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(54) Title: SELF-FORMING SOLID STATE BATTERIES AND SELF-HEALING SOLID ELECTROLYTES

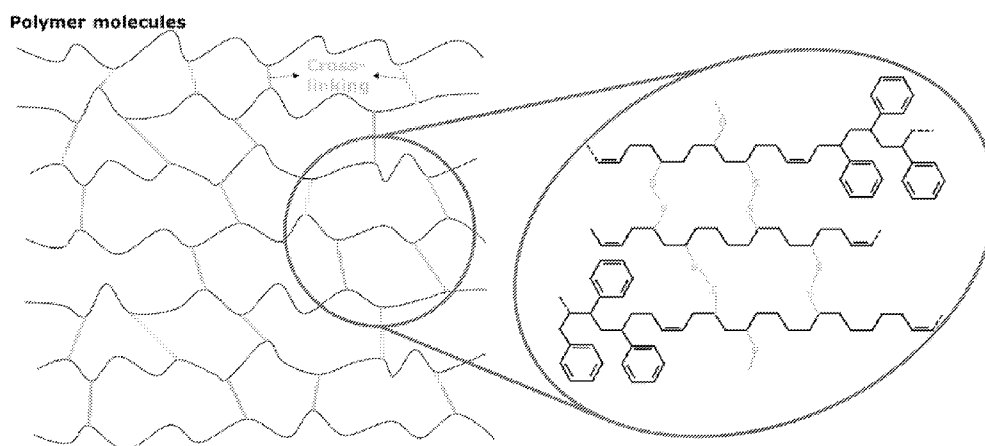


Fig. 1

(57) Abstract: Compositions, manufacturing processes, articles of manufacture, and structures/batteries for self-forming batteries and self-healing solid electrolytes are disclosed. Example embodiments include a self-forming battery. The battery may include a first electrode material and a second electrode material. Assembly of the two electrode materials may result in a chemical reaction that forms an electrolyte layer between the two electrode materials.





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, 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).

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INTERNATIONAL SEARCH REPORT

International application No.

PCT/US 18/36970

A. CLASSIFICATION OF SUBJECT MATTER

IPC(8) H01M 10/052, H01M 10/056, H01M 4/136 (2018.01)

CPC - H01M 10/052, H01M 10/056, H01M 10/0562, H01M 10/0565, H01M 10/0567, H01M 10/0568, H01M 10/0569, H01M 10/4242, H01M 4/136, Y10T 29/49108

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.
X --- A	US 2007/0048610 A1 (TSANG) 01 March 2007 (01.03.2007), para [0005], [0015], [0016]	1, 2, 5, 8 ----- 3, 4, 6, 7, 9-12
X --- A	US 4,278,746 A (SKARETAD et al.) 14 July 1981 (14.07.1981), col 4, ln 10-40	1, 2, 5, 8 ----- 3, 4, 6, 7, 9-12
A	US 2015/0303515 A1 (SEEO, INC.) 22 October 2015 (22.10.2015), entire document, especially	9-12
A	US 2016/0344008 A1 (SEEO, INC.) 24 November 2016 (24.11.2016), entire document	1-12

☐ 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

"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

25 December 2018

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07 JAN 2019

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INTERNATIONAL SEARCH REPORT

International application No.

PCT/US 18/36970

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 examined, the appropriate additional examination fees must be paid.

Group I: Claims 1-12 drawn to a self-forming battery.

Group II: Claims 13-16, drawn to a method of producing self-forming batteries.

Group III: Claims 17-20, drawn to a method of producing self-forming batteries.

-- 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.:
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.:
1-12

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 18/36970

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

The inventions listed in the above-mentioned groups 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 wherein assembly of the two electrode materials results in a chemical reaction that forms an electrolyte layer between the two electrode materials, not included in the other groups.

Group II includes the special technical feature of exposing a metal to a solution of an oxidant for a period of time and rendering the metal free from solvents, not included in the other groups.

Group III includes the special technical feature of disposing a solid electrolyte separator onto the solid electrolyte interphase and disposing activate material onto the solid electrolyte separator, not included in the other groups.

Common Technical Features:

The only technical feature shared by Groups I-III that would otherwise unify the groups, is a self-forming battery. However, this shared technical feature does not represent a contribution over prior art, because the shared technical feature is disclosed by WO 2017/023884 A1 to The Research Foundation for the State University of New York (hereinafter Research) 09 February 2017 (09.02.2017) .

Research discloses a self-forming battery (para [01]: dual- function secondary batteries formed by self-assembly).

As the common technical feature was known in the art at the time of the invention, this cannot be considered a special technical feature that would otherwise unify the groups.

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