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(71) Applicant: **TOYOTA MOTOR EUROPE** [BE/BE]; Avenue du Bourget 60, 1140 BRUSSELS (BE).

(72) Inventors: **KATO**, Yuki; c/o TOYOTA MOTOR EUROPE, European Technical Administration Division, Avenue du Bourget 60, 1140 BRUSSELS (BE). **HAUTIER**, Geoffroy; Avenue Prekelinden 90, 1200 BRUSSELS (BE). **MIGLIO**, Anna; Place de l'Equerre 61/301, 1348 LOUVAIN-LA-NEUVE (BE).

(74) Agent: **URBAIN**, Isabelle et al.; CABINET BEAU DE LOMENIE, 158 Rue de l'Université, 75340 PARIS CEDEX 07 (FR).

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HR, HU, ID, IL, IN, IR, IS, JO, JP, KE, KG, KH, KN, KP, KR, KW, KZ, LA, LC, LK, LR, LS, LU, LY, MA, MD, ME, MG, MK, MN, 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, SM, ST, SV, SY, TH, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW.

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ARIPO (BW, GH, GM, KE, LR, LS, MW, MZ, NA, RW, 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, 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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(54) Title: METHOD FOR PRODUCING SOLID ELECTROLYTE AND ELECTRODE FOR ALL-SOLID STATE BATTERIES

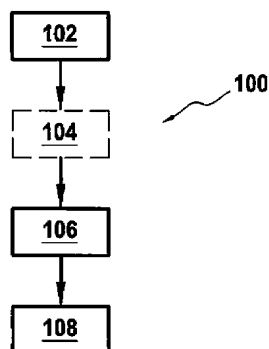


FIG.1

(57) Abstract: A method (100) for producing a sintered component being a solid electrolyte and/or an electrode including sulfur for an all-solid state battery, the method including mixing powders (102) so as to obtain a powder mixture, at least one of the powders comprising sulfur, pressing (106) a component with the powder mixture and sintering (108) the component under a partial pressure of sulfur comprised between 150 Pa and 0,2 MPa so as to obtain a sintered component comprising sulfur, the sintered component exhibiting the peaks in positions of $2\theta = 15,08^\circ (\pm 0,50^\circ)$, $15,28^\circ (\pm 0,50^\circ)$, $15,92^\circ (\pm 0,50^\circ)$, $17,5^\circ (\pm 0,50^\circ)$, $18,24^\circ (\pm 0,50^\circ)$, $20,30^\circ (\pm 0,50^\circ)$, $23,44^\circ (\pm 0,50^\circ)$, $24,48^\circ (\pm 0,50^\circ)$, and $26,66^\circ (\pm 0,50^\circ)$ in a X-ray diffraction measurement using $\text{CuK}\alpha$ line.



METHOD FOR PRODUCING SOLID ELECTROLYTE AND ELECTRODE FOR ALL-SOLID STATE BATTERIES

FIELD OF THE DISCLOSURE

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[0001] The present disclosure is related to all-solid state batteries, and more particularly to solid state batteries comprising a solid electrolyte and/or an electrode comprising sulfur.

10

BACKGROUND OF THE DISCLOSURE

[0002] All-solid state batteries offer the possibility of having a battery pack with high energy density.

[0003] Different materials are studied for solid electrolyte and/or electrode for all-solid state batteries. Of particular interest are materials comprising sulfur and exhibiting peaks in positions of $2\theta = 15,08^\circ (\pm 0,50^\circ)$, $15,28^\circ (\pm 0,50^\circ)$, $15,92^\circ (\pm 0,50^\circ)$, $17,5^\circ (\pm 0,50^\circ)$, $18,24^\circ (\pm 0,50^\circ)$, $20,30^\circ (\pm 0,50^\circ)$, $23,44^\circ (\pm 0,50^\circ)$, $24,48^\circ (\pm 0,50^\circ)$, and $26,66^\circ (\pm 0,50^\circ)$ in a X-ray diffraction measurement using $\text{CuK}\alpha$ line. These materials generally exhibit good lithium ionic conductivity.

