOCKET NO.
12/817,028	06/16/2010	429	1726	042787-0109

APPLICANTS

Xiaoping REN, Beijing, CHINA;
Jie Sun, Beijing, CHINA;

**** CONTINUING DATA ***************************

This application is a DIV of 10/491,134 05/06/2004 PAT 7,749,641
which is a 371 of PCT/CN02/00696 09/28/2002

**** FOREIGN APPLICATIONS ***************************

CHINA 01141615.7 09/28/2001

**** IF REQUIRED, FOREIGN FILING LICENSE GRANTED **** ** SMALL ENTITY **
06/24/2010

Foreign Priority claimed ☑ Yes ☐ No 35 USC 119(a-d) conditions met ☑ Yes ☐ No Verified and Acknowledged /MUHAMMAD S SIDDIQUEE/ Examiner's Signature	☐ Met after Allowance Initials	STATE OR COUNTRY	SHEETS DRAWINGS	TOTAL CLAIMS	INDEPENDENT CLAIMS
		CHINA	0	8	3

ADDRESS

FOLEY AND LARDNER LLP
SUITE 500
3000 K STREET NW
WASHINGTON, DC 20007
UNITED STATES

TITLE

SECONDARY LITHIUM ION CELL OR BATTERY, AND PROTECTING CIRCUIT, ELECTRONIC DEVICE AND CHARGING DEVICE OF THE SAME

FILING FEE RECEIVED		
462	FEES: Authority has been given in Paper No._____ to charge/credit DEPOSIT ACCOUNT No._____ for following:	☐ All Fees ☐ 1.16 Fees (Filing) ☐ 1.17 Fees (Processing Ext. of time) ☐ 1.18 Fees (Issue) ☐ Other _____ ☐ Credit

Search Notes	Application/Control No.	Applicant(s)/Patent Under Reexamination
	12817028	REN ET AL.
	Examiner	Art Unit
	MUHAMMAD SIDDIQUEE	1726

SEARCHED			
Class	Subclass	Date	Examiner
429	60, 231.95	11/7/2010	MSS

SEARCH NOTES		
Search Notes	Date	Examiner
Consulted with Jonathan Crepeau in Art unit 1795	11/3/2010	MSS
Searched for Inventor in EAST and PALM	11/14/2010	MSS
Class 429/60,231.95 was limited by text, see EAST search history.	11/7/2010	MSS
Searched USPAT, US-PGPUB, USOCR	11/7/2010	MSS

INTERFERENCE SEARCH			
Class	Subclass	Date	Examiner

/MUHAMMAD SIDDIQUEE/ Examiner.Art Unit 1726	

Index of Claims	Application/Control No.	Applicant(s)/Patent Under Reexamination
	12817028	REN ET AL.
	Examiner	Art Unit
	MUHAMMAD SIDDIQUEE	1795

✓	Rejected	-	Cancelled	N	Non-Elected	A	Appeal
=	Allowed	÷	Restricted	I	Interference	O	Objected

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

CLAIM		DATE								
Final	Original	08/11/2010	11/07/2010							
	1	÷	N							
	2	÷	N							
	3	÷	N							
	4	÷	✓							
	5	÷	✓							
	6	÷	N							
	7	÷	N							
	8	÷	N							

EAST Search History

EAST Search History (Prior Art)

Ref #	Hits	Search Query	DBs	Default Operator	Plurals	Time Stamp
S1	6	US-1135103-$.DID. OR US-1185860-$.DID. OR JP-2000270491-$.DID.	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT	NEAR	ON	2008/07/09 11:57
S2	2	"5604418".pn.	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT	NEAR	ON	2008/07/09 11:59
S3	1	"5604418".pn.	US-PGPUB; USPAT; USOCR	NEAR	ON	2008/07/09 11:59
S4	196	US-5743921-$.DID. OR US-5920181-$.DID. OR US-5969502-$.DID. OR US-5648187-$.DID. OR US-5962166-$.DID. OR US-5986430-$.DID. OR US-6194874-$.DID. OR US-5998051-$.DID. OR US-5604057-$.DID. OR US-6025696-$.DID. OR US-5674644-$.DID. OR US-6043629-$.DID. OR US-6137265-$.DID. OR US-6046514-$.DID. OR US-5939864-$.DID. OR US-6046575-$.DID. OR US-6114835-$.DID. OR US-6075343-$.DID. OR US-4888258-$.DID. OR US-6104165-$.DID. OR US-5192629-$.DID. OR US-6127804-$.DID. OR US-5587133-$.DID. OR US-6221531-$.DID. OR US-5631539-$.DID. OR US-5635138-$.DID. OR US-6228528-$.DID. OR US-5705291-$.DID. OR US-6242893-$.DID. OR US-6057670-$.DID. OR US-6245464-$.DID. OR US-6091227-$.DID. OR US-4299890-$.DID. OR US-6143444-$.DID. OR US-4362794-$.DID. OR US-6204634-$.DID. OR US-4414093-$.DID. OR US-	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT	NEAR	ON	2008/07/09 12:01

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S7	1	10/491134	US-PGPUB; USPAT; USOCR	NEAR	ON	2008/07/09 12:04
S18	17537	(charge near5 ((cut-off or cut off) near5 voltage) or ((cut-off or cut off) near5 voltage))	US-PGPUB; USPAT; USOCR	NEAR	ON	2008/07/11 18:21
S19	12169	S18 not (battery or celectrochemical cell)	US-PGPUB; USPAT; USOCR	NEAR	ON	2008/07/11 18:22
S20	5368	S18 not S19	US-PGPUB; USPAT; USOCR	NEAR	ON	2008/07/11 18:22
S21	2857	(positive electrode or negative electrode or anode or cathode) near5 material with ratio	US-PGPUB; USPAT; USOCR	NEAR	ON	2008/07/11 18:23
S22	724	S21 not (battery or celectrochemical cell)	US-PGPUB; USPAT; USOCR	NEAR	ON	2008/07/11 18:23
S23	2133	S21 not S22	US-PGPUB; USPAT; USOCR	NEAR	ON	2008/07/11 18:24
S24	5	S20 same S23	US-PGPUB; USPAT; USOCR	NEAR	ON	2008/07/11 18:24
S25	153	S20 and S23	US-PGPUB; USPAT; USOCR	NEAR	ON	2008/07/11 18:24
S26	62	S25 and @ad<"20020928"	US-PGPUB; USPAT; USOCR	NEAR	ON	2008/07/11 18:25
S27	9	JP-01304664-$.DID. OR WO-03030293-$.DID. OR WO-2004021502-$.DID. OR EP-1189299-$.DID. OR EP-1324418-$.DID.	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT	NEAR	ON	2008/07/11 18:36
S28	9	US-7128998-$.DID. OR US-5464705-$.DID. OR US-20010024757-$.DID. OR US-20040209156-$.DID. OR US-20050196664-$.DID.	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT	NEAR	ON	2008/07/11 18:37
S29	924	(ratio with positive adj electrode with negative adj electrode with material) or (ratio with anode with cathode with material)	US-PGPUB; USPAT; USOCR	NEAR	ON	2008/07/11 19:31

S30	97	(ratio near5 positive adj electrode near5 negative adj electrode near5 material) or (ratio near5 anode near5 cathode near5 material)	US-PGPUB; USPAT; USOCR	NEAR	ON	2008/07/11 19:33
S31	5	S20 and S30	US-PGPUB; USPAT; USOCR	NEAR	ON	2008/07/11 19:38
S32	0	S26 and (overcharg$4 near5 protect$4 near5 voltage)	US-PGPUB; USPAT; USOCR	NEAR	ON	2008/07/11 20:53
S33	228	(overcharg$4 near5 protect $4 near5 voltage)	US-PGPUB; USPAT; USOCR	NEAR	ON	2008/07/11 20:53
S34	0	S30 and (overcharg$4 near5 protect$4 near5 voltage)	US-PGPUB; USPAT; USOCR	NEAR	ON	2008/07/11 20:54
S35	0	S30 and S33	US-PGPUB; USPAT; USOCR	NEAR	ON	2008/07/11 20:54
S36	116	S33 and @ad<"20020928"	US-PGPUB; USPAT; USOCR	NEAR	ON	2008/07/11 20:55
S37	5	S30 and (overcharg$4 near5 voltage)	US-PGPUB; USPAT; USOCR	NEAR	ON	2008/07/11 20:57
S38	4	S26 and (overcharg$4 near5 voltage)	US-PGPUB; USPAT; USOCR	NEAR	ON	2008/07/11 20:57
S39	44	S26 and (charg$4 near5 volt$4) and discharg$4 near5 volt$4	US-PGPUB; USPAT; USOCR	NEAR	ON	2008/07/11 21:01
S40	38	S26 and((charg$4 near5 volt$4) with (discharg$4 near5 volt$4))	US-PGPUB; USPAT; USOCR	NEAR	ON	2008/07/11 21:01
S41	2	09/768298	US-PGPUB; USPAT; USOCR	NEAR	ON	2008/07/12 09:08
S42	1	10/320319	US-PGPUB; USPAT; USOCR	NEAR	ON	2008/07/12 09:13
S43	8	US-6453198-$.DID. OR US-6544689-$.DID. OR US-6617074-$.DID. OR US-6706441-$.DID.	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT	NEAR	ON	2008/07/12 10:10
S44	15	overcharge near5 releas$4 near5 volt$4	US-PGPUB; USPAT; USOCR	NEAR	ON	2008/07/12 12:50
S45	146	429/60.ccls.	US-PGPUB; USPAT; USOCR	NEAR	ON	2008/07/12 13:17
S46	97	S45 and (ratio near5 positive adj electrode near5 negative adj electrode near5 material) or (ratio near5 anode near5 cathode near5 material)	US-PGPUB; USPAT; USOCR	NEAR	ON	2008/07/12 13:18

S48	1737	429/231.95.ccls.	US-PGPUB; USPAT; USOCR	NEAR	ON	2008/07/12 13:20
S49	710	S48 and (charg$4 near5 volt$4) and discharg$4 near5 volt$4	US-PGPUB; USPAT; USOCR	NEAR	ON	2008/07/12 13:22
S50	22	(SUN-JIE or REN-XIAOPING).in.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT	NEAR	ON	2008/07/12 13:23
S51	1	S50 and (charg$4 near5 volt$4) and discharg$4 near5 volt$4	US-PGPUB; USPAT; USOCR	NEAR	ON	2008/07/12 13:24
S52	1	"5654622".pn.	US-PGPUB; USPAT; USOCR	NEAR	ON	2009/01/02 18:23
S53	8	US-1135103-$.DID. OR US-1185860-$.DID. OR US-5604418-$.DID. OR JP-2000270491-$.DID.	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT	NEAR	ON	2009/01/02 18:27
S55	1	10/491134	US-PGPUB; USPAT; USOCR	NEAR	ON	2009/01/02 18:33
S56	17919	(charge near5 ((cut-off or cut off) near5 voltage) or ((cut-off or cut off) near5 voltage))	US-PGPUB; USPAT; USOCR	NEAR	ON	2009/01/02 18:36
S57	99	S56 same ("4.3" V or "4.4" V or "4.5" V or "4.6" V)	US-PGPUB; USPAT; USOCR	NEAR	ON	2009/01/02 18:38
S58	129	S56 same ("4.2" V)	US-PGPUB; USPAT; USOCR	NEAR	ON	2009/01/02 18:38
S59	5	"6558848"	US-PGPUB; USPAT; USOCR	NEAR	ON	2009/01/10 16:26
S60	39	(US-20030082448-$ or US-20030049534-$ or US-20040209156-$ or US-20010024757-$ or US-20020098416-$ or US-20020086214-$ or US-20020076612-$ or US-20030113613-$ or US-20010023983-$).did. or (US-5604418-$ or US-5464705-$ or US-7135251-$ or US-6998071-$ or US-6949312-$ or US-6617073-$ or US-6558847-$ or US-6558843-$ or US-6436577-$ or US-5478673-$ or US-7001690-$ or US-6528033-$ or US-6451483-$ or US-6268087-$ or US-5882218-$ or US-5744264-$ or US-5716728-$ or US-5344431-$ or US-5260148-$ or US-	US-PGPUB; USPAT; EPO; JPO; DERWENT	NEAR	ON	2009/01/10 16:30

