



(51) International Patent Classification:

H01M 10/0566 (2010.01) H01M 10/0569 (2010.01)
H01M 10/0568 (2010.01) H01M 10/0525 (2010.01)

(21) International Application Number:

PCT/US2023/085490

(22) International Filing Date:

21 December 2023 (21.12.2023)

(25) Filing Language:

English

(26) Publication Language:

English

(30) Priority Data:

63/435,658 28 December 2022 (28.12.2022) US

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(81) Designated States (*unless otherwise indicated, for every kind of national protection available*): AE, AG, AL, AM, AO, AT, AU, AZ, BA, BB, BG, BH, BN, BR, BW, BY, BZ, CA, CH, CL, CN, CO, CR, CU, CV, CZ, DE, DJ, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IQ, IR, IS, IT, JM, JO, JP, KE, KG, KH, KN, KP, KR, KW, KZ, LA, LC, LK, LR, LS, LU, LY, MA, MD, MG, MK, MN, MU, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PA, PE, PG, PH, PL, PT, QA, RO, RS, RU, RW, SA, SC, SD, SE, SG, SK, SL, ST, SV, SY, TH, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, WS, ZA, ZM, ZW.

(54) Title: LOCALIZED HIGH SALT CONCENTRATION ELECTROLYTE

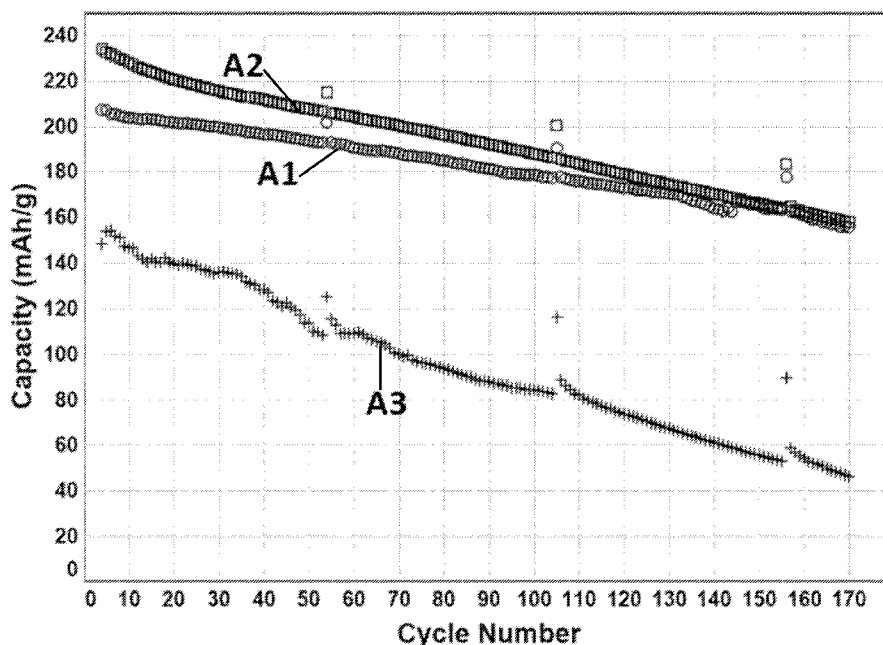


FIG. 1A

(57) Abstract: A battery includes a cathode comprising a disordered rocksalt structure and an electrolyte. The electrolyte includes a solvating solvent and a lithium salt that is soluble in the solvating solvent. The electrolyte includes a diluent that is miscible with the solvating solvent. The lithium salt is at least 5 times more soluble in the solvating solvent than in the diluent, and the solvating solvent and diluent are present in the battery at a diluent ratio/solvating solvent ratio of 0.1 to less than 3.0.





(84) **Designated States** (*unless otherwise indicated, for every kind of regional protection available*): ARIPO (BW, CV, GH, GM, KE, LR, LS, MW, MZ, NA, RW, SC, SD, SL, ST, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, RU, TJ, TM), European (AL, AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV, MC, ME, MK, MT, NL, NO, PL, PT, RO, RS, SE, SI, SK, SM, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, KM, ML, MR, NE, SN, TD, TG).

Published:

- *with international search report (Art. 21(3))*
- *before the expiration of the time limit for amending the claims and to be republished in the event of receipt of amendments (Rule 48.2(h))*

(88) **Date of publication of the international search report:**

08 August 2024 (08.08.2024)

INTERNATIONAL SEARCH REPORT

International application No.

PCT/US 23/85490

A. CLASSIFICATION OF SUBJECT MATTER

IPC - INV. H01M 10/0566, H01M 10/0568, H01M 10/0569 (2024.01)
ADD. H01M 10/0525 (2024.01)

CPC - INV. H01M 10/0566, H01M 10/0568, H01M 10/0569

ADD. H01M 10/0525

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)

See Search History document

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

See Search History document

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

See Search History document

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	US 2019/0148775 A1 (BATTELLE MEMORIAL INSTITUTE) 16 May 2019 (16.05.2019) entire document; especially para [0005]-[0009], para [0131]	1-16, 40, 41
Y	WO 2022/178271 A1 (MASSACHUSETTS INSTITUTE OF TECHNOLOGY) 25 August 2022 (25.08.2022) entire document; especially para [0077]	1-16
Y	US 2019/0229373 A1 (TOYOTA JIDOSHA KABUSHIKI KAISHA) 25 July 2019 (25.07.2019) entire document; especially para [0019]-[0020] 40, 41	40, 41
A	US 2022/0059816 A1 (WILDCAT DISCOVERY TECHNOLOGIES, INC.) 24 February 2022 (24.02.2022) entire document	1-16, 40, 41

☐ Further documents are listed in the continuation of Box C.