[0004] However, increase of the lithium ionic conductivity of such materials is still required for application as solid electrolyte and/or electrode.

SUMMARY OF THE DISCLOSURE

25

[0005] Therefore, according to embodiments of the present disclosure, a method for producing a sintered component being a solid electrolyte and/or an electrode comprising sulfur for an all-solid state battery is provided. The method comprises:

- 30
- mixing powders so as to obtain a powder mixture, at least one of the powders comprising sulfur;
 - pressing a component with the powder mixture; and

- sintering the component under a partial pressure of sulfur comprised between 200 Pa and 0,2 MPa so as to obtain a sintered component comprising sulfur;

wherein the sintered component exhibits the peaks in positions of $2\theta =$
5 $15,08^\circ (\pm 0,50^\circ)$, $15,28^\circ (\pm 0,50^\circ)$, $15,92^\circ (\pm 0,50^\circ)$, $17,5^\circ (\pm 0,50^\circ)$, $18,24^\circ$
 $(\pm 0,50^\circ)$, $20,30^\circ (\pm 0,50^\circ)$, $23,44^\circ (\pm 0,50^\circ)$, $24,48^\circ (\pm 0,50^\circ)$, and $26,66^\circ$
 $(\pm 0,50^\circ)$ in a X-ray diffraction measurement using $\text{CuK}\alpha$ line.

[0006] Sintered components, i.e., solid electrolytes and/or electrodes
exhibiting peaks in positions of $2\theta = 15,08^\circ (\pm 0,50^\circ)$, $15,28^\circ (\pm 0,50^\circ)$, $15,92^\circ$
10 $(\pm 0,50^\circ)$, $17,5^\circ (\pm 0,50^\circ)$, $18,24^\circ (\pm 0,50^\circ)$, $20,30^\circ (\pm 0,50^\circ)$, $23,44^\circ (\pm 0,50^\circ)$,
 $24,48^\circ (\pm 0,50^\circ)$, and $26,66^\circ (\pm 0,50^\circ)$ in a X-ray diffraction measurement using
 $\text{CuK}\alpha$ line, generally exhibit good lithium ionic conductivity.

[0007] By providing such a method, it is possible to increase the lithium
ionic conductivity through the solid electrolyte and/or the electrode. Indeed, by
15 sintering the component under partial pressure of sulfur comprised between
200 Pa (Pascal) and 0,2 MPa, evaporation of the sulfur during sintering is
limited and the bulk density of the sintered component is increased. Therefore,
the porosity of the sintered component is reduced and the lithium ionic
conductivity of the sintered component is increased, i.e., the lithium ionic
20 conductivity of the solid electrolyte and/or of the electrode.

[0008] In some embodiments, the sintered component comprises $\text{XTi}_2(\text{PS}_4)_3$
and/or $\text{XZr}_2(\text{PS}_4)_3$, X being lithium (Li), sodium (Na) or silver (Ag).

[0009] In some embodiments, the partial pressure of sulfur is obtained by
evaporating solid sulfur.

25 [0010] In some embodiments, the component is placed in a container and
sealed under Argon at a pressure equal to or smaller than 100 Pa, preferably
equal to or smaller than 50 Pa.

[0011] In some embodiments, the partial pressure of sulfur is obtained from
a sulfur containing gas.

30 [0012] The sulfur containing gas may be a gas such as hydrogen sulfide,
carbon sulfide or phosphorous sulfide.

[0013] In some embodiments, the method comprises a step of amorphasizing the powder mixture so as to obtain an amorphasized powder mixture.

[0014] In some embodiments, sintering comprises a sintering plateau
5 temperature equal to or smaller than 500°C, preferably equal to or smaller than 400°C.

[0015] The powder mixture being amorphasized, the powder mixture is more reactive and sintering of the powder mixture may be obtained at temperature equal to or smaller than 500°C.