		6071489-$ or US-6040090-$ or US-5998063-$ or US-5965293-$ or US-6756154-$ or US-6558848-$ or US-6497980-$).did. or (US-5654622-$).did. or (EP-1189299-$).did. or (JP-2000270491-$).did. or (JP-2000270491-$ or US-20010024757-A-$ or EP-1189299-A-$).did.				
S61	18	S60 and cut-off voltage	US-PGPUB; USPAT; USOCR	NEAR	ON	2009/01/10 16:31
S62	9	cut-off voltage with "4.5V"	US-PGPUB; USPAT; USOCR	NEAR	ON	2009/01/10 16:43
S63	46	cut-off voltage with ("4.5V" or "4.4V" or "4.35V" or "4.3" V)	US-PGPUB; USPAT; USOCR	NEAR	ON	2009/01/10 16:45
S64	32	TANAKA-MITSUTOSHI.in.	US-PGPUB; USPAT; USOCR	NEAR	ON	2009/01/10 17:07
S65	171	TANAKA-MITSUTOSHI.in.	JPO	NEAR	ON	2009/01/10 17:08
S68	10	S65 and ratio	JPO	NEAR	ON	2009/01/10 17:09
S69	980	(ratio with positive adj electrode with negative adj electrode with material) or (ratio with anode with cathode with material)	US-PGPUB; USPAT; USOCR	NEAR	ON	2009/01/10 18:28
S70	24	((cut-off or cut off) near3 voltage) with ("4.5V" or "4.4V" or "4.35V" or "4.3V")	US-PGPUB; USPAT; USOCR	NEAR	ON	2009/01/10 18:31
S71	1963	(((cut-off or cut off) near3 voltage) or voltage) with ("4.5V" or "4.4V" or "4.35V" or "4.3V")	US-PGPUB; USPAT; USOCR	NEAR	ON	2009/01/10 18:32
S72	28	S69 and S71	US-PGPUB; USPAT; USOCR	NEAR	ON	2009/01/10 18:32
S73	26	"5487960"	US-PGPUB; USPAT; USOCR	NEAR	ON	2009/08/11 15:50
S74	1	"5487960".pn.	US-PGPUB; USPAT; USOCR	NEAR	ON	2009/08/11 15:50
S75	12	("5213914" | "5464705" | "5693435" | "5763119" | "5885544" | "5989744" | "6022640" | "6153336" | "6453198" | "6544689" | "6617074" | "6706441"). PN.	US-PGPUB; USPAT; USOCR	NEAR	ON	2009/09/02 12:21

S76	3	(capacity ratio or specific capacity) with "400" cycle	US-PGPUB; USPAT; USOCR	NEAR	ON	2010/01/14 09:13
S77	859	(capacity ratio or specific capacity) with cycle	US-PGPUB; USPAT; USOCR	NEAR	ON	2010/01/14 09:14
S78	1	"5487960".pn.	US-PGPUB; USPAT; USOCR	NEAR	ON	2010/01/14 09:57
S82	2	US-5604418-$.DID.	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT	NEAR	ON	2010/01/14 18:36
S83	18851	(charge near5 ((cut-off or cut off) near5 voltage) or ((cut-off or cut off) near5 voltage))	US-PGPUB; USPAT; USOCR	NEAR	ON	2010/01/14 18:43
S84	16890	"320"/$.ccls.	US-PGPUB; USPAT; USOCR	NEAR	ON	2010/01/14 18:44
S85	596	S83 and S84	US-PGPUB; USPAT; USOCR	NEAR	ON	2010/01/14 18:44
S86	1	S85 and (capacity ratio or specific capacity) with cycle	US-PGPUB; USPAT; USOCR	NEAR	ON	2010/01/14 18:46
S87	17	S85 and (capacity ratio or specific capacity)	US-PGPUB; USPAT; USOCR	NEAR	ON	2010/01/14 18:46
S88	1109	429/49,50.ccls.	US-PGPUB; USPAT; USOCR	NEAR	ON	2010/01/14 18:47
S89	16	S83 and S88	US-PGPUB; USPAT; USOCR	NEAR	ON	2010/01/14 18:47
S90	51	S88 and (capacity ratio or specific capacity)	US-PGPUB; USPAT; USOCR	NEAR	ON	2010/01/14 18:48
S91	785	"320"/137.ccls.	US-PGPUB; USPAT; USOCR	NEAR	ON	2010/01/14 18:49
S92	21	S83 and S91	US-PGPUB; USPAT; USOCR	NEAR	ON	2010/01/14 18:49
S94	1	12/817028	US-PGPUB; USPAT; USOCR	NEAR	ON	2010/11/07 15:23
S95	44	(US-20030082448-$ or US-20030049534-$ or US-20040209156-$ or US-20010024757-$ or US-20020098416-$ or US-20020086214-$ or US-20020076612-$ or US-20030113613-$ or US-20010023983-$ or US-20100253292-$).did. or (US-5604418-$ or US-5464705-$ or US-7135251-$ or US-6998071-$ or US-6949312-$ or US-6617073-$ or US-6558847-$ or US-6558843-$ or US-6436577-	US-PGPUB; USPAT; EPO; JPO; DERWENT	NEAR	ON	2010/11/07 15:24

		$ or US-5478673-$ or US-7001690-$ or US-6528033-$ or US-6451483-$ or US-6268087-$ or US-5882218-$ or US-5744264-$ or US-5716728-$ or US-5344431-$ or US-5260148-$ or US-6071489-$ or US-6040090-$ or US-5998063-$ or US-5965293-$ or US-6756154-$ or US-6558848-$ or US-6497980-$).did. or (US-5654622-$ or US-5487960-$ or US-6432585-$ or US-6459564-$).did. or (EP-1189299-$).did. or (JP-2000270491-$ or JP-63250566-$).did. or (JP-2000270491-$ or US-20010024757-A-$ or EP-1189299-A-$).did.				
S96	20	S95 and (electronic device or (computer or laptop or phone))	US-PGPUB; USPAT; USOCR	NEAR	ON	2010/11/07 15:25
S97	32	((cut-off or cut off) near3 voltage) with ("4.5V" or "4.4V" or "4.35V" or "4.3V")	US-PGPUB; USPAT; USOCR	NEAR	ON	2010/11/07 15:33
S98	4	S95 and S97	US-PGPUB; USPAT; USOCR	NEAR	ON	2010/11/07 15:34
S99	2	S98 and (electronic device or (computer or laptop or phone))	US-PGPUB; USPAT; USOCR	NEAR	ON	2010/11/07 15:36
S100	0	((cut-off or cut off) near3 voltage) with ("4.5V" or "4.4V" or "4.35V" or "4.3V") same protect$4 near3 circuit	US-PGPUB; USPAT; USOCR	NEAR	ON	2010/11/07 15:41
S101	1	((cut-off or cut off) near3 voltage) with ("4.5V" or "4.4V" or "4.35V" or "4.3V") and protect$4 near3 circuit	US-PGPUB; USPAT; USOCR	NEAR	ON	2010/11/07 15:41
S102	1	((cut-off or cut off) near3 voltage) with ("4.5V" or "4.4V" or "4.35V" or "4.3V" or "4.2V") and protect$4 near3 circuit	US-PGPUB; USPAT; USOCR	NEAR	ON	2010/11/07 15:42
S103	93	((cut-off or cut off) near3 voltage) with ("4.5V" or "4.4V" or "4.35V" or "4.3V" or "4.2V")	US-PGPUB; USPAT; USOCR	NEAR	ON	2010/11/07 15:43

S104	7	((cut-off or cut off) near3 voltage) with ("4.5V" or "4.4V" or "4.35V" or "4.3V" or "4.2V") same circuit	US-PGPUB; USPAT; USOCR	NEAR	ON	2010/11/07 15:43
S105	2	overcharge release voltage with ("4.5V" or "4.4V" or "4.35V" or "4.3V" or "4.2V")	US-PGPUB; USPAT; USOCR	NEAR	ON	2010/11/07 15:49
S106	8	overcharge voltage with ("4.5V" or "4.4V" or "4.35V" or "4.3V" or "4.2V")	US-PGPUB; USPAT; USOCR	NEAR	ON	2010/11/07 15:49
S107	10	overcharge voltage same ("4.5V" or "4.4V" or "4.35V" or "4.3V" or "4.2V")	US-PGPUB; USPAT; USOCR	NEAR	ON	2010/11/07 15:53
S108	2	S107 not S106	US-PGPUB; USPAT; USOCR	NEAR	ON	2010/11/07 15:53
S109	1	"6558848".pn.	US-PGPUB; USPAT; USOCR	NEAR	ON	2010/11/07 18:39
S110	1	S109 and (charge near5 ((cut-off or cut off) near5 voltage))	US-PGPUB; USPAT; USOCR	NEAR	ON	2010/11/07 18:40
S111	1	S109 and (cut-off or cut off)	US-PGPUB; USPAT; USOCR	NEAR	ON	2010/11/07 18:40
S112	152	(Kobayash-Naoya or Kawakami-Soichiro).in.	US-PGPUB; USPAT; USOCR	NEAR	ON	2010/11/07 18:42
S113	5	S112 and (charge near5 ((cut-off or cut off) near5 voltage))	US-PGPUB; USPAT; USOCR	NEAR	ON	2010/11/07 18:42
S114	152	(Kobayash-Naoya or Kawakami-Soichiro).in.	US-PGPUB; USPAT; USOCR	NEAR	ON	2010/11/07 20:51
S115	78	S114 and circuit	US-PGPUB; USPAT; USOCR	NEAR	ON	2010/11/07 20:51
S116	0	S114 and protect$ circuit	US-PGPUB; USPAT; USOCR	NEAR	ON	2010/11/07 20:52
S117	0	S114 and cut-off circuit	US-PGPUB; USPAT; USOCR	NEAR	ON	2010/11/07 20:53
S118	1	S114 and charge circuit	US-PGPUB; USPAT; USOCR	NEAR	ON	2010/11/07 20:54
S119	15896	battery same protect$4 with circuit	US-PGPUB; USPAT; USOCR	NEAR	ON	2010/11/07 20:58
S120	5885	battery with protect$4 near3 circuit	US-PGPUB; USPAT; USOCR	NEAR	ON	2010/11/07 20:59
S121	749	battery with voltage near3 protect$4 near3 circuit	US-PGPUB; USPAT; USOCR	NEAR	ON	2010/11/07 20:59

S124	1	S121 and ((cut-off or cut off) near3 voltage) with ("4.5V" or "4.4V" or "4.35V" or "4.3V")	US-PGPUB; USPAT; USOCR	NEAR	ON	2010/11/07 21:07
S125	39	S121 and ((cut-off or cut off) near3 voltage)	US-PGPUB; USPAT; USOCR	NEAR	ON	2010/11/07 21:07
S126	7	S121 same ((cut-off or cut off) near3 voltage)	US-PGPUB; USPAT; USOCR	NEAR	ON	2010/11/07 21:08
S127	7	US-5604418-$.DID. OR US-4185487-$.DID. OR US-5487960-$.DID. OR US-5260148-$.DID. OR US-20030113613-$.DID. OR US-6558848-$.DID. OR US-1135103-$.DID. OR US-1185860-$.DID. OR JP-2000270491-$.DID.	USPAT	NEAR	ON	2010/11/07 22:17
S128	18	US-5604418-$.DID. OR US-4185487-$.DID. OR US-5487960-$.DID. OR US-5260148-$.DID. OR US-20030113613-$.DID. OR US-6558848-$.DID. OR US-1135103-$.DID. OR US-1185860-$.DID. OR JP-2000270491-$.DID.	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT	NEAR	ON	2010/11/07 22:17
S129	18	US-5604418-$.DID. OR US-4185487-$.DID. OR US-5487960-$.DID. OR US-5260148-$.DID. OR US-20030113613-$.DID. OR US-6558848-$.DID. OR US-1135103-$.DID. OR US-1185860-$.DID. OR JP-2000270491-$.DID.	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT	NEAR	ON	2010/11/07 22:17
S130	22	(SUN-JIE or REN-XIAOPING).in.	US-PGPUB; USPAT; USOCR	NEAR	ON	2010/11/07 22:37
S131	3	S130 and ((cut-off or cut off) near3 voltage)	US-PGPUB; USPAT; USOCR	NEAR	ON	2010/11/07 22:38

11/7/2010 10:39:29 PM
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PTO/SB/08 (09-06)
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Substitute for form 1449/PTO				Complete if Known	
INFORMATION DISCLOSURE STATEMENT BY APPLICANT				**Application Number**	12/817,028
				Filing Date	6/16/2010
Date Submitted: August 18, 2010				**First Named Inventor**	Xiaoping REN
				Art Unit	1795
(use as many sheets as necessary)				Examiner Name	Muhammad S. Siddiquee
Sheet	1	of	2	Attorney Docket Number	042787-0109

OPAP IAP3 AUG 18 2010 PATENT & TRADEMARK OFFICE

U.S. PATENT DOCUMENTS

Examiner Initials*	Cite No.[1]	Document Number Number-Kind Code[2] (*if known*)	Publication Date MM-DD-YYYY	Name of Patentee or Applicant of Cited Document	Pages, Columns, Lines, Where Relevant Passages or Relevant Figures Appear
/M.S./	A1	5 604 418	2/18/1997	ALCATEL ALSTHOM COMPAGNIE GENERALE	
/M.S./	A2	5 487 960	1/1996	Tanaka MITSUTOSHI	
/M.S./	A3	5 260 148	11/1993	Yoshio IDOTA	
/M.S./	A4	2003/0113613 A1	6/2003	TAKEUCHI et al.	
/M.S./	A5	6 558 848 B1	5/2003	KOBAYASHI et al.	

