

(19) World Intellectual Property Organization
International Bureau



(43) International Publication Date
29 October 2009 (29.10.2009)

(10) International Publication Number
WO 2009/131700 A3

(51) International Patent Classification:
H01M 4/66 (2006.01) *H01M 4/02* (2006.01)
H01M 4/70 (2006.01)

(74) Agents: **DARDI, Peter, S.** et al.; Dardi & Associates, PLLC, US Bank Plaza, Suite 2000, 220 South 6th Street, Minneapolis, MN 55402 (US).

(21) International Application Number:
PCT/US2009/002532

(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, BR, BW, BY, BZ, CA, CH, CN, CO, CR, CU, CZ, DE, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IS, JP, KE, KG, KM, KN, KP, KR, KZ, LA, LC, LK, LR, LS, LT, LU, LY, MA, MD, ME, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PG, PH, PL, PT, RO, RS, RU, SC, SD, SE, SG, SK, SL, SM, ST, SV, SY, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW.

(22) International Filing Date:
24 April 2009 (24.04.2009)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
61/125,476 25 April 2008 (25.04.2008) US
61/113,445 11 November 2008 (11.11.2008) US

(71) Applicant (for all designated States except US): **ENVIA SYSTEMS, INC.** [US/US]; 26138 Research Road, Hayward, CA 94545 (US).

(84) Designated States (unless otherwise indicated, for every kind of regional protection available): ARIPO (BW, GH, GM, KE, LS, MW, MZ, NA, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European (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, SE, SI, SK, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