10 [0016] In some embodiments, sintering comprises a sintering plateau time equal to or smaller than 20 hours, preferably equal to or smaller than 10 hours.

[0017] The powder mixture being amorphasized, the powder mixture is more reactive and sintering of the powder mixture may be obtained with sintering plateau time equal to or smaller than 20 hours, preferably equal to or
15 smaller than 10 hours.

[0018] In some embodiments, sintering is a two-step sintering, a first sintering step under a partial pressure of sulfur comprised between 200 Pa and 0,2 MPa so as to obtain an intermediate product, the intermediate product being grinded so as to obtain a sintered powder, the sintered powder being
20 pressed and sintered during a second sintering step under a partial pressure of sulfur comprised between 200 Pa and 0,2 MPa.

[0019] In some embodiments, the component is pressed at a pressure equal to or greater than 25 MPa, preferably equal to or greater than 50 MPa, more preferably equal to or greater than 75 MPa, and equal to or smaller than
25 500 MPa, preferably equal to or smaller than 400 MPa, more preferably equal to or smaller than 300 MPa.

[0020] It is intended that combinations of the above-described elements and those within the specification may be made, except where otherwise contradictory.

30 [0021] It is to be understood that both the foregoing general description and the following detailed description are exemplary and explanatory only and are not restrictive of the disclosure, as claimed.

[0022] The accompanying drawings, which are incorporated in and constitute a part of this specification, illustrate embodiments of the disclosure and together with the description, serve to explain the principles thereof.

5

BRIEF DESCRIPTION OF THE DRAWINGS

[0023] Fig. 1 shows a first flow chart of the method according to embodiments of the present disclosure;

[0024] Fig. 2 shows a second flow chart of the method according to
10 embodiments of the present disclosure;

[0025] Fig. 3 shows a X-ray diffraction spectrum of a sample according to the present disclosure;

[0026] Fig. 4 shows a X-ray diffraction spectrum of a comparative sample.

15

DESCRIPTION OF THE EMBODIMENTS

[0027] Reference will now be made in detail to exemplary embodiments of the disclosure, examples of which are illustrated in the accompanying drawings. Wherever possible, the same reference numbers will be used throughout the
20 drawings to refer to the same or like parts.

[0028] Fig. 1 shows a representation of a first flow chart of the method according to embodiments of the present disclosure.

[0029] Sample 1 is a sample according to the present disclosure and Sample 2 is a comparative sample.

25 [0030] Sample 1 and Sample 2 are both $\text{LiTi}_2(\text{PS}_4)_3$ solid electrolyte or electrode.

[0031] Every experiment are done under the argon or under vacuum or under sulfur atmosphere so as never be in contact with air.

[0032] A method 100 for producing a solid electrolyte and/or an electrode
30 comprising sulfur for an all-solid state battery will be described in reference to Fig. 1, taking Sample 1.

[0033] In step 102, 0,0396 g (gram) of Li_2S , 0,5745 g of P_2S_5 and 0,3859 g of TiS_2 are mixed together so as to obtain a powder mixture. Li_2S (99%, lithium

sulphide, Sigma-Aldrich®), P_2S_5 (98%, phosphorous pentasulfide, Sigma-Aldrich®) and TiS_2 (99,9%, titanium disulphide, Sigma-Aldrich®) are powders having a degree of purity equal to or greater than 99 mass%.

[0034] In step 104, which is not a mandatory step, the powder mixture is
5 amorphasized in a planetary milling equipment (Fritsch, P7). The powder mixture was disposed in a zirconium pot of 45 mL (millilitre) content with 18 zirconium balls having a diameter of 10 mm (millimetre) under Argon. The powder mixture was amorphasized for 40 hours at 370 rpm (round per minute) so as to obtain amorphasized powder mixture.

10 [0035] In step 106, the amorphasized powder mixture is pressed at a pressure equal to or greater than 25 MPa, preferably equal to or greater than 50 MPa, more preferably equal to or greater than 75 MPa, and equal to or smaller than 500 MPa, preferably equal to or smaller than 400 MPa, more preferably equal to or smaller than 300 MPa.