FOREIGN PATENT DOCUMENTS

Examiner Initials*	Cite No.[1]	Foreign Patent Document Country Code[3]-Number[4]-Kind Code[5] (*if known*)	Publication Date MM-DD-YYYY	Name of Patentee or Applicant of Cited Documents	Pages, Columns, Lines, Where Relevant Passages or Relevant Figures Appear	T[6]
/M.S./	A6	CN 1135103 A	11/6/1996			
/M.S./	A7	CN 1185860 A	6/26/1998			
/M.S./	A8	JP 2000-270491 A	9/29/2000			

NON PATENT LITERATURE DOCUMENTS

Examiner Initials*	Cite No.[1]	Include name of the author (in CAPITAL LETTERS), title of the article (when appropriate), title of the item (book, magazine, journal, serial, symposium, catalog, etc.) date, page(s), volume-issue number(s), publisher, city and/or country where published.	T[6]
/M.S./	A9	Notice of Allowance USSN 10/491,134 dated February 22, 2010.	
/M.S./	A10	Office Action dated June 9, 2009, in corresponding Japanese Application No. 2003-533374, English Translation 3 pages	
/M.S./	A11	Patent Abstracts of Japan Publication No. 2001-176559 dated June 29, 2001, *ABSTRACT*	

Examiner Signature	/Muhammad Siddiquee/	Date Considered	11/07/2010

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Substitute for form 1449/PTO				*Complete if Known*	
INFORMATION DISCLOSURE STATEMENT BY APPLICANT				**Application Number**	12/817,028
				Filing Date	6/16/2010
Date Submitted: August 18, 2010				**First Named Inventor**	Xiaoping REN
				Art Unit	1795
(use as many sheets as necessary)				Examiner Name	Muhammad S. Siddiquee
Sheet	2	of	2	Attorney Docket Number	042787-0109

NON PATENT LITERATURE DOCUMENTS			
Examiner Initials*	Cite No.[1]	Include name of the author (in CAPITAL LETTERS), title of the article (when appropriate), title of the item (book, magazine, journal, serial, symposium, catalog, etc.) date, page(s), volume-issue number(s), publisher, city and/or country where published.	T[6]
/M.S./	A12	Patent Abstracts of Japan Publication No. 09-259928 dated October 3, 1977, *ABSTRACT*	
/M.S./	A13	International Search Report dated 5/6/2003	
/M.S./	A14	Final Office Action U.S. Serial No. 10/491,134 dated August 14, 2009.	
/M.S./	A15	Non-Final Office Action U.S. Serial No. 10/491,134 dated July 21, 2008.	
/M.S./	A16	K. MIZUSHIMA et al., "Li_xCo_2 (0<x<1): A NEW CATHODE MATERIAL FOR BATTERIES OF HIGH ENERGY DENSITY ", Mat. Res. Bull., Vol. 15, pp. 783-789 1980.	
/M.S./	A17	G. PISTOIA et al., 'Synthesis of Mn spinels from different polymorphs of MnO_2" Journal of Power Sources, 56 (1995) 37-43.	
/M.S./	A18	Lei Yongquan, "Materials for New Energy", 2000, pg. 136.	
/M.S./	A19	Non-Final Office Action U.S. Serial No. 10/491,134 dated May 23, 2008.	

Examiner Signature	/Muhammad Siddiquee/	Date Considered	11/07/2010

*EXAMINER: Initial if reference considered, whether or not citation is in conformance with MPEP 609. Draw line through citation if not in conformance and not considered. Include copy of this form with next communication to applicant. 1 Applicant's unique citation designation number (optional). 2 See Kinds Codes of USPTO Patent Documents at www.uspto.gov or MPEP 901.04. 3 Enter Office that issued the document, by the two-letter code (WIPO Standard ST.3). 4 For Japanese patent documents, the indication of the year of the reign of the Emperor must precede the serial number of the patent document. 5 Kind of document by the appropriate symbols as indicated on the document under WIPO Standard ST.16 if possible. 6 Applicant is to place a check mark here if English language Translation is attached.

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APPLICATION NUMBER	FILING OR 371(C) DATE	FIRST NAMED APPLICANT	ATTY. DOCKET NO./TITLE
12/817,028	06/16/2010	Xiaoping REN	042787-0109

CONFIRMATION NO. 4654

22428
FOLEY AND LARDNER LLP
SUITE 500
3000 K STREET NW
WASHINGTON, DC 20007

PUBLICATION NOTICE

OC000000043889695

Title:SECONDARY LITHIUM ION CELL OR BATTERY, AND PROTECTING CIRCUIT, ELECTRONIC DEVICE AND CHARGING DEVICE OF THE SAME

Publication No.US-2010-0253292-A1
Publication Date:10/07/2010

NOTICE OF PUBLICATION OF APPLICATION

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

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

The publication process established by the Office does not provide for mailing a copy of the publication to applicant. A copy of the publication may be obtained from the Office upon payment of the appropriate fee set forth in 37 CFR 1.19(a)(1). Orders for copies of patent application publications are handled by the USPTO's Office of Public Records. The Office of Public Records can be reached by telephone at (703) 308-9726 or (800) 972-6382, by facsimile at (703) 305-8759, by mail addressed to the United States Patent and Trademark Office, Office of Public Records, Alexandria, VA 22313-1450 or via the Internet.

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

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Office of Data Managment, Application Assistance Unit (571) 272-4000, or (571) 272-4200, or 1-888-786-0101

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Applicant: Xiaoping REN *et al.*

Title: **SECONDARY LITHIUM ION CELL OR BATTERY, AND PROTECTING CIRCUIT, ELECTRONIC DEVICE AND CHARGING DEVICE OF THE SAME**

Appl. No.: 12/817,028

Filing Date: 06/16/2010

Examiner: Muhammad S. Siddiquee

Art Unit: 1795

Confirmation Number: 4654

RESPONSE TO RESTRICTION REQUIREMENT

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

Sir:

In response to the restriction requirement set forth in the Office Action mailed August 12, 2010 ("Office Action"), applicant provisionally elects for examination claims 4 and 5 (Group III), drawn to an electronic device. The election is made with traverse because the examiner's requirement for restriction is based on the erroneous proposition that elected Group III and the other asserted groupings, namely, Group I (claim 1), drawn to a secondary lithium ion battery, Group II (claims 2 and 3), drawn to a protection circuit, and Group IV (claims 6-8), drawn to a charging device, do not embody or constitute a single general inventive concept under PCT Rule 13.1.

In this vein, Examiner Siddiquee has asserted that ***the*** "special technical feature of the ratio of positive electrode material to negative electrode material of a single cell is lacking among the groups" (Office Action at 2; emphasis added). So contending, however, the examiner has failed to recognize that the asserted groupings have in common ***other*** special technical features, including one related to voltage:

- Group I (claim 1): a *charge cut-off voltage of greater than 4.2V*;
- Group II (claims 2 and 3): *a first overcharge protection voltage of greater than 4.35V* and an overcharging protection release voltage of greater than 4.15V;
- Group III (claims 4 and 5): *a first overcharge protection voltage of greater than 4.35V* and an overcharging protection release voltage of greater than 4.15V; and
- Group IV (claims 6-8*): a charge cut-off voltage* to the single lithium ion cell within the range *of greater than 4.3V but less than 5.8V.*

(Emphasis added.)

It is apparent, therefore, that each group is defined by reference to, *inter alia*, an overcharge protection voltage or charge cut-off voltage that is above the conventional threshold of 4.2V. That is, each group includes a claim element directed to charging a battery above the traditional level of 4.2V.

Groups I-IV thus relate to a general inventive concept, as is evidenced by the absence of a unity objection during the international phase. By the same token, the commonality of special technical features among the four groups renders the present restriction requirement inappropriate under the relevant PCT rules.

Applicant therefore requests withdrawal of the restriction requirement, whereby each of pending claims 1-8 would be examined together. Alternatively, applicant requests that the PTO substantiate its position in view of the foregoing.

The Commissioner is hereby authorized to charge any additional fees, which may be required under 37 C.F.R. §§ 1.16-1.17, and to credit any overpayment to Deposit Account No. 19-0741. Should no proper payment accompany this response, then the Commissioner is authorized to charge the unpaid amount to the same deposit account. If any extension is needed for timely acceptance of submitted papers, then applicant hereby petitions for such extension under 37 C.F.R. §1.136 and authorizes payment of the relevant fee(s) from the deposit account.

Respectfully submitted,

Date September 13, 2010

By

FOLEY & LARDNER LLP
Customer Number: 22428
Telephone: (202) 672-5404
Facsimile: (202) 672-5399

Stephen A. Bent
Attorney for Applicant
Registration No. 29,768

Electronic Acknowledgement Receipt	
EFS ID:	8400571
Application Number:	12817028
International Application Number:	
Confirmation Number:	4654
Title of Invention:	SECONDARY LITHIUM ION CELL OR BATTERY, AND PROTECTING CIRCUIT, ELECTRONIC DEVICE AND CHARGING DEVICE OF THE SAME
First Named Inventor/Applicant Name:	Xiaoping REN
Customer Number:	22428
Filer:	Stephen A. Bent/Linda Novak
Filer Authorized By:	Stephen A. Bent
Attorney Docket Number:	042787-0109
Receipt Date:	13-SEP-2010
Filing Date:	16-JUN-2010
Time Stamp:	10:10:46
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	no

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1	Response to Election / Restriction Filed	RestrictionResponse.pdf	28253 539ce7b35792c6f56b3c98eef0f98999875d0864	no	3
Warnings:					
Information:					

Total Files Size (in bytes):	28253

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

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

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PATENT APPLICATION FEE DETERMINATION RECORD Substitute for Form PTO-875	Application or Docket Number 12/817,028	Filing Date 06/16/2010	☐ To be Mailed

APPLICATION AS FILED – PART I

	(Column 1)	(Column 2)	SMALL ENTITY ☒		OR	OTHER THAN SMALL ENTITY	
FOR	NUMBER FILED	NUMBER EXTRA	RATE ($)	FEE ($)		RATE ($)	FEE ($)
☐ BASIC FEE (37 CFR 1.16(a), (b), or (c))	N/A	N/A	N/A			N/A	
☐ SEARCH FEE (37 CFR 1.16(k), (i), or (m))	N/A	N/A	N/A			N/A	
☐ EXAMINATION FEE (37 CFR 1.16(o), (p), or (q))	N/A	N/A	N/A			N/A	
TOTAL CLAIMS (37 CFR 1.16(i))	minus 20 =	*	X $ =		OR	X $ =	
INDEPENDENT CLAIMS (37 CFR 1.16(h))	minus 3 =	*	X $ =			X $ =	
☐ APPLICATION SIZE FEE (37 CFR 1.16(s))	If the specification and drawings exceed 100 sheets of paper, the application size fee due is $250 ($125 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			TOTAL	

APPLICATION AS AMENDED – PART II

AMENDMENT		(Column 1)		(Column 2)	(Column 3)	SMALL ENTITY		OR	OTHER THAN SMALL ENTITY	
	09/13/2010	CLAIMS REMAINING AFTER AMENDMENT		HIGHEST NUMBER PREVIOUSLY PAID FOR	PRESENT EXTRA	RATE ($)	ADDITIONAL FEE ($)		RATE ($)	ADDITIONAL FEE ($)
	Total (37 CFR 1.16(i))	* 8	Minus	** 20	= 0	X $26 =	0	OR	X $ =	
	Independent (37 CFR 1.16(h))	* 3	Minus	***3	= 0	X $110 =	0	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	0	OR	TOTAL ADD'L FEE	

AMENDMENT		(Column 1)		(Column 2)	(Column 3)	RATE ($)	ADDITIONAL FEE ($)		RATE ($)	ADDITIONAL FEE ($)
		CLAIMS REMAINING AFTER AMENDMENT		HIGHEST NUMBER PREVIOUSLY PAID FOR	PRESENT EXTRA					
	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 number found in the appropriate box in column 1.

Legal Instrument Examiner:
/Ruth Graden/

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

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

PTO/SB/08 (09-06)
Approved for use through 03/31/2007. 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.

Substitute for form 1449/PTO				Complete if Known	
INFORMATION DISCLOSURE STATEMENT BY APPLICANT				**Application Number**	12/817,028
				Filing Date	6/16/2010
Date Submitted: August 18, 2010				**First Named Inventor**	Xiaoping REN
				Art Unit	1795
(use as many sheets as necessary)				Examiner Name	Muhammad S. Siddiquee
Sheet	1	of	2	Attorney Docket Number	042787-0109

OPAP IAP3 AUG 18 2010 PATENT & TRADEMARK OFFICE

U.S. PATENT DOCUMENTS					
Examiner Initials*	Cite No.[1]	Document Number Number-Kind Code[2] *(if known)*	Publication Date MM-DD-YYYY	Name of Patentee or Applicant of Cited Document	Pages, Columns, Lines, Where Relevant Passages or Relevant Figures Appear
	A1	5 604 418	2/18/1997	ALCATEL ALSTHOM COMPAGNIE GENERALE	
	A2	5 487 960	1/1996	Tanaka MITSUTOSHI	
	A3	5 260 148	11/1993	Yoshio IDOTA	
	A4	2003/0113613 A1	6/2003	TAKEUCHI et al.	
	A5	6 558 848 B1	5/2003	KOBAYASHI et al.	

