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Published:
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— *before the expiration of the time limit for amending the claims and to be republished in the event of receipt of amendments*

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30 April 2009

(54) Title: METHOD OF DEPOSITING SILICON ON CARBON MATERIALS AND FORMING AN ANODE FOR USE IN LITHIUM ION BATTERIES

(57) Abstract: A method of modifying the surface of carbon materials such as vapor grown carbon nanofibers is provided in which silicon is deposited on vapor grown carbon nanofibers using a chemical vapor deposition process. The resulting silicon-carbon alloy may be used as an anode in a rechargeable lithium ion battery.

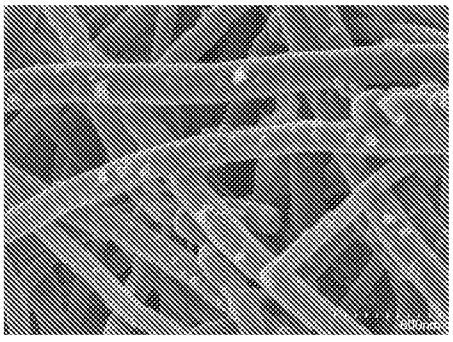

Fig. 1A

WO 2009/009206 A3

INTERNATIONAL SEARCH REPORT

International application No
PCT/US2008/061197

A. CLASSIFICATION OF SUBJECT MATTER
INV. C23C16/24 H01M4/38

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)
C23C H01M

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 practical, search terms used)
EPO-Internal

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	WO 2006/097380 A (DEGUSSA [DE]; PETRAT FRANK-MARTIN [DE]; WIGGERS HARTMUT [DE]; REEKEN B) 21 September 2006 (2006-09-21)	1,2,5,7, 9,11,12, 14-19,22
Y	page 4, line 25 - line 30 page 7, line 22 - line 28 page 9, line 10 page 10, line 24 - line 28 page 14, line 1 - line 11 page 16 - page 17; example 1 page 14, line 20 figure 2 page 9, line 28 figure 1	1,3,4
Y	US 2003/165740 A1 (EDWARDS STEPHEN JOHN [GB] ET AL) 4 September 2003 (2003-09-04) paragraphs [0001], [0031]	3,4

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[X] Further documents are listed in the continuation of Box C.

[X] 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 document 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	Date of mailing of the international search report
27 January 2009	16/03/2009

Name and mailing address of the ISA/	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL – 2280 HV Rijswijk Tel. (+31–70) 340–2040, Fax: (+31–70) 340–3016	Schuhmacher, Jörg

INTERNATIONAL SEARCH REPORT

International application No
PCT/US2008/061197

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	US 7 189 476 B1 (MACKLIN WILLIAM JOHN [GB] ET AL) 13 March 2007 (2007-03-13) column 1, line 44 - line 49	1
Y	US 2007/059600 A1 (KIM GUE-SUNG [KR] ET AL) 15 March 2007 (2007-03-15) examples 1,2	1
A	US 6 988 304 B2 (MOSELEY DOUGLAS D [US] ET AL) 24 January 2006 (2006-01-24) cited in the application	1

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US2008/061197

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 additional sheet

1. ☐ As all required additional search fees were timely paid by the applicant, this international search report covers allsearchable claims.

2. ☐ As all searchable claims could be searched without effort justifying an 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 reportcovers 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.:

(1,2,5,7-9,11,12,14-22) all partial, 3,4

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.

FURTHER INFORMATION CONTINUED FROM PCT/ISA/ 210

This International Searching Authority found multiple (groups of) inventions in this international application, as follows:

1. claims: (1, 2, 5, 7- 9, 11, 12, 14-22) all partial, 3, 4

Method of depositing silicon onto a carbon material as indicated in claim 1 and corresponding silicon coated anode as indicated in claim 16, wherein the provided carbon material is selected from vapor grown carbon fibers, vapor grown carbon nanofibers, PAN or pitch derived carbon fibers, or carbon nanotubes.

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2. claims: (1, 2, 5, 7- 9, 11, 12, 14-22) all partial

Method of depositing silicon onto a carbon material as indicated in claim 1 and corresponding silicon coated anode as indicated in claim 16, wherein the provided carbon material is graphene platelets.

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3. claim: 6

Method of depositing silicon onto a carbon material as indicated in claim 1 and corresponding silicon coated anode as indicated in claim 16, wherein the provided carbon material further includes a carbide material selected from metal carbides, silicon carbides and silicon oxides.

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4. claim: 10

Method of depositing silicon onto a carbon material as indicated in claim 1 and corresponding silicon coated anode as indicated in claim 16, wherein the provided carbon materials in the form of a low density composite or preform.

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5. claim: 13

Method of depositing silicon onto a carbon material as indicated in claim 1 and corresponding silicon coated anode as indicated in claim 16, wherein the silicon-coated carbon material has a graded interface.

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No
PCT/US2008/061197

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