15 [0036] For example 100 mg of the amorphasized powder mixture is pressed at 200 MPa so as to form a component.

[0037] In step 108, the component is sintered under a partial pressure of sulfur comprised between 150 Pa and 0,2 MPa so as to obtain a sintered component comprising sulfur.

20 [0038] For example, the 100 mg component is put into a glass tube with 5 mg flakes of sulfur from Sigma-Aldrich® (99,99%) and the glass tube is sealed under Argon under very low pressure, for example 30 Pa. The component is sintered at a plateau temperature of 400°C (degree Celsius) for a plateau temperature time of 8 hours so as to obtain a sintered component
25 comprising sulfur. Upon heating, the solid flakes of sulfur allow for a partial pressure of sulfur to be comprised between 200 Pa and 0,2 MPa in the sealed glass tube.

[0039] Alternatively, the partial pressure of sulfur comprised between 150 Pa and 0,2 MPa may be obtained from a sulfur containing gas such as
30 hydrogen sulfide (H_2S), carbon disulfide (CS_2) or phosphorous sulfide (P_xS_y , e.g. P_4S_3 , P_2S_3 or P_2S_5) in a closed container, such as a sealed glass tube or in an open container with gas flush.

[0040] As shown in Fig. 2, sintering step 108 may be a two-step sintering step. Sintering step 108 may comprise a first sintering step 110 under a partial pressure of sulfur comprised between 200 Pa and 0,2 MPa so as to obtain an intermediate product. The intermediate product is then grinded (step 112) so as to obtain a sintered powder, the sintered powder being pressed (step 114) and sintered during a second sintering step (116) under a partial pressure of sulfur comprised between 200 Pa and 0,2 MPa.

[0041] The pressure used in steps 106 and 114 may be different. The pressure used in steps 106 and 114 may be equal. However, the pressure in both steps 106 and 114 is equal to or greater than 25 MPa, preferably equal to or greater than 50 MPa, more preferably equal to or greater than 75 MPa, and equal to or smaller than 500 MPa, preferably equal to or smaller than 400 MPa, more preferably equal to or smaller than 300 MPa.

[0042] For example, the pressure in step 106 may be equal to 200 MPa and the pressure in step 114 may be equal to 100 MPa.

[0043] The sintering parameter in steps 110 and 116 may be different. The sintering parameter in steps 110 and 116 may be equal.

[0044] For example, in both steps 110 and 116, the temperature plateau may be equal to 400°C and the temperature plateau time may be equal to 8 hours, the sintered component of Sample 1 having therefore been sintered at 400°C for 16 hours under a partial pressure of sulfur comprised between 200 Pa and 0,2 MPa.

[0045] Sample 1 is obtained with the method of Fig. 2, with a two-step sintering.

[0046] The method for producing Sample 2 is similar to the method for producing Sample 1, except that the two-step sintering step is not carried out under a partial pressure of sulfur comprised between 200 Pa and 0,2 MPa but under a partial pressure of sulfur smaller than 150 Pa.

[0047] The pressed component is sintered at 400°C for 8 hours under a partial pressure of sulfur or smaller than 150 Pa, for example by sealing the component of Sample 2 in a glass tube under Argon under very low pressure, for example 30 Pa without flakes of sulfur. The sintered component of Sample 2

has therefore been sintered at 400°C for 16 hours under a partial pressure of sulfur smaller than 150 MPa.

[0048] Figs. 3 and 4 show X-ray diffraction spectra respectively of Sample 1 and Sample 2. As may be seen on Figs. 3 and 4, both Sample 1 and Sample 2 exhibit the peaks in positions of $2\theta = 15,08^\circ (\pm 0,50^\circ)$, $15,28^\circ (\pm 0,50^\circ)$, $15,92^\circ (\pm 0,50^\circ)$, $17,5^\circ (\pm 0,50^\circ)$, $18,24^\circ (\pm 0,50^\circ)$, $20,30^\circ (\pm 0,50^\circ)$, $23,44^\circ (\pm 0,50^\circ)$, $24,48^\circ (\pm 0,50^\circ)$, and $26,66^\circ (\pm 0,50^\circ)$ in a X-ray diffraction measurement using CuK α line.