FOREIGN PATENT DOCUMENTS						
Examiner Initials*	Cite No.[1]	Foreign Patent Document Country Code[3]-Number[4]-Kind Code[5] *(if known)*	Publication Date MM-DD-YYYY	Name of Patentee or Applicant of Cited Documents	Pages, Columns, Lines, Where Relevant Passages or Relevant Figures Appear	T[6]
	A6	CN 1135103 A	11/6/1996			
	A7	CN 1185860 A	6/26/1998			
	A8	JP 2000-270491 A	9/29/2000			

NON PATENT LITERATURE DOCUMENTS			
Examiner Initials*	Cite No.[1]	Include name of the author (in CAPITAL LETTERS), title of the article (when appropriate), title of the item (book, magazine, journal, serial, symposium, catalog, etc.) date, page(s), volume-issue number(s), publisher, city and/or country where published.	T[6]
	A9	Notice of Allowance USSN 10/491,134 dated February 22, 2010.	
	A10	Office Action dated June 9, 2009, in corresponding Japanese Application No. 2003-533374, English Translation 3 pages	
	A11	Patent Abstracts of Japan Publication No. 2001-176559 dated June 29, 2001, *ABSTRACT*	

Examiner Signature		Date Considered	

*EXAMINER: Initial if reference considered, whether or not citation is in conformance with MPEP 609. Draw line through citation if not in conformance and not considered. Include copy of this form with next communication to applicant. 1 Applicant's unique citation designation number (optional). 2 See Kinds Codes of USPTO Patent Documents at www.uspto.gov or MPEP 901.04. 3 Enter Office that issued the document, by the two-letter code (WIPO Standard ST.3). 4 For Japanese patent documents, the indication of the year of the reign of the Emperor must precede the serial number of the patent document. 5 Kind of document by the appropriate symbols as indicated on the document under WIPO Standard ST.16 if possible. 6 Applicant is to place a check mark here if English language Translation is attached. 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 2 hours 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, 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 (1-800-786-9199) and select option 2.

WASH_7257539.1

PTO/SB/08 (09-06)
Approved for use through 03/31/2007. 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.

Substitute for form 1449/PTO				*Complete if Known*	
INFORMATION DISCLOSURE STATEMENT BY APPLICANT				**Application Number**	12/817,028
				Filing Date	6/16/2010
Date Submitted: August 18, 2010				**First Named Inventor**	Xiaoping REN
				Art Unit	1795
(use as many sheets as necessary)				Examiner Name	Muhammad S. Siddiquee
Sheet	2	of	2	Attorney Docket Number	042787-0109

NON PATENT LITERATURE DOCUMENTS			
Examiner Initials*	Cite No.[1]	Include name of the author (in CAPITAL LETTERS), title of the article (when appropriate), title of the item (book, magazine, journal, serial, symposium, catalog, etc.) date, page(s), volume-issue number(s), publisher, city and/or country where published.	T[6]
	A12	Patent Abstracts of Japan Publication No. 09-259928 dated October 3, 1977, *ABSTRACT*	
	A13	International Search Report dated 5/6/2003	
	A14	Final Office Action U.S. Serial No. 10/491,134 dated August 14, 2009.	
	A15	Non-Final Office Action U.S. Serial No. 10/491,134 dated July 21, 2008.	
	A16	K. MIZUSHIMA et al., "Li_xCo_2 (0<x<1): A NEW CATHODE MATERIAL FOR BATTERIES OF HIGH ENERGY DENSITY ", Mat. Res. Bull., Vol. 15, pp. 783-789 1980.	
	A17	G. PISTOIA et al., 'Synthesis of Mn spinels from different polymorphs of MnO_2" Journal of Power Sources, 56 (1995) 37-43.	
	A18	Lei Yongquan, "Materials for New Energy", 2000, pg. 136.	
	A19	Non-Final Office Action U.S. Serial No. 10/491,134 dated May 23, 2008.	

Examiner Signature		Date Considered	

*EXAMINER: Initial if reference considered, whether or not citation is in conformance with MPEP 609. Draw line through citation if not in conformance and not considered. Include copy of this form with next communication to applicant. 1 Applicant's unique citation designation number (optional). 2 See Kinds Codes of USPTO Patent Documents at www.uspto.gov or MPEP 901.04. 3 Enter Office that issued the document, by the two-letter code (WIPO Standard ST.3). 4 For Japanese patent documents, the indication of the year of the reign of the Emperor must precede the serial number of the patent document. 5 Kind of document by the appropriate symbols as indicated on the document under WIPO Standard ST.16 if possible. 6 Applicant is to place a check mark here if English language Translation is attached. 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 2 hours 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, 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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WASH_7257539.1

OPAP IAP3 AUG 18 2010 PATENT & TRADEMARK OFFICE

Atty. Dkt. No. 042787-0109

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Applicant: Xiaoping REN et al.

Title: ***SECONDARY LITHIUM ION CELL OR BATTERY, AND PROTECTING CIRCUIT, ELECTRONIC DEVICE AND CHARGING DEVICE OF THE SAME***

Appl. No.: 12/817,028

Filing Date: 6/16/2010

Examiner: Muhammad S. Siddiquee

Art Unit: 1795

Confirmation Number: 4654

INFORMATION DISCLOSURE STATEMENT UNDER 37 CFR §1.56

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

Sir:

Submitted herewith on Form PTO/SB/08 is a listing of the documents and Office Actions cited by the Examiner or submitted to the USPTO in parent application Serial No. 10/491,134, filed 5/6/2004. As provided in 37 CFR §1.98(d), copies of the documents are not being provided since they were previously submitted to the United States Patent & Trademark Office in the above-identified parent application.

The submission of any document herewith, which is not a statutory bar, is not intended as an admission that such document constitutes prior art against the claims of the present application or that such document is considered material to patentability as defined in 37 CFR

§1.56(b). Applicants do not waive any rights to take any action which would be appropriate to antedate or otherwise remove as a competent reference any document which is determined to be a *prima facie* art reference against the claims of the present application.

TIMING OF THE DISCLOSURE

The listed documents are being submitted in compliance with 37 CFR §1.97(b), within three (3) months of the filing date of the application.

RELEVANCE OF EACH DOCUMENT

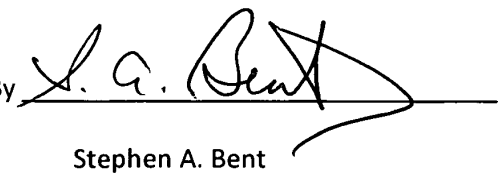
All of the documents are in English.

Applicants respectfully request that each listed document be considered by the Examiner and be made of record in the present application and that an initialed copy of Form PTO/SB/08 be returned in accordance with MPEP §609.

Although Applicant believes that no fee is required, the Commissioner is hereby authorized to charge any additional fees which may be due to Deposit Account No. 19-0741.

Respectfully submitted,

Date August 18, 2010

By 

FOLEY & LARDNER LLP
Customer Number: 22428
Telephone: (202) 672-5404
Facsimile: (202) 672-5399

Stephen A. Bent
Attorney for Applicant
Registration No. 29,768

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.
12/817,028	06/16/2010	Xiaoping REN	042787-0109	4654

22428 7590 08/12/2010
FOLEY AND LARDNER LLP
SUITE 500
3000 K STREET NW
WASHINGTON, DC 20007

EXAMINER	
SIDDIQUEE, MUHAMMAD S	
ART UNIT	PAPER NUMBER
1795	

MAIL DATE	DELIVERY MODE
08/12/2010	PAPER

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.

Office Action Summary	Application No.	Applicant(s)	
	12/817,028	REN ET AL.	
	Examiner	Art Unit	
	MUHAMMAD SIDDIQUEE	1795	

-- 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 *1* MONTH(S) OR THIRTY (30) DAYS, WHICHEVER IS LONGER, 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 *16 June 2010*.

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

3)☐ 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

4)☒ Claim(s) *1-8* is/are pending in the application.

4a) Of the above claim(s) _____ is/are withdrawn from consideration.

5)☐ Claim(s) _____ is/are allowed.

6)☐ Claim(s) _____ is/are rejected.

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

8)☒ Claim(s) *1-8* are subject to restriction and/or election requirement.

Application Papers

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

10)☐ The drawing(s) filed on _____ is/are: a)☐ accepted or b)☐ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).

11)☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

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).

a)☐ All b)☐ Some * c)☐ None of:

1.☐ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. _____.

3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

1) ☐ Notice of References Cited (PTO-892)
2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
3) ☐ Information Disclosure Statement(s) (PTO/SB/08) Paper No(s)/Mail Date _____.
4) ☐ Interview Summary (PTO-413) Paper No(s)/Mail Date. _____ .
5) ☐ Notice of Informal Patent Application
6) ☐ Other: _____.

DETAILED ACTION

Election/Restrictions

1. Restriction is required under 35 U.S.C. 121 and 372.

This application contains the following inventions or groups of inventions which are not so linked as to form a single general inventive concept under PCT Rule 13.1.

In accordance with 37 CFR 1.499, applicant is required, in reply to this action, to elect a single invention to which the claims must be restricted.

Group I, claim(s) 1, drawn to A secondary lithium ion battery.

Group II, claim(s) 2-3, drawn to A protection circuit.

Group III, claim(s) 4-5, drawn to An electronic device.

Group IV, claim(s) 6-8, drawn to A charging device.

2. The inventions listed as Groups I to IV do not relate to a single general inventive concept under PCT Rule 13.1 because, under PCT Rule 13.2, they lack the same or corresponding special technical features for the following reasons: the special technical feature of the ratio of positive electrode material to negative electrode material of a single cell is lacking among the groups.

3. In light of the complexity of the restriction requirement for this application, no telephone communication regarding the restriction has been made. See MPEP § 812.01.

Applicant is advised that the reply to this requirement to be complete must include (i) an election of a species or invention to be examined even though the

requirement may be traversed (37 CFR 1.143) and (ii) identification of the claims encompassing the elected invention.

The election of an invention or species may be made with or without traverse. To preserve a right to petition, the election must be made with traverse. If the reply does not distinctly and specifically point out supposed errors in the restriction requirement, the election shall be treated as an election without traverse.

4. Applicant is reminded that upon the cancellation of claims to a non-elected invention, the inventorship must be amended in compliance with 37 CFR 1.48(b) if one or more of the currently named inventors is no longer an inventor of at least one claim remaining in the application. Any amendment of inventorship must be accompanied by a request under 37 CFR 1.48(b) and by the fee required under 37 CFR 1.17(i).

Any inquiry concerning this communication or earlier communications from the examiner should be directed to MUHAMMAD SIDDIQUEE whose telephone number is (571)270-3719. The examiner can normally be reached on Monday-Thursday, 7:30 am to 4:00 pm EST.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Patrick Ryan can be reached on 571-272-1292. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see http://pair-direct.uspto.gov. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free). If you would like assistance from a USPTO Customer Service Representative or access to the automated information system, call 800-786-9199 (IN USA OR CANADA) or 571-272-1000.

/Muhammad Siddiquee/
Examiner, Art Unit 1795

/PATRICK RYAN/
Supervisory Patent Examiner, Art Unit 1795

Index of Claims	Application/Control No.	Applicant(s)/Patent Under Reexamination
	12817028	REN ET AL.
	Examiner	Art Unit
	MUHAMMAD SIDDIQUEE	1795

✓	Rejected	-	Cancelled	N	Non-Elected	A	Appeal
=	Allowed	÷	Restricted	I	Interference	O	Objected

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

CLAIM		DATE								
Final	Original	08/11/2010								
	1	÷								
	2	÷								
	3	÷								
	4	÷								
	5	÷								
	6	÷								
	7	÷								
	8	÷								

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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
12/817,028	06/16/2010	2858	462	042787-0109	8	3

CONFIRMATION NO. 4654

22428
FOLEY AND LARDNER LLP
SUITE 500
3000 K STREET NW
WASHINGTON, DC 20007

FILING RECEIPT

OC00000042274732

Date Mailed: 06/25/2010

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

Applicant(s)

Xiaoping REN, Beijing, CHINA;
Jie Sun, Beijing, CHINA;

Power of Attorney: The patent practitioners associated with Customer Number 22428

Domestic Priority data as claimed by applicant

This application is a DIV of 10/491,134 05/06/2004 PAT 7,749,641
which is a 371 of PCT/CN02/00696 09/28/2002

Foreign Applications

CHINA 01141615.7 09/28/2001

If Required, Foreign Filing License Granted: 06/24/2010

The country code and number of your priority application, to be used for filing abroad under the Paris Convention, is **US 12/817,028**

Projected Publication Date: 10/07/2010

Non-Publication Request: No

Early Publication Request: No
** **SMALL ENTITY** **

Title

SECONDARY LITHIUM ION CELL OR BATTERY, AND PROTECTING CIRCUIT, ELECTRONIC DEVICE AND CHARGING DEVICE OF THE SAME

Preliminary Class

320

PROTECTING YOUR INVENTION OUTSIDE THE UNITED STATES

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

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

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

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

For information on preventing theft of your intellectual property (patents, trademarks and copyrights), you may wish to consult the U.S. Government website, http://www.stopfakes.gov. Part of a Department of Commerce initiative, this website includes self-help "toolkits" giving innovators guidance on how to protect intellectual property in specific countries such as China, Korea and Mexico. For questions regarding patent enforcement issues, applicants may call the U.S. Government hotline at 1-866-999-HALT (1-866-999-4158).

LICENSE FOR FOREIGN FILING UNDER

Title 35, United States Code, Section 184

Title 37, Code of Federal Regulations, 5.11 & 5.15

GRANTED

The applicant has been granted a license under 35 U.S.C. 184, if the phrase "IF REQUIRED, FOREIGN FILING LICENSE GRANTED" followed by a date appears on this form. Such licenses are issued in all applications where

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IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Applicant: Xiaoping REN et al.

