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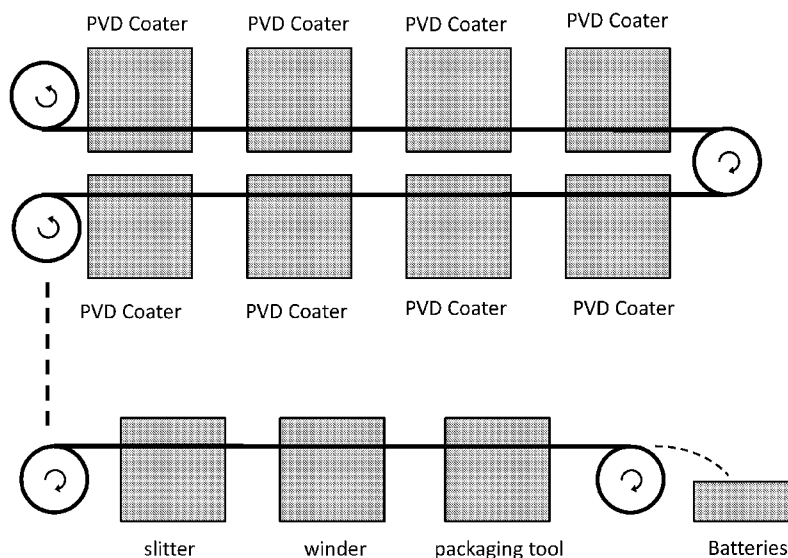
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[Continued on next page]

(54) Title: MANUFACTURE OF HIGH CAPACITY SOLID STATE BATTERIES

Figure 5



(57) Abstract: Techniques related to the manufacture of electrochemical cells are disclosed in herein. Specifically, a method for manufacturing solid state batteries can include an iterative set of process sequences that can be repeated a number of times to build multiple stacks to achieve high capacity which is greater than 0.1 mAh.

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## INTERNATIONAL SEARCH REPORT

International application No.

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<b>A. CLASSIFICATION OF SUBJECT MATTER</b> IPC(8) - H01M 10/04, 10/585, 4/04 (2016.01) CPC - H01M 10/0404, 10/585, 4/0421 According to International Patent Classification (IPC) or to both national classification and IPC		
<b>B. FIELDS SEARCHED</b> Minimum documentation searched (classification system followed by classification symbols) IPC(8) Classification(s): H01M 2/14, 4/04, 4/139, 10/04, 10/0562, 10/585 (2016.01) CPC Classification(s): H01M 2/14, 4/0421, 4/139, 10/0404, 10/0562, 10/585; Y02P 70/54 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) PatSeer (US, EP, WO, JP, DE, GB, CN, FR, KR, ES, AU, IN, CA, INPADOC Data); Google; Google Scholar; EBSCO Keywords searched: solid state battery, manufacture, electrolyte, substrate, release layer, electrode, ionic diffusion, capacity thickness, deposition, current collector, cell stack, micron, ampere hours		
<b>C. DOCUMENTS CONSIDERED TO BE RELEVANT</b>		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	US 2012/0058280 A1 (CHUNG, M. et al.) March 08, 2012; figures 1-4; paragraphs [0008, 0028-0032, 0043-0054]	1-10
Y	US 6,432,584 B1 (VISCO, S. et al.) August 13, 2002; figures 1, 3; column 4, lines 5-40; column 16, lines 15-25	1-10
Y	US 2009/0208671 A1 (NIEH, K. et al.) August 20, 2009; figures 3a, 4; paragraphs [0019, 0021])	2, 7
A	US 2012/0274273 A1 (JACOBS, H. et al.) November 01, 2012; figures 1b, 1d, 2b, 3a, 28a; paragraphs [0136-0139, 0148-0159, 0310, 0316]	2-10
<input type="checkbox"/> Further documents are listed in the continuation of Box C. <input type="checkbox"/> 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 22 April 2016 (22.04.2016)		Date of mailing of the international search report 03 MAY 2016
Name and mailing address of the ISA/ Mail Stop PCT, Attn: ISA/US, Commissioner for Patents P.O. Box 1450, Alexandria, Virginia 22313-1450 Facsimile No. 571-273-8300		Authorized officer Shane Thomas PCT Helpdesk: 571-272-4300 PCT OSP: 571-272-7774

## INTERNATIONAL SEARCH REPORT

International application No.