[0049] However, Sample 1 has a bulk density of 1,65 g/cm³ whereas Sample 2 has a bulk density of 1,59 g/cm³.

[0050] Sample 1 and Sample 2 were each sandwiched between two SUS current collectors (Stainless steel, SUS301). Impedance of both Sample 1 and Sample 2 was measured using an impedance gain-phase analyser manufactured by Biologic. VMP3 manufactured by Biologic was used for the measurement as Frequency Response Analyzer (FRA). The measurements were started from a high-frequency range with an alternative voltage of 10 mV (millivolt) and a frequency range between 1 Hz (hertz) to 1 MHz.

[0051] The ionic conductivity of Sample 1 is equal to $6,3 \cdot 10^{-4}$ S/cm (Siemens per centimetre) whereas the ionic conductivity of Sample 2 is equal to $3,5 \cdot 10^{-4}$ S/cm.

[0052] Thus, by sintering under a partial pressure of sulfur comprised between 200 Pa and 0,2 MPa, the ionic conductivity of the sintered component, i.e., of the solid electrolyte and/or of the electrode, has been increased significantly.

[0053] Although Sample 1 was obtained with the method of Fig. 2, with a two-step sintering, similar results may be obtained with a single sintering step 108.

[0054] When the powder mixture is not amorphasized, i.e., when step 104 is not carried out, in step 106, the powder mixture is pressed at a pressure equal to or greater than 25 MPa, preferably equal to or greater than 50 MPa, more preferably equal to or greater than 75 MPa, and equal to or smaller than 500 MPa, preferably equal to or smaller than 400 MPa, more preferably equal to or smaller than 300 MPa.

[0055] For example 100 mg of the powder mixture is pressed at 200 MPa so as to form a component.

[0056] In step 108, the component is sintered under a partial pressure of sulfur comprised between 200 Pa and 0,2 MPa so as to obtain a sintered component comprising sulfur.

[0057] For example, the 100 mg component is put into a glass tube with 5 mg flakes of sulfur from Sigma-Aldrich® (99,99%) and the glass tube is sealed under Argon under very low pressure, for example 30 Pa. The component is sintered at a plateau temperature above 500°C (degree Celsius), for example 750°C for a plateau temperature time of 10 hours so as to obtain a sintered component comprising sulfur.

[0058] Alternatively, the partial pressure of sulfur comprised between 200 Pa and 0,2 MPa may be obtained from a sulfur containing gas such as hydrogen sulfide (H₂S), carbon disulfide (CS₂) or phosphorous sulfide (P_xS_y, e.g. P₄S₃, P₂S₃ or P₂S₅) in a closed container, such as a sealed glass tube or in an open container with gas flush.

[0059] Throughout the description, including the claims, the term "comprising a" should be understood as being synonymous with "comprising at least one" unless otherwise stated. In addition, any range set forth in the description, including the claims should be understood as including its end value(s) unless otherwise stated. Specific values for described elements should be understood to be within accepted manufacturing or industry tolerances known to one of skill in the art, and any use of the terms "substantially" and/or "approximately" and/or "generally" should be understood to mean falling within such accepted tolerances.

[0060] Although the present disclosure herein has been described with reference to particular embodiments, it is to be understood that these embodiments are merely illustrative of the principles and applications of the present disclosure.

[0061] It is intended that the specification and examples be considered as exemplary only, with a true scope of the disclosure being indicated by the following claims.