Title: ***SECONDARY LITHIUM ION CELL OR BATTERY, AND PROTECTING CIRCUIT, ELECTRONIC DEVICE AND CHARGING DEVICE OF THE SAME***

Prior Appl. No.: 10/491134

Prior Appl. Filing Date: 9/28/2002

Examiner: Unassigned

Art Unit: Unassigned

CONTINUING PATENT APPLICATION TRANSMITTAL LETTER

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

Sir:

Transmitted herewith for filing under 37 C.F.R. § 1.53(b) is a:

[ ] Continuation [**X**] Division [ ] Continuation-In-Part (CIP)

of the above-identified copending prior application in which no patenting, abandonment, or termination of proceedings has occurred. Priority to the above-identified prior application is hereby claimed under 35 U.S.C. § 120 for this continuing application. The entire disclosure of the above-identified prior application is considered as being part of the disclosure of the accompanying continuing application and is hereby incorporated by reference therein.

[**X**] Applicant claims small entity status under 37 CFR 1.27.

Enclosed are:

[X] Description, Claim(s), and Abstract (24 pages).

[X] Declaration and Power of Attorney (3 pages).

[X] Application Data Sheet (37 CFR 1.76).

The adjustment to the number of sheets for EFS-Web filing follows:

Number of Sheets		**EFS-Web Adjustment**	**Number of Sheets for EFS-Web**
24	x	75%	18

The filing fee is calculated below:

	Number Filed		**Included in Basic Fee**		**Extra**		Rate		Fee Totals
Basic Filing Fee							$330.00	=	$330.00
Search Fee							$540.00		$540.00
Examination Fee							$220.00		$220.00
Size Fee	18	-	100	= 0		x	$270.00		$0.00
Total Claims:	8	-	20	= 0		x	$52.00	=	$0.00
Independents:	3	-	3	= 0		x	$220.00	=	$0.00
If any Multiple Dependent Claim(s) present:						+	$390.00	=	$0.00
Surcharge under 37 CFR 1.16(e) for late filing of Executed Declaration or late payment of filing fee						+	$130.00	=	$0.00
							SUBTOTAL:	=	$1090.00
[X]					Small Entity Fees Apply (subtract ½ of above):			=	$545.00
					Basic Filing Fee Reduction for Filing via EFS-Web				$83.00
							TOTAL FILING FEE:	=	$462.00
Assignment Recordation Fee:						+	$40.00	=	$0.00
Processing Fee under 37 CFR 1.17(i) for Late Filing of English Translation of Application:						+	$130.00	=	$0.00
TOTAL FEE								=	$462.00

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The Commissioner is hereby authorized to charge any additional fees which may be required regarding this application under 37 C.F.R. §§ 1.16-1.17, or credit any overpayment, to Deposit Account No. 19-0741. Should no proper payment be enclosed herewith, as by the credit card payment instructions in EFS-Web being incorrect or absent, resulting in a rejected or incorrect credit card transaction, the Commissioner is authorized to charge the unpaid amount to Deposit Account No. 19-0741.

Please direct all correspondence to the undersigned attorney or agent at the address indicated below.

Respectfully submitted,

Date June 16, 2010

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Application Data Sheet

Application Information

Application Type::	Regular
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Suggested Group Art Unit::	
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Representative Information

Representative Customer Number::	22428	

Domestic Priority Information

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This Application	Division of	10/491,134	5/6/2004
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Foreign Priority Information

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China P.R.	01141615.7	9/28/2001	Yes

Assignee Information

SECONDARY LITHIUM ION CELL OR BATTERY, AND PROTECTING CIRCUIT, ELECTRONIC DEVICE AND CHARGING DEVICE OF THE SAME

CROSS-REFERENCE TO RELATED APPLICATIONS

This application is a Divisional Application of U.S. Serial No. 10/491,134 filed May 6, 2004 which is the U.S. national phase of PCT/CN02/00696 filed September 28, 2002, which claims priority from Chinese Application No. 011416157 filed September 28, 2001. The subject matter of each of the above-referenced applications is incorporated in entirety by reference.

TECHNICAL FIELD

The present invention relates to a new method for improving capacity, average operating voltage and specific energy of a secondary lithium ion cell or battery, and to a secondary lithium ion cell or battery prepared by using the method, a protecting circuit adapted for the secondary lithium ion cell or battery, a electronic device using the secondary lithium ion cell or battery, and a charging device for the secondary lithium ion cell or battery.

BACKGROUND ART

The industry of lithium ion cell develops quickly since SONY corporation of Japan invented and commercialized a secondary lithium ion cell. Up to 2000, the manufactures of lithium ion battery around the world compete allsidedly for improving the competitive power of their products mainly around the key issue, the capacity of lithium ion battery. At present, the improvement of capacity of commercialized secondary lithium ion battery generally depends on the increase of loading quantities of active substances (positive electrode materials and negative electrode materials). However, the limitation of the volume of lithium ion battery greatly restricts the increase of the battery capacity. For notably raising the capacity, the researches for the development of active substances (positive electrode materials and negative electrode materials) having higher specific energy are been conducting around the world, but so far, there is no notable breakthrough in this aspect for various technical difficulties.

In fact, the positive electrode materials and negative electrode materials used in the current secondary lithium ion battery have relatively higher theoretical capacity, and the problem merely lies in the lower actual utilization rate of said capacity. For example, lithium cobalt oxides as a positive electrode material of secondary lithium ion cell has a theoretical capacity of 248 mAh/g, while the actually used capacity of it is

merely about 140 mAh/g, i.e., about half of said theoretic capacity is not utilized. This is mainly caused by the limitation of charge cut-off voltage commonly used in the art. At present, the charge cut-off voltage of single secondary lithium ion cell is limited to no more than 4.2 V, and this is well accepted as a technical requirement in the industry of manufacture of secondary lithium ion battery. Further, all lithium ion batteries in the markets around the world are manufactured under this technical requirement. For example, the charge cut-off voltage is limited to below 4.2 V and the overcharge release voltage of its protection circuit is controlled below 4.15 V during the formation of single lithium ion cell. The reasons that the charge cut-off voltage being limited to below 4.2 V lie in the following opinions in the prior research results and documents: although the capacity and average operating voltage are improved by increasing the charge cut-off voltage, the positive electrode materials and the negative electrode materials will undergo structure change, the electrolyte may decompose, and the recycle property of the cell will be adversely affected when the charge cut-off voltage is greater than 4.2 V.

For instance, as to lithium cobalt oxides that is used as positive electrode material in the most commercial lithium ion batteries, the charge cut-off voltage is limited to below 4.2 V and the actual capacity is 120-140 mAh/g, i.e., about 50% of the theoretical capacity, although many documents indicate that the charge cut-off voltage can be over 4.2 V for a test cell using metallic lithium as counter electrode. In fact, according to MIZUSHIMAK et al., "A new cathode material for batteries of high energy density", Mater. Res. Bull., 1980, 15:783, the quantity of dedoped lithium ion increases with the increase of charge voltage, and the electrochemical capacity of lithium cobalt oxides increases accordingly. However, the study deems that the reversible charge-discharge voltage is about 4.3 V when metallic lithium is used as counter electrode, and when said voltage is higher than 4.3 V, the structure of lithium cobalt oxides changes and the lattice parameter C decreases from 4.4 nm to 4.0 nm, and thus the recycle life of cell is affected.

G. PISTOIA et al., J. Power Source, 56(1995), 37-43, deems that the structure the lithium cobalt oxides changes with the charge voltage, and the coexistence of monoclinic phase and hexagonal phase will appear when the charge voltage is over a certain value, which will spoil the recycle property of cell. The results of experiments showed that as to a test button cell having metallic lithium as negative electrode, the capacity of lithium cobalt oxides reaches 159 mAh/g when the charge cut-off voltage is 4.35 V, but it drops to 135 mAh/g after several cycles; and the capacity attenuates quickly when the charge cut-off voltage is 4.25 V. This document takes the opinion that lithium cobalt oxides maintains excellent recycle property and a

capacity about 130 mAh/g only when the charge cut-off voltage is 4.15 V, and the corresponding voltages of monoclinic phase and hexagonal phase separately is 4.05 V and 4.17 V, i.e., both of them are below 4.2 V.

In addition, Lei Yongquan, "Materials for New Energy" (in Chinese), 2000, p136, discloses that the decomposition voltage of electrolyte solution using $LiPF_6$ as electrolyte and EC/DMC as mixture solvent is 4.2 V, and thus deems that the electrolyte solution will be decomposed and the recycle life will be affected when the charge cut-off voltage is above 4.2 V.

In 1990, Sony Corporation issued the lithium ion cell using coke as negative electrode, which has a charge cut-off voltage of not more than 4.20 V, and it is accepted as a common technical requirement of lithium ion cells thereafter.

The prior art deems:

1. The increase of charge cut-off voltage will change the structure of positive electrode material, which mainly exhibits at the following two aspects: one aspect is that the phase change, i.e., the coexistence of monoclinic phase and hexagonal phase and the conversion between them may seriously affect the recycle life of lithium ion cell; and another aspect is that the change of lattice parameter may narrow the channel for passing lithium ions, squeeze the space occupied by lithium ions, jam the channel of lithium ions, and decrease the recycle property of lithium ion cell.

2. The elevated charge cut-off voltage may decompose the electrolyte solution, and the loss of electrolyte solution renders the transportation of lithium ion more difficult, and thus the recycle life of cell is seriously affected.

Therefore, it can be seen that the limitation of charge voltage restricts the actual utilization of active electrode materials. Under this condition, even if new positive electrode material and negative electrode material having higher specific energy are developed, the lithium ion cell cannot exhibit the best performance. Hence, it is urgently needed to provide a method that can improve the efficacy of active substances of lithium ion cell, consequently increase the capacity and average operating voltage, and maintain the better cell performance simultaneously.

SUMMARY OF INVENTION

As to the common opinion in the art that increasing the charge cut-off voltage above 4.2 V may greatly shorten the recycle life, the inventor of the present invention conducted a large number of experiments and studies to elevate the charge cut-off voltage and the capacity of cell. Contrary to this opinion, the inventor unexpectedly found that the efficacy of electrode active materials is greatly increased by increasing the charge cut-off voltage and properly adjusting the ratio of positive electrode material to negative electrode material of single lithium ion cell. Consequently, the specific energy, capacity and average operating voltage of secondary lithium ion cell or battery are improved, while the performance of cell is substantially not changed. The present invention is fulfilled based on the aforesaid discovery.

It is one object of the present invention to provide a new method for improving capacity, average operating voltage and energy density of a secondary lithium ion cell or battery, wherein the charge cut-off voltage of the singe cell is greater than 4.2 V, and less than 5.8 V, and the ratio of positive electrode material to negative electrode material of the single cell is from 1:1.0 to 1:2.5, preferably from 1:1.15 to 1:2.5, as calculated by the specific capacity with the charge voltage limited to 4.2 V.

Another object of the present invention is to provide a secondary lithium ion cell or battery, wherein the single secondary lithium ion cell has an charge cut-off voltage of greater than 4.2 V but less than 5.8 V, and the ratio of positive electrode material to negative electrode material of the single cell is from 1:1.0 to 1:2.5, preferably from 1:1.15 to 1:2.5, as calculated by the specific capacity with the charge voltage limited to 4.2 V.

Yet another object of the present invention is to provide a protecting circuit adapted for the secondary lithium ion cell or battery, said protecting circuit having a first overcharging protection voltage of greater than 4.35 V, and an overcharge release voltage of greater than 4.15 V.

Yet another object of the present invention is to provide an electronic device using the secondary lithium ion cell or battery as power supply, said electronic device comprising a protecting circuit having a first overcharging protection voltage of greater than 4.35 V, and an overcharge release voltage of greater than 4.15 V.

Yet another object of the present invention is to provide a charging device for the secondary lithium ion cell or battery, said charging device controlling an charge cut-off voltage for the single lithium ion cell within the

range of greater than 4.3V but less than 5.8V, preferably within the range from 4.3V to 5.2V, and more preferably from 4.3V to 4.8V.

EMBODIMENTS FOR CARRYING OUT THE PRESENT INVENTION

Being contrary to the common opinion in the art that the charge cut-off voltage shall be controlled below 4.2 V, the present inventor unexpectedly found that the capacity, specific energy and average operating voltage of the secondary lithium ion cell or battery were notably improved with little cost and with the other properties substantially unchanged, when investigating the effect of the elevated charge cut-off voltage on the cell performances with a large number of experiments of gradually elevating the charge cut-off voltage and appropriately adjusting the ratio of the positive electrode to the negative electrode of the single lithium ion cell. In the present invention, "lithium ion cell or battery" means that the present invention can be applied to either a single lithium ion cell, or a single lithium ion cell comprising a protecting circuit, or a battery comprising a number of single lithium ion cells, or a battery comprising a number of single lithium ion cell and protecting circuits. For briefness, sometimes it may also be termed as "lithium ion cell". In addition, "theoretical capacities of positive electrode and negative electrode" means the capacities of the positive electrode and the negative electrode calculated with an charge cut-off voltage set at 4.2 V.

The present inventor studied the relation between the charge cut-off voltage and the cell properties of secondary lithium ion cell by gradually elevating the charge cut-off voltage. For example, in the formation test for the commercial secondary single lithium ion cells and the self made single secondary lithium ion cells, the inventor elevated the charge cut-off voltage from 4.2 V to 4.30 V, 4.35 V, 4.40 V, 4.45 V and 4.6 V, and the results showed that when the charge cut-off voltage is, 4.3 V, 4.35 V and 4.40 V, the specific energy of cell increases by 6-20% than that under the charge cut-off voltage of 4.2 V, and the cells still maintain excellent recycle property, e.g., the capacity maintains more than 95% after 50 cycles, and more than 80% after 300 cycles. However, when the charge cut-off voltage is 4.45 V or high, the specific energy increases by about 30%, but the cell exhibits inferior recycle property, e.g., the capacity maintains merely 83.9% after 6 cycles.