PCT/US15/66525

**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:  
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.:  
1-10

**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.

-\*\*\*-Continued from Box No. III Observations where unity of invention is lacking -\*\*\*-

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 fee must be paid.

Group I: Claims 1-10 appear to be directed towards a method includes battery device releasing step from the substrate, or another method of processing on thin polymer substrates (0.1  $\mu\text{m}$  to 100  $\mu\text{m}$ ) that are included as a part of battery device by minimizing the penalty on energy density.

Group II: Claims 11 & 12 appear to be directed towards forming a multiple stack battery characterized by a capacity greater than 0.1 mAh by winding, z-folding, stacking precut films, or directly depositing multiple layers on an area less than 1  $\text{m}^2$ .

Group III: Claims 13-16 appear to be directed towards forming the multiple stack battery device within a footprint of an arbitrary shape by cutting the battery including the polymeric substrate to conform to a battery powered appliance.

The inventions listed as Groups I-III 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.

The special technical features of Group I are at least a method for manufacturing solid state batteries using an iterative set of process sequences that repeats a number of times to build multiple stacks to achieve high capacity which is greater than 0.1 mAh, wherein a method includes battery device releasing step from the substrate, or another method of processing on thin polymer substrates (0.1  $\mu\text{m}$  to 100  $\mu\text{m}$ ) that are included as a part of battery device by minimizing the penalty on energy density, the process comprising: moving a substrate in a closed loop process sequence for a number of times to build the target number of stacks based on the battery capacity specification, wherein the capacity is greater than 0.1 mAh; performing a plurality of processes to build a single stack by sequentially depositing a plurality of materials derived from deposition sources to form a resulting electrochemical cell overlying the substrate, the plurality of processes comprising at least: forming a release material overlying the substrate; depositing a first current collector overlying the release material; depositing a first electrode layer that is capable of an electrochemical reaction with ions overlying current collector in the deposition chamber; depositing an electrolyte material overlying the cathode that is capable of ionic diffusion, the electrolyte material having an electrical conductivity and being a solid state material; depositing a second electrode layer overlying the electrolyte material; depositing a second current collector overlying the second electrode layer; depositing an interlayer overlying the second current collector; following the resulting electrochemical cell overlying the release material, moving the substrate back to the start of the process sequence to form a second electrochemical cell overlying the first cell stack on the same substrate; repeating the cell stack deposition sequence for 1 to N times until the multiple stack electrochemical batteries that have high capacity greater than 0.1 mAh; forming the high capacity battery by stacking the combination of the substrate and the deposited single electrochemical cell stack until the multiple stack electrochemical batteries meet the targeted capacity; causing removal of the resulting electrochemical cell from the release material to detach the substrate from the resulting electrochemical cell, which Groups II & III do not have.

Group II has at least a method of fabricating a thin film solid state battery device, the method comprising: forming a multiple stack battery characterized by a capacity greater than 0.1 mAh by winding, z-folding, stacking precut films, or directly depositing multiple layers on an area less than 1  $\text{m}^2$ ; forming a multiple stack battery of uniform thickness including a substrate, ranging from 1.5  $\mu\text{m}$  to 500  $\mu\text{m}$  each stack and curvature by cutting boundaries of wound, or z-folded battery to achieve higher energy density by eliminating curves, and to prevent stress concentration at corners which are frequent failure locations, which Groups I & III do not have.

Group III has at least forming the multiple stack battery device within a footprint of an arbitrary shape by cutting the battery including the polymeric substrate to conform to a battery powered appliance, which Groups I & II do not have.

The common technical features are at least a method of fabricating a thin film solid state battery device comprising forming a film by depositing electrode materials using a low temperature process on a thin polymeric substrate; forming a multiple stack battery characterized by a capacity greater than 0.1 mAh. These common features are previously disclosed by WO 01/73833 A2 to Jensen, M (hereinafter 'Jensen'). Jensen discloses a method of fabricating a thin film solid state battery device (a method of fabricating a thin film solid state battery 50; page 13, line 25 to page 14, line 13) comprising forming a film by depositing electrode materials using a low temperature process on a thin polymeric substrate (forming a film by depositing cathode films using a low temperature process on a polymer substrate; page 28, lines 1-29); forming a multiple stack battery characterized by a capacity greater than 0.1 mAh (forming a stack battery which has a capacitance of 1000 mah; page 84, lines 22-23).

Since the common technical feature is previously disclosed by Jensen these common features are not special and so Groups I-III lack unity