CLAIMS

1. A method (100) for producing a sintered component being a solid electrolyte and/or an electrode comprising sulfur for an all-solid state battery, the method comprising:

- mixing powders (102) so as to obtain a powder mixture, at least one of the powders comprising sulfur;
- pressing (106) a component with the powder mixture; and
- sintering (108) the component under a partial pressure of sulfur comprised between 200 Pa and 0,2 MPa so as to obtain a sintered component comprising sulfur;

wherein the sintered component exhibits the peaks in positions of $2\theta = 15,08^\circ (\pm 0,50^\circ)$, $15,28^\circ (\pm 0,50^\circ)$, $15,92^\circ (\pm 0,50^\circ)$, $17,5^\circ (\pm 0,50^\circ)$, $18,24^\circ (\pm 0,50^\circ)$, $20,30^\circ (\pm 0,50^\circ)$, $23,44^\circ (\pm 0,50^\circ)$, $24,48^\circ (\pm 0,50^\circ)$, and $26,66^\circ (\pm 0,50^\circ)$ in a X-ray diffraction measurement using $\text{CuK}\alpha$ line.

2. The method (100) according to claim 1, wherein the sintered component comprises $\text{XTi}_2(\text{PS}_4)_3$ and/or $\text{XZr}_2(\text{PS}_4)_3$, X being lithium (Li), sodium (Na) or silver (Ag).

3. The method (100) according to claim 1 or 2, wherein the partial pressure of sulfur is obtained by evaporating solid sulfur.

4. The method (100) according to claim 3, wherein the component is placed in a container and sealed under Argon at a pressure equal to or smaller than 100 Pa, preferably equal to or smaller than 50 Pa.

5. The method (100) according to claim 1 or 2, wherein the partial pressure of sulfur is obtained from a sulfur containing gas.

6. The method (100) according to any of claims 1-5, the method comprising a step (104) of amorphasizing the powder mixture so as to obtain an amorphasized powder mixture.

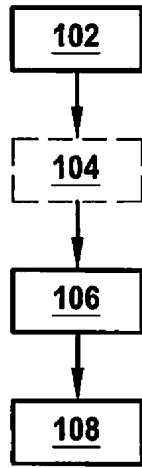
7. The method (100) according to claim 6, wherein sintering (108) comprises a sintering plateau temperature equal to or smaller than 500°C , preferably equal to or smaller than 400°C .

8. The method (100) according to claim 6 or 7, wherein sintering (108) comprises a sintering plateau time equal to or smaller than 20 hours, preferably equal to or smaller than 10 hours.

9. The method according to any of claims 1-8, wherein sintering (108) is a two-step sintering, a first sintering step (110) under a partial pressure of sulfur comprised between 200 Pa and 0,2 MPa so as to obtain an intermediate product, the intermediate product being grinded (112) so as to obtain a sintered powder, the sintered powder being pressed (114) and sintered during a second sintering step (116) under a partial pressure of sulfur comprised between 200 Pa and 0,2 MPa.

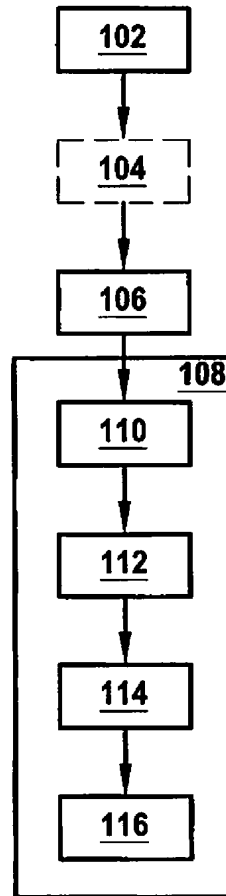
10. The method (100) according to any of claims 1-9, wherein the component is pressed (106, 114) at a pressure equal to or greater than 25 MPa, preferably equal to or greater than 50 MPa, more preferably equal to or greater than 75 MPa, and equal to or smaller than 500 MPa, preferably equal to or smaller than 400 MPa, more preferably equal to or smaller than 300 MPa.