For investigating the reasons of poor recycle property when the charge cut-off voltage is 4.45 V or high, the inventor adjusted the ratio of positive electrode material to negative electrode material, i.e., said ratio was adjusted within the range from 1:1.3 to 1:2.5 calculated according to the theoretical capacity under the charge cut-off voltage of 4.2 V, and then the single lithium ion cell having the adjusted ratios were tested by

charging at an charge cut-off voltage of 4.45 V, 4.6 V, 4.8 V, 5.0 V, 5.2 V, 5.4 V, 5.6 V and 5.8 V, preferably said charging tests were conducted during the formation and test of the cells. Experimental results show that the specific energy was greatly increased under the charge cut-off voltage of 4.45 V or higher, and the corresponding recycle property was essentially not affected, when appropriate ratios of positive electrode material to negative electrode material were adopted.

In the present method, the elevating of the charge cut-off voltage is advantageously carried out during the formation and examination of the cell. The use of charge cut-off voltage of 4.20 V or high could increase the specific energy of cell, the capacity of positive electrode active material and the average operating voltage, and activate the cell so that the cell reaches its optimal working state with simultaneously achieving the effect of the formation, substantial improvement of the specific energy of commercial lithium ion cells, and imparting the competitiveness of lithium ion cells without altering the original process.

The mechanism of the above experimental results needs more researches. Without limited by any theory, the presumed reasons are as follows.

1. After the elevation of charge cut-off voltage, the amount of lithium ion dedoped from the positive electrode greatly increases, which renders an unmatched state to the original negative electrode material, and deposition of excessive lithium ions on the surface of negative electrode as metallic lithium, which jam part of the channel for passing lithium ions and result in the reduction of capacity and the deterioration of recycle property. The increase of the amount of negative electrode material meets the requirement of doping the relatively excessive lithium ions, and avoids the deposition of lithium ions on the surface of negative electrode as metallic lithium, and thus the maintaining properties (self-discharge properties) and recycle property are not affected. The suitable ratio of positive electrode material to negative electrode material will avoid the deposition of metallic lithium on the surface of negative electrode and the obstruction of channel for passing lithium ions, and consequently avoid the attenuation of capacity of cell. In particular, when the charge cut-off voltage of lithium ion cell is greater than 4.45 V, the negative electrode material of the ordinary commercial lithium ion cell is still more deficient, and the excessive lithium ions will deposit on the surface of negative electrode and form metallic lithium, which jams the channel for passing lithium ions and attenuates the capacity of cell. The great increase of content of negative electrode could reduce the attenuation of capacity of lithium ion

cell caused by the increase of recycle times. According to this viewpoint, the inventor performed a lot of experiments, and the results prove the aforesaid assumption (see the Examples).

2. Within a certain range of charge cut-off voltage, the decomposition of little electrolyte solution brings about negligible effect on the recycle property of cell. The electrolyte having a high decomposition potential or an additive increasing the decomposition potential of electrolyte solution may bring about better performance. The decomposition of electrolyte solution mainly occurs on the positive electrode. Although prior documents disclosed that the decomposition voltage of the electrolyte solution comprising $LiPF_6$ as electrolyte and the mixture of EC/DMC as solvent on the surface of aluminum foil is 4.2 V, according to the results of experiments, this factor essentially does not affect the recycle life of the currently commercialized lithium ion cell. Namely, even though the electrolyte solution decomposes under a voltage higher than 4.2 V, the electric energy is mainly converted into chemical energy and the electric energy involved in the decomposition of electrolyte is very little, thus, this decomposition of electrolyte can hardly affect the recycle life of the lithium ion cell. As to the voltages above the decomposition voltage, such as above 5.0 V, the substance A can be added into the electrolyte solution, or the electrolyte solution B having a higher decomposition voltage can be used. The decomposition potentials of the components of electrolyte solution commonly used in the art are depicted in Table 1. It can be seen that the lowest decomposition voltage of solvent is above 4.5 V.

Table 1. Decomposition potentials of various mixture electrolyte solutions

Solute	$LiClO_4$	$LiAsF_6$	$LiPF_6$
Mixture solvent	Decomposition potentials (V)	Decomposition potentials (V)	Decomposition potentials (V)
PC:DME	4.51	4.72	
PC:DEC	4.5	4.5	
PC:EC		4.5	
PC:EC:DME	4.5	4.62	
PC:DEC:2MLF		4.52	
EC:DEC		4.9	4.8
EC:DMC			4.9
B			5.9

3. As to the reason that the lithium ion cell does not appear attenuation of capacity caused by the change of structure as mentioned in the prior documents when the charge cut-off voltage is above 4.2 V, it may be due to that: after the ithium ions first intercalaton into anode, there is about 10% lithium ions which form a SEI film, so that the actual space of the lithium ions is more than the space that should be occupied by the lithium ions, i.e., the space available to the lithium ions exceeds about 10% of the space needed by the activated lithium ions, thus, although the elevation of the charge voltage changes the structure of positive electrode material, i.e., reduces the lattice parameter, the recycle life is not affected because the space occupied by the actually deintercalation and intercalation lithium ions is less than the space actually possessed by the positive electrode material, and thus the change of structure in a certain extent will not obstruct the dedoping and doping of lithium ions and will not affect the recycle life of cell. Using positive material more stable in structure with respect to the change of charge voltage exhibit better performance. Although the positive electrode generates inert substance poor in conductivity when overcharged, according to the results of experiments, it occurs only when the lithium ions completely dedoped. For example, as to lithium cobalt oxides, lithium nickel oxides, and doped lithium cobalt oxides and lithium nickel oxides, when they are charged with 3C5A current, the experimental data show that only when the voltage is about 6.20 V the lithium ions completely dedoped, with releasing a lot of oxygen, and forming an insulator. As to lithium manganese oxides and doped lithium manganese oxides, the lithium ions completely dedoped under the same charge current when the cell potential is about 6.50 V. Generally, the specific energy of positive electrode active substance actually used in the present commercialized lithium ion cell is far less than the theoretical capacity thereof, and even if the charge cut-off voltage is elevated up to 5.8 V, the theoretical capacity cannot be achieved under the proviso that suitable formulation is used, thus, the cell is not overcharged. Therefore, the present method still enjoys satisfactory safety.

4. Besides the aforementioned factors, the self-discharge of cell, the selection of current collector, and the formation of passive film all affect the recycle life of lithium ion cell, while these factors mainly depend on the preparation of lithium ion cell. It is believable that if the optimal processes are used, the capacity, average operating voltage and specific energy can be greatly improved, while the recycle life and other properties of the cell are not affected.

Hence, the present invention is to provide a novel method for effectively improving the specific energy and average operating voltage of secondary lithium ion cell or battery. Contrary to the prior art, the present method elevates the charge cut-off voltage to greater than 4.2 V but less than 5.8 V, and control the ratio of positive electrode material to negative electrode material of single lithium ion cell at 1:1.0 to 1:2.5 calculated by theoretical specific energy, so as to increase the efficacy of electrode active materials, to improve the capacity, energy density and output voltage of cell, and to maintain the performance of cell. For achieving the better effect, the charge cut-off voltage used in the present invention is preferably 4.3-5.2 V, and more preferably 4.2-4.8 V. In addition, the ratio of positive electrode material to negative electrode material of cell is 1:1.0 to 1:2.5 calculated by the theoretical capacity under the charge cut-off voltage of 4.2 V. The experiments showed that when the process parameters go beyond the aforesaid ranges, the properties of cell are deteriorated and unsuitable for use. When the ratio of positive electrode material to negative electrode material is less than 1.0 calculated by theoretical capacity, the recycle life of cell is excessively reduced, while when said ratio is greater than 2.5, the volume efficiency of cell is notably reduced. Further, when the charge cut-off voltage is greater than 5.8 V, the cell has inferior properties and is unsuitable for use.

It can be seen that the capacity, specific energy and average operating voltage of secondary lithium ion cell can be greatly improved by elevating the charge cut-off voltage and by appropriately adjusting the ratio of positive electrode material to negative electrode material calculated by the theoretical capacity, while the recycle property of cell is not affected, which renders the lithium ion cell possess more commercial value and broader application range. Hence, it can also be seen that the present method further optimizes the utilization of positive electrode material, and thus is an economical method. The inventors believe that the method can still be used to positive and negative electrode materials having higher specific energy developed in future, and achieves the optimal effect.

In addition, it is worthy to be noted that the used in the present method is not such that the cell works in extreme conditions. After repetitive experiments, the inventor never found that the present method increased the probability of damage of cell. Hence, the present method is also a safe method.

Further, the present invention further provides a novel secondary cell or battery having improved specific energy and average operating voltage. Contrary to the prior art, the charge cut-off voltage of the single cell

of said secondary cell or battery is greater than 4.2 V but less than 5.8 V, and the ratio of positive electrode material to negative electrode material calculated by the theoretical capacity under the charge cut-off voltage of 4.2 V is 1:1.0 to 1:2.5. As compared to the prior secondary lithium ion cell or battery cell, the capacity, energy density and output voltage of the present secondary lithium ion cell or battery are greatly improved, while its recycle life is equivalent to that of the prior art cell. For achieving better effect, the aforesaid charge cut-off voltage used in the present invention is preferably in the range from 4.3 V to 5.2 V, more preferably in the range from 4.3 V to 4.8 V. In addition, the ratio of positive electrode material to negative electrode material of said singe lithium ion cell, which is calculated by the theoretical capacity under the charge cut-off voltage of 4.2 V, is 1:1.5 to 1:2.5. Experiments showed that when the process parameters go beyond the aforesaid ranges, the properties of cell are deteriorated and unsuitable for use. When the ratio of positive electrode material to negative electrode material is less than 1.0 calculated by theoretical capacity, the recycle life of cell is excessively reduced, while when said ratio is greater than 2.5, the volume efficiency of cell is notably reduced. Further, when the charge cut-off voltage is greater than 5.8 V, the cell has inferior properties and is unsuitable for use.

Moreover, it is important that the present method not only can be used to the secondary lithium ion cell or battery of the present invention, but also can be used to the secondary lithium ion cell or battery prepared according to the method of the prior art, such as the present commercialized secondary lithium ion cell or battery.

Without limitation, the following contents more concretely introduce the secondary lithium ion cell used in the present method. Generally, a secondary lithium ion cell comprises a positive electrode, a negative electrode, a non-aqueous electrolyte, and a separator the positive electrode and the negative electrode. The non-aqueous electrolyte can be obtained by dissolving lithium-containing metal salt, such as $LiPF_6$, as electrolyte into a non-aqueous solvent, such as ethylene carbonate or dimethyl carbonate. The separator can be insoluble in said non-aqueous solvent, and is a porous membrane made of polyethylene or polypropylene resin. The ratio of positive electrode material to negative electrode material is calculated by theoretical capacity under the charge cut-off voltage of 4.2 V.

Positive electrode

The positive electrode is prepared e.g., by dispersing positive electrode active material, conducting agent and binder in a suitable solvent to form a suspension, coating said suspension on a current collector, such as aluminum foil, then drying and pressing the coated current collector by rollers.

The positive electrode active substance used in the present invention is lithium-containing compound. Although the examples use lithium cobalt oxides (lithium cobalt composite oxides), lithium manganese oxides and lithium nickel oxides as positive electrode material, it is understood that the practice of the present invention is not limited to the specific properties of said lithium-containing composite oxides, rather a wide range of positive electrode active substance can be used in the present invention. The common feature of these oxides is that their specific energy increases with the increase of voltage, and the experiments (see the examples) prove that the capacity of cell is greatly elevated when the charge cut-off voltage is above 4.20 V, while the other properties of cell are not affected. The present invention can also be used to lithium ion cells having doped lithium-containing compound as positive electrode active material, such as various positive electrode active materials containing various oxides and sulfides, such as lithium cobalt composite oxides, lithium manganese composite oxides, lithium nickel composite oxides, lithium nickel cobalt composite oxides, lithium manganese cobalt composite oxides, and vanadium oxides. Among these positive electrode materials, lithium cobalt composite oxides (such as $LiCoO_2$), lithium manganese composite oxides (such as $LiMn_2O_4$), lithium nickel composite oxides (such as $LiNiO_2$), lithium nickel cobalt composite oxides (such as $LiNi_{1-x}Co_xO_2$), and lithium manganese cobalt composite oxides (such as $LiMn_xCo_{1-x}O_2$), which have higher cell voltage, are preferably used. In addition, the present invention can use conventional conducting agent and binder, and the mixture ratio for each components in the positive electrode active material can be those well known in the art.

Separator

The separator used in the present invention is a separator well known in the art. For example, it can be a non-woven fabric made of synthetic resin, polyethylene porous membrane or polypropylene porous membrane, and a material formed by like materials.

Negative electrode

The negative electrode is prepared e.g., by dispersing negative electrode active material, conducting agent and binder in a suitable solvent to form a suspension, coating said suspension on a current collector, such as copper foil, nickel foil or stainless steel foil, then drying and pressing the coated current collector by rollers.