☐ See patent family annex.

* Special categories of cited documents:

"A" document defining the general state of the art which is not considered to be of particular relevance

"D" document cited by the applicant in the international application

"E" earlier application or patent but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

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

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

"&" document member of the same patent family

Date of the actual completion of the international search

06 May 2024

Date of mailing of the international search report

JUN 05 2024

Name and mailing address of the ISA/US

Mail Stop PCT, Attn: ISA/US, Commissioner for Patents
P.O. Box 1450, Alexandria, Virginia 22313-1450

Facsimile No. 571-273-8300

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INTERNATIONAL SEARCH REPORT

International application No.

PCT/US 23/85490

Box No. II Observations where certain claims were found unsearchable (Continuation of item 2 of first sheet)

This international search report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. ☐ Claims Nos.:
because they relate to subject matter not required to be searched by this Authority, namely:

2. ☐ Claims Nos.:
because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:

3. ☐ Claims Nos.:
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

Box No. III Observations where unity of invention is lacking (Continuation of item 3 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:
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 order for all inventions to be searched, the appropriate additional search fees must be paid.

Group I: Claims 1-16 are directed to a battery comprising a cathode comprising a disordered rocksalt structure.

Group II: Claims 17-36 are directed to a battery comprising a second lithium salt.

Group III: Claims 37-39 are directed to a method of forming an electrolyte.

Group IV: Claims 40 and 41 are directed to an electrolyte being a solution having a saturation point.

--see extra sheet

1. ☐ As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims.
2. ☐ As all searchable claims could be searched without effort justifying additional fees, this Authority did not invite payment of additional fees.
3. ☒ As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims for which fees were paid, specifically claims Nos.:
1-16, 40, 41
4. ☐ No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

Remark on Protest

- ☐ The additional search fees were accompanied by the applicant's protest and, where applicable, the payment of a protest fee.
- ☐ The additional search fees were accompanied by the applicant's protest but the applicable protest fee was not paid within the time limit specified in the invitation.
- ☒ No protest accompanied the payment of additional search fees.

INTERNATIONAL SEARCH REPORT

International application No.

PCT/US 23/85490

Continuation of Box No. III -- Observations where unity of invention is lacking:

The inventions listed as Groups I-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:

Special Technical Features

Group I includes the special technical feature of disordered rocksalt structure, not included in the other groups.

Group II includes the special technical feature of the second lithium salt being present in a concentration that is less than or equal to a concentration of the first lithium salt, not included in the other groups.

Group III includes the special technical feature of dissolving more of the first lithium salt or the second lithium salt to a concentration that exceeds an amount of the lithium salt soluble in the solvating solvent to form the electrolyte, not included in the other groups.

Group IV includes the special technical feature of the first and second lithium salts are present in an amount below the saturation point of the electrolyte and above the saturation point of the solvating solvent, not included in the other groups.

COMMON TECHNICAL FEATURES

The only technical feature shared by Groups I-IV that would otherwise unify the groups is an electrolyte comprising a solvating solvent, a lithium salt soluble in the solvating solvent, and a diluent. However, this shared technical feature does not represent a contribution over the prior art, because the shared technical feature is disclosed by US 2019/0148775 A1 to Battelle Memorial Institute (hereinafter "Battelle").

The only additional technical feature shared by Groups I, II and IV that would otherwise unify the groups is the lithium salt being at least 5 times more soluble in the solvating solvent than in the diluent. However, this shared technical feature does not represent a contribution over the prior art, because the shared technical feature is disclosed by Battelle.

The only additional technical feature shared by Groups I and II that would otherwise unify the groups is battery comprising a cathode, a diluent that is miscible in the solvating solvent, the solvating solvent and diluent being present in the battery at a diluent ratio/solvating solvent ratio of 0.1 to less than 3.0. However, this shared technical feature does not represent a contribution over the prior art, because the shared technical feature is disclosed by Battelle.

The only additional technical feature shared by Groups II-IV that would otherwise unify the groups is battery comprising a lithium salt comprised of a first lithium salt and a second lithium salt. However, this shared technical feature does not represent a contribution over the prior art, because the shared technical feature is disclosed by Battelle.

Battelle discloses a battery (para [0005]- in lithium ion batteries), comprising: a cathode (para [0005]- The system may further comprise a cathode.); and an electrolyte (para [0005]- the electrolyte), comprising: a solvating solvent (para [0005]- a nonaqueous solvent); a lithium salt comprised of a first lithium salt and a second lithium salt that are soluble in the solvating solvent (para [0005]-[0006]- an active salt comprising lithium cations... the active salt is soluble in the nonaqueous solvent...the active salt may comprise...LiPF₆, LiAsF₆, LiBF₄, LiCF₃SO₃, LiClO₄, lithium difluoro oxalato borate anion (LiDFOB), LiI, LiBr, LiCl, LiSCN, LiNO₃, LiNO₂, Li₂SO₄, or any combination thereof), and a diluent that is miscible in the solvating solvent (para [0005]- a diluent; para [0131]- the diluent is miscible with solvent A), the lithium salt being at least 5 times more soluble in the solvating solvent than in the diluent (para [0005]- the active salt has a solubility in the diluent at least 10 times less than a solubility of the active salt in the nonaqueous solvent.), and the solvating solvent and diluent being present in the battery at a diluent ratio/solvating solvent ratio of 0.1 to less than 3.0 (para [0009]- a molar ratio of EC-EMC to the diluent is within a range of from 1-3).

As the common features were known in the art at the time of the invention, they cannot be considered special technical features that would otherwise unify the groups.

Therefore, Groups I-IV lack unity under PCT Rule 13.