1/1



100

FIG.1



100

FIG.2

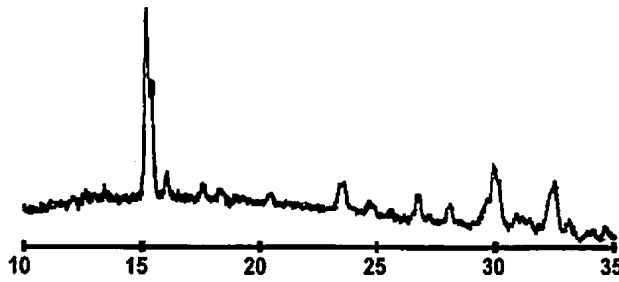


FIG.3

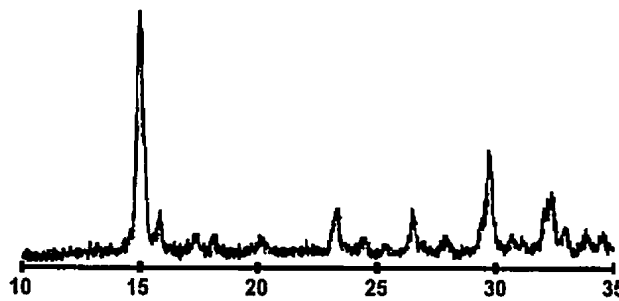


FIG.4

INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2017/069856

A. CLASSIFICATION OF SUBJECT MATTER
 INV. H01M4/04 C01B25/14 H01M4/1397 H01M4/58 H01M10/0562
 C01B25/08 C01B17/20 C04B35/547
 ADD.
 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)
 H01M C01B C04B
 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)
 EPO-Internal, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	B. R Shin ET AL: "All-Solid-State Rechargeable Lithium Batteries Using LiTi ₂ (PS ₄) ₃ Cathode with Li ₂ S-P ₂ S ₅ Solid Electrolyte", Journal of the Electrochemical Society, 27 November 2013 (2013-11-27), pages A154-A159, XP055383648, DOI: 10.1149/2.072401jes Retrieved from the Internet: URL:http://jes.ecsdl.org/content/161/1/A154.full.pdf [retrieved on 2017-06-21]	1,2,5-10
Y	abstract figure 1 Experimental section; page A154, right-hand column, lines 11-18 Experimental section; page A154, right-hand column, lines 19-45 Materials characterization section; -/--	2-4,6

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	"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
"E" earlier application or patent but published on or after the international filing date	"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
"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)	"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
"O" document referring to an oral disclosure, use, exhibition or other means	"&" document member of the same patent family
"P" document published prior to the international filing date but later than the priority date claimed	

Date of the actual completion of the international search 4 September 2017	Date of mailing of the international search report 14/09/2017
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Name and mailing address of the ISA/ European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Fax: (+31-70) 340-3016	Authorized officer Gregori, Giuliano
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INTERNATIONAL SEARCH REPORT

International application No

PCT/EP2017/069856

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	page A155, left-hand column, lines 22-27 ----- KIM ET AL: "Lithium Intercalation into ATi ₂ (PS ₄) ₃ (A=Li, Na, Ag)", ELECTROCHEMISTRY COMMUNICATIONS, ELSEVIER, AMSTERDAM, NL, vol. 10, no. 4, 26 January 2008 (2008-01-26), pages 497-501, XP022552874, ISSN: 1388-2481, DOI: 10.1016/J.ELECOM.2008.01.014 abstract figure 1 page 497, right-hand column, line 3 - line 19 page 498, right-hand column, line 1 - line 4	2
Y	----- CN 101 013 753 A (SHANGHAI INST CERAMICS [CN]) 8 August 2007 (2007-08-08) abstract paragraphs [0026], [0027]	2
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Y	----- CN 103 401 017 A (BEIJING INST TECHNOLOGY) 20 November 2013 (2013-11-20) figure 4 paragraphs [0031], [0032], [0033], [0035], [0040]	6
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INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No

PCT/EP2017/069856

Patent document cited in search report		Publication date	Patent family member(s)	Publication date
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