The negative electrode active material used in the present invention is a carbonaceous or non-carbonaceous substance capable of doping and dedoping lithium ion, including, such as, lithium alloy (such as $Li_4Ti_5O_{12}$), metal oxide (such as amorphous tin oxide, WO_2 and MoO_2), TiS_2 and carbonaceous substance capable of absorbing and desorbing lithium ions, and especially, the carbonaceous substance is the desired negative electrode active material.

The carbonaceous substance used in the present invention includes: graphite, non-oriented graphite, coke, carbon fiber, spherical carbon, carbon sintered from resin, carbon grown in gas phase, and carbon nanometer tube. Since the negative electrode comprising the aforesaid specific carbon fiber or spherical carbon exhibits high charge efficiency, mesophase asphalt based carbon fiber or mesophase asphalt based spherical carbon is preferably used as the carbonaceous substance. The mesophase asphalt based carbon fiber or mesophase asphalt based spherical carbon can be obtained according to the conventional method.

Without any specific restriction, non-aqueous electrolytes and shells of the type well known in the art can be used in the present invention. For example, use can be made of non-aqueous electrolyte is a liquid non-aqueous electrolyte prepared by dissolving electrolyte in a non-aqueous solvent, a gel non-aqueous electrolyte prepared by mixing polymer, non-aqueous solvent and solute, or a solid polymer non-aqueous electrolyte, etc.

The cell structure can be a helical structure formed by wrapping anode and cathode with a separator inbetween, or a laminate structure formed by stacking anode and cathode with a separator inbetween, but the structure of cell is not limited to a certain shape, and it can be cylinder shape, prism shape, coin shape, button shape and so on.

Except voltage, all process parameters for charge and discharge are commonly used in the art.

Since the voltage used in the present invention is higher than the voltage currently used in the art, the necessary modification is made to the protecting circuit or relevant devices and equipments comprising said circuit which are used in the present method and for the present secondary lithium ion cell. The type and structure of the protecting circuit for said secondary lithium ion cell or battery shall not be specifically restricted, i.e., the well known structure can be used, provided that the first overcharging protection voltage is greater than 4.35 V, and the overcharge release voltage is greater than 4.15 V, preferably the first overcharging protection voltage is greater than 4.45 V, and the overcharge release voltage is greater than 4.25 V.

In addition, the electronic device of the present invention using a secondary lithium ion cell or battery as energy source shall not be specifically limited. The device can be a common structure, provided that said electronic device containing a single lithium ion cell having a first overcharging protection voltage of greater than 4.35 V, and an overcharge release voltage of greater than 4.15 V, preferably a first overcharging protection voltage of greater than 4.45 V, and the overcharge release voltage of greater than 4.25 V. The electronic device of the present invention includes: notebook type computer, PDA, electromotive bicycle, and electromotive automobile etc.

Similarly, the charging device for the secondary lithium ion cell or battery of the present invention can be a charging device having any type and structure with the proviso that said charging device controls the charge cut-off voltage of the single lithium ion cell within a range from 4.3V to 5.8V, preferably from 4.3V to 5.2V, more preferably from 4.3V to 4.8V.

EXAMPLES

The present invention is described in detail hereinafter according to the results of specific experiments.

Preparation of single lithium ion cell

In one of examples of the present invention, the process for preparing the single lithium ion cell is described as follows.

Said single lithium ion cell uses copper foil as current collector of negative electrode, aluminum foil as current collector of positive electrode, lithium cobalt oxides as positive electrode active substance, and MCMB as negative electrode active substance. The type of cell is prismatic 653466. The lithium cobalt oxides is mixed with 7% PVDF as binder and 5% conductive carbon black, and then is added into NMP solvent in a ratio of 1:1. The negative electrode material is directly mixed with 10% PVDF as binder in a ratio of 1:1 to form a slurry. The positive electrode slurry is coated on the positive electrode current collector, and the negative electrode slurry is coated on the negative electrode current collector, and then they are dried and pressed, and treated by coating. The coating slurry for the positive electrode is prepared by dissolving a mixture of carbonaceous material and PVDF in an organic solvent, which is coated on the dried positive electrode. The coated positive electrode is pressed and baked again.

The dried positive electrode and negative electrode are connected to a lead, and a separator made of PP is inserted between them. After being wrapped by a winder to form an assembly, and this assembly is mounted into a cell shell made of aluminum or steel material. The shell and the cover are soldered together by laser soldering. An electrolyte solution is injected into the cell under relative humidity less than 1.5%, wherein said electrolyte solution contains a mixture solvent of EC:DEC:DMC = 1:1:1, and an electrolyte of 1M $LiPF_6$. The cell is immediately sealed after the injection.

Example 1

Several lithium ion cells of quadrate type 653466 are prepared according to the above method, and they each have a ratio of positive electrode material to negative electrode material of 1:1.0, 1:1.05, 1:1.1, 1:1.15, 1:1.2, 1:1.25 and 1:1.3. After formation and test using an charge cut-off voltage of 4.20 V, these cells have an arithmetic mean capacity of 1113 mAh, a weight specific energy of 102 Wh/kg, an average operating voltage of 3.70 V, and maintain 85.72% of capacity after 400 recycles.

Example 2

Several lithium ion cells of quadrate type 653466 are prepared according to the above method, and they each have a ratio of positive electrode material to negative electrode material of 1:1.0, 1:1.05, 1:1.1, 1:1.15, 1:1.2, 1:1.25 and 1:1.3. After formation and test using an charge cut-off voltage of 4.30 V, these cells have an arithmetic mean capacity of 1206 mAh, a weight specific energy of 113 Wh/kg, an average operating

voltage of 3.75 V, and maintain 86.31% of capacity after 400 recycles.

Example 3

Several lithium ion cells of quadrate type 653466 are prepared according to the above method, and they each have a ratio of positive electrode material to negative electrode material of 1:1.0, 1:1.05, 1:1.1, 1:1.15, 1:1.2, 1:1.25 and 1:1.3. After formation and test using an charge cut-off voltage of 4.35 V, these cells have an arithmetic mean capacity of 1253 mAh, a weight specific energy of 119 Wh/kg, an average operating voltage of 3.8 V, and maintain 84.79% of capacity after 400 recycles.

Example 4

Several lithium ion cells of quadrate type 653466 are prepared according to the above method, and they each have a ratio of positive electrode material to negative electrode material of 1:1.0, 1:1.05, 1:1.1, 1:1.15, 1:1.2, 1:1.25 and 1:1.3. After formation and test using an charge cut-off voltage of 4.40 V, these cells have an arithmetic mean capacity of 1302 mAh, a weight specific energy of 123 Wh/kg, an average operating voltage of 3.80 V, and maintain 83.93% of capacity after 400 recycles.

Example 5

Lithium ion cells of quadrate type 653466 are prepared according to the above method, and it has a ratio of positive electrode material to negative electrode material of 1:1.45. After formation and test using an charge cut-off voltage of 4.45 V, said cell has a capacity of 1365 mAh, a weight specific energy of 129 Wh/kg, an average operating voltage of 3.85 V, and maintain 84.56% of capacity after 400 recycles.

Example 6

Lithium ion cells of quadrate type 653466 are prepared according to the above method, and it has a ratio of positive electrode material to negative electrode material of 1:1.60. After formation and test using an charge cut-off voltage of 4.60 V, said cell has a capacity of 1692 mAh, a weight specific energy of 165 Wh/kg, an average operating voltage of 3.9 V, and maintain 85.13% of capacity after 400 recycles.

Example 7

Lithium ion cells of quadrate type 653466 are prepared according to the above method, and it has the ratio of positive electrode material to negative electrode material of 1:1.7. After formation and test using an

charge cut-off voltage of 4.80 V, said cell has a capacity of 1824 mAh, a weight specific energy of 178 Wh/kg, an average operating voltage of 3.9 V, and maintain 83.92% of capacity after 400 recycles.

Example 8

Lithium ion cells of quadrate type 653466 are prepared according to the above method, and it has the ratio of positive electrode material to negative electrode material of 1:1.9, wherein the substance A having high decomposition potential is added, or the electrolyte solution B having high decomposition potential is used. After formation and test using an charge cut-off voltage of 5.00 V, said cell has a capacity of 1894 mAh, a weight specific energy of 186 Wh/kg, an average operating voltage of 3.93 V, and maintain 81.23% of capacity after 400 recycles.

Example 9

Lithium ion cells of quadrate type 653466 are prepared according to the above method, wherein 15% of another lithium-containing compound C is added into the positive electrode slurry, and the ratio of positive electrode material to negative electrode material is 1:2.2. After formation and test using an charge cut-off voltage of 5.20 V, said cell has a capacity of 1962 mAh, a weight specific energy of 194 Wh/kg, an average operating voltage of 3.96 V, and maintain 81.19% of capacity after 400 recycles.

Example 10

Lithium ion cells of quadrate type 653466 are prepared according to the above method, wherein 15% of another lithium-containing compound C is added into the positive electrode slurry, and the ratio of positive electrode material to negative electrode material is 1:2.3. After formation and test using an charge cut-off voltage of 5.40 V, said cell has a capacity of 1968 mAh, a weight specific energy of 195 Wh/kg, an average operating voltage of 3.96 V, and maintain 81.19% of capacity after 400 recycles.

Example 11

Lithium ion cells of quadrate type 653466 are prepared according to the above method, wherein 15% of another lithium-containing compound C is added into the positive electrode slurry, and the ratio of positive electrode material to negative electrode material is 1:2.4. After formation and test using an charge cut-off voltage of 5.60 V, said cell has a capacity of 1970 mAh, a weight specific energy of 195 Wh/kg, an average

operating voltage of 3.96 V, and maintain 79.97% of capacity after 400 recycles.

Example 12

Lithium ion cells of quadrate type 653466 are prepared according to the above method, wherein 15% of another lithium-containing compound C is added into the positive electrode slurry, and the ratio of positive electrode material to negative electrode material is 1:2.5. After formation and test using an charge cut-off voltage of 5.80 V, said cell has a capacity of 1972 mAh, a weight specific energy of 195 Wh/kg, an average operating voltage of 3.96 V, and maintain 78.82% of capacity after 400 recycles.

Example 13

Lithium ion cells of quadrate type 653466 are prepared according to the above method, wherein 15% of another lithium-containing compound C is added into the positive electrode slurry, and the ratio of positive electrode material to negative electrode material is 1:2.6. After formation and test using an charge cut-off voltage of 5.90 V, said cell has a capacity of 1565 mAh, and maintain 12.31% of capacity after 15 cycles.

It can be seen from the above examples that when the charge voltage is elevated above 4.2 V, the capacity, operating voltage and weight specific energy increase with the elevation of the charge voltage; and when the charge voltage is elevated above 4.45 V, the capacity, operating voltage and weight specific energy continuously further increase with the elevation of the charge voltage and of the ratio of positive electrode material to negative electrode material; but when the charge voltage is greater than 5.8 V, the properties of cell decrease.

Examples 14-18

Using lithium manganese oxide as positive electrode active material, Lithium ion cells are prepared according to the aforesaid method, wherein the positive electrode slurry consists of 4 g lithium manganese oxide, 0.6 g carbon black, 0.32 g PVDF, and 4.92 g NMP, and the negative electrode slurry consists of 2.6 g MCMB, 0.26 g PVDF, and 3.0 g NMP. The cell is a quadrate type 653466 lithium ion cell. The data of experiments are depicted in Table 2.

Table 2

Example	Charge cut-off voltage (V)	Processing change	Recycle property	Capacity (mAh)
14	4.20	--	Maintaining 84.23% after 400 recycles	375
15	4.30	--	Maintaining 85.12% after 400 recycles	405
16	4.60	The ratio of positive electrode material to negative electrode material is 1:1.6.	Maintaining 83.45% after 400 recycles	575
17	5.80	The ratio of positive electrode material to negative electrode material is 1:2.5, and substance A is added into the electrolyte solution.	Maintaining 82.83% after 400 recycles	567
18	5.90	The ratio of positive electrode material to negative electrode material is 1:2.7, and substance A is added into the electrolyte solution.	Maintaining 54.23% after 30 cycles	312

Examples 14-18 show that when using lithium manganese oxide as positive electrode active material, the cells obtain the results similar to that of examples 1-13. Namely, when the charge voltage is elevated above 4.2 V, the capacity, operating voltage and weight specific energy increase with the elevation of the charge voltage; and when the charge voltage is elevated above 4.45 V, the capacity, operating voltage and weight specific energy continuously increase with the elevation of the charge voltage and of the ratio of positive electrode material to negative electrode material; but when the charge voltage is greater than 5.8 V, the properties of cell decrease.

Examples 19-23

Using lithium nickel oxide as positive electrode active material, Secondary lithium ion cells are prepared according to the aforesaid method for preparing the lithium ion cells using lithium cobalt oxide as positive electrode active material, wherein the positive electrode slurry consists of 4 g lithium nickel oxide, 0.2 g

carbon black, 0.2 g PVDF, and 4.80 g NMP, and the negative electrode slurry consists of 3.5 g MCMB, 0.35 g PVDF, and 4.0 g NMP. The cell is a quadrate type 063048 lithium ion cell. The data of experiments are depicted in Table 3.

Table 3

Example	Charge cut-off voltage (V)	Processing change	Recycle property	Capacity (mAh)
19	4.20	--	Maintaining 81.23% after 400 recycles	610
20	4.30	--	Maintaining 80.72% after 400 recycles	675
21	4.60	The ratio of positive electrode material to negative electrode material is 1:1.6.	Maintaining 78.32% after 400 recycles	912
22	5.80	The ratio of positive electrode material to negative electrode material is 1:2.5, and substance A is added into the electrolyte solution.	Maintaining 75.83% after 400 recycles	879
23	5.90	The ratio of positive electrode material to negative electrode material is 1:2.7, and substance A is added into the electrolyte solution.	Maintaining 47.53% after 50 cycles	796

Examples 19-23 show that when using lithium nickel oxide as positive electrode active material, the cells obtain the results similar to those of examples 1-16. Namely, when the charge voltage is elevated above 4.2 V, the capacity, operating voltage and weight specific energy increase with the elevation of the charge voltage; and when the charge voltage is elevated above 4.45 V, the capacity, operating voltage and weight specific energy continuously increase with the elevation of the charge voltage and of the ratio of positive electrode material to negative electrode material; but when the charge voltage is greater than 5.8 V, the properties of cell decrease.

Examples 24-28

Using cobalt-doping lithium nickel oxide as positive electrode active material, a secondary lithium ion cell is prepared according to the aforesaid method for preparing the secondary lithium ion cells using lithium cobalt oxide as positive electrode active material, wherein the positive electrode slurry consists of 4 g lithium nickel oxide, 0.2 g carbon black, 0.2 g PVDF, and 4.80 g NMP, and the negative electrode slurry consists of 3.5 g MCMB, 0.35 g PVDF, and 4.0 g NMP. The cell is a quadrate type 063048 lithium ion cell. The data of experiments are depicted in Table 4.

Table 4

Example	Charge cut-off voltage (V)	Processing change	Recycle property	Capacity (mAh)
24	4.20	--	Maintaining 81.23% after 400 recycles	623
25	4.30	--	Maintaining 80.72% after 400 recycles	682
26	4.60	The ratio of positive electrode material to negative electrode material is 1:1.6.	Maintaining 78.32% after 400 recycles	934
27	5.80	The ratio of positive electrode material to negative electrode material is 1:2.5, and substance A is added into the electrolyte solution.	Maintaining 75.83% after 400 recycles	919
28	5.90	The ratio of positive electrode material to negative electrode material is 1:2.7, and substance A is added into the electrolyte solution.	Maintaining 39.53% after 50 cycles	697

Examples 24-28 show that when using cobalt-doping lithium nickel oxide as positive electrode active material, the cells obtain the results similar to those of examples 1-21. Namely, when the charge voltage is elevated above 4.2 V, the capacity, operating voltage and weight specific energy increase with the elevation of the charge voltage; and when the charge voltage is elevated above 4.45 V, the capacity, operating voltage and

weight specific energy continuously increase with the elevation of the charge voltage and of the ratio of positive electrode material to negative electrode material; but when the charge voltage is greater than 5.8 V, the properties of cell decrease. In the meantime, these results indicate that the present method is not limited to some specific lithium-containing composite oxides as positive electrode material, but can be widely used in various secondary lithium ion cells.

The present method can be used in the production of lithium ion cell and for improvement of relevant products in the following aspects.

1. After adjustment of ratio of positive electrode material to negative electrode material so that the single lithium ion cell obtains the optimal capacity calculated by theoretical specific energy, a secondary lithium ion cell having high capacity and excellent recycle property can be obtained by controlling the charge cut-off voltage within a range from 4.2 V to 5.8 V during the formation and test of the cell. The merits of this method lie in that the specific energy and average operating voltage are greatly improved without substantially increasing the cost and simultaneously with the effects that the original formation process should achieve. Thus, as to the manufacturer of lithium ion cell, the profit margin and the competitiveness of enterprise are improved; and as to the products using lithium ion cells, their performances are improved with the increase of capacity and average operating voltage of the lithium ion cells.

2. The protecting circuit of single secondary lithium ion cell based on the present invention possesses an overcharge release voltage of greater than 4.15 V, and an overcharge first protection voltage of greater than 4.35 V.

3. The single lithium ion cell prepared according to the present invention can combine with the aforesaid protecting circuit having the technical features of the present invention and form a secondary lithium ion cell or battery.

4. The protecting circuit having the technical features of the present invention can be used in a mobile electronic device and product having a secondary lithium ion cell or battery as energy source.

The technology of the present invention possesses a great commercial value for improving the capacity,

average operating voltage and specific energy of the secondary lithium ion cell, and makes a certain contribution to the research of the basic theory of lithium ion cell. It is believable that the present technology could improve the development of the whole secondary lithium ion cell industry.

CLAIMS:

1. A secondary lithium ion cell or battery, characterized in that the single secondary lithium ion cell has a charge cut-off voltage of greater than 4.2 V but less than 5.8 V, and the ratio of positive electrode material to negative electrode material of the single cell is from 1:1.0 to 1:2.5, as calculated by the theoretic capacity with the charge cut-off voltage set at 4.2 V.

2. A protecting circuit for the secondary lithium ion cell or battery according to claim 1, characterized in that the single lithium ion cell of said protecting circuit has a first overcharge protection voltage of greater than 4.35 V, and an overcharging protection release voltage of greater than 4.15 V.

3. A protecting circuit according to claim 2, characterized in that the single lithium ion cell of said protecting circuit has a first overcharge protection voltage of greater than 4.45 V, and an overcharge protection release voltage of greater than 4.25 V.

4. An electronic device using a secondary lithium ion cell or battery as energy source, characterized in that said electronic device comprises a protecting circuit, wherein the single lithium ion cell has a first overcharging protection voltage of greater than 4.35 V, and an overcharge protection release voltage of greater than 4.15 V.

5. An electronic device according to claim 4, characterized in that said electronic device comprises a protecting circuit, wherein the single lithium ion cell has a first overcharging protection voltage of greater than 4.45 V, and an overcharge protection release voltage of greater than 4.25 V.

6. A charging device for a secondary lithium ion cell or battery, characterized in that said charging device controls a charge cut-off voltage to the single lithium ion cell within the range of greater than 4.3 V but less than 5.8 V.

7. A charging device according to claim 6, characterized in that said charging device controls a charge cut-off voltage to the single lithium ion cell within the range from 4.3 V to 5.2 V.

8. A charging device according to claim 6, characterized in that said charging device controls a charge cut-off voltage to the single lithium ion cell within the range from 4.3 V to 4.8 V.

ABSTRACT

The present invention provides a new method for improving capacity, average operating voltage and specific energy of a secondary lithium ion cell or battery. This method is achieved by means of properly adjusting the ratio between a positive material and negative material, which is calculated by theoretical specific energy, and properly increasing charge cut-off voltage. The present method can greatly increasing specific energy and average operating voltage of a secondary lithium ion cell without influence on recycle property of the cell. The present invention also provides a secondary lithium ion cell or battery practicing the method, a protecting circuit adapted for the secondary lithium ion cell or battery, a electronic device using said protecting circuit and said secondary lithium ion cell or battery, and a charging device for the secondary lithium ion cell or battery.

IEC 020210 PUS.

Atty. Dkt. No. 042787-0106

DECLARATION AND POWER OF ATTORNEY

As a below named inventor, I HEREBY DECLARE:

THAT my residence, post office address, and citizenship are as stated below next to my name;

THAT I believe I am the original, first, and sole inventor (if only one inventor is named below) or an original, first, and joint inventor (if plural inventors are named below or in an attached Declaration) of the subject matter which is claimed and for which a patent is sought on the invention entitled

SECONDARY LITHIUM ION CELL OR BATTERY, AND PROTECTING CIRCUIT, ELECTRONIC DEVICE AND CHARGING DEVICE OF THE SAME

(Attorney Docket No. 042787-0106)

the specification of which (check one)

___ is attached hereto.

_X_ was filed on 9/28/2002 as United States Application Number or PCT International Application Number PCT/CN02/00696 and was amended on _____ (if applicable).

THAT I do not know and do not believe that the same invention was ever known or used by others in the United States of America, or was patented or described in any printed publication in any country, before I (we) invented it;

THAT I do not know and do not believe that the same invention was patented or described in any printed publication in any country, or in public use or on sale in the United States of America, for more than one year prior to the filing date of this United States application;

THAT I do not know and do not believe that the same invention was first patented or made the subject of an inventor's certificate that issued in any country foreign to the United States of America before the filing date of this United States application if the foreign application was filed by me (us), or by my (our) legal representatives or assigns, more than twelve months (six months for design patents) prior to the filing date of this United States application;

THAT I have reviewed and understand the contents of the above-identified specification, including the claim(s), as amended by any amendment specifically referred to above;

THAT I believe that the above-identified specification contains a written description of the invention, and of the manner and process of making and using it, in such full, clear, concise, and exact terms as to enable any person skilled in the art to which it pertains, or with which it is most nearly connected, to make and use the invention, and sets forth the best mode contemplated by me of carrying out the invention; and

THAT I acknowledge the duty to disclose to the U.S. Patent and Trademark Office all information known to me to be material to patentability as defined in Title 37, Code of Federal Regulations, §1.56.

I HEREBY CLAIM foreign priority benefits under Title 35, United States Code §119(a)-(d) or § 365(b) of any foreign application(s) for patent or inventor's certificate, or §365(a) of any PCT international application which designated at least one country other than the United States of America, listed below and have also identified below any foreign application for patent or inventor's certificate or of any PCT international application having a filing date before that of the application on which priority is claimed.

Prior Foreign Application Number	Country	Foreign Filing Date	Priority Claimed?	Certified Copy Attached?
01141615.7	China P.R.	9/28/2001	YES	No

I HEREBY CLAIM the benefit under Title 35, United States Code § 119(e) of any United States provisional application(s) listed below.

U.S. Provisional Application Number	Filing Date

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U.S. Parent Application Number	PCT Parent Application Number	Parent Filing Date	Parent Patent Number

I HEREBY APPOINT the registered ~~attorneys and agents~~ at Customer Number 22428

Customer Number: 22428

to have full power to prosecute this application and any continuations, divisions, reissues, and reexaminations thereof, to receive the patent, ~~and to transact~~ all business in the United States Patent and Trademark Office connected therewith.

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I UNDERSTAND AND AGREE THAT the foregoing attorneys and agents appointed by me to prosecute this application do not personally represent me or my legal interests, but instead represent the interests of the legal owner(s) of the invention described in this application.

I FURTHER 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 issuing thereon.

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First Named Inventor/Applicant Name:	Xiaoping REN
Filer:	Stephen A. Bent
Attorney Docket Number:	042787-0109
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Basic Filing:				
Utility filing Fee (Electronic filing)	4011	1	82	82
Utility Search Fee	2111	1	270	270
Utility Examination Fee	2311	1	110	110
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Miscellaneous:				
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PTO/SB/06 (12-04)

Date: **06/16/10**

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PATENT APPLICATION FEE DETERMINATION RECORD
Substitute for Form PTO-875

Application or Docket Number: **12/817,028**

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	**82**		N/A	
SEARCH FEE (37 CFR 1.16(k), (i), or (m))	N/A	N/A	N/A	**270**		N/A	
EXAMINATION FEE (37 CFR 1.16(o), (p), or (q))	N/A	N/A	N/A	**110**		N/A	
TOTAL CLAIMS (37 CFR 1.16(i))	**8** minus 20 =		x$26		OR	x$52	
INDEPENDENT CLAIMS (37 CFR 1.16(h))	**3** minus 3 =	*	x$110			x$220	
APPLICATION SIZE FEE (37 CFR 1.16(s))	If the specification and drawings exceed 100 sheets of paper, the application size fee due is $270 ($135 for small entity) for each additional 50 sheets or fraction thereof. See 35 U.S.C. 41(a)(1)(G) and 37 CFR						
MULTIPLE DEPENDENT CLAIM PRESENT (37 CFR 1.16(j))			195			390	
			TOTAL	**462**		TOTAL	

* If the difference in column 1 is less than zero, enter "0" in column 2.

APPLICATION AS AMENDED – PART II

AMENDMENT A

	(Column 1) CLAIMS REMAINING AFTER AMENDMENT		(Column 2) HIGHEST NUMBER PREVIOUSLY PAID FOR	(Column 3) PRESENT EXTRA	SMALL ENTITY RATE ($)	SMALL ENTITY ADDITIONAL FEE ($)	OR	OTHER THAN SMALL ENTITY RATE ($)	OTHER THAN SMALL ENTITY ADDITIONAL FEE ($)
Total (37 CFR 1.16(i))	*	Minus	**	=	x =		OR	x =	
Independent (37 CFR 1.16(h))	*	Minus	***	=	x =		OR	x =	
Application Size Fee (37 CFR 1.16(s))									
FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j))					N/A		OR	N/A	
					TOTAL ADD'T FEE		OR	TOTAL ADD'T FEE	

AMENDMENT B

	(Column 1) CLAIMS REMAINING AFTER AMENDMENT		(Column 2) HIGHEST NUMBER PREVIOUSLY PAID FOR	(Column 3) PRESENT EXTRA	RATE ($)	ADDITIONAL FEE ($)	OR	RATE ($)	ADDITIONAL FEE ($)
Total (37 CFR 1.16(i))	*	Minus	**	=	x =		OR	x =	
Independent (37 CFR 1.16(h))	*	Minus	***	=	x =		OR	x =	
Application Size Fee (37 CFR 1.16(s))									
FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j))					N/A		OR	N/A	
					TOTAL ADD'T FEE		OR	TOTAL ADD'T 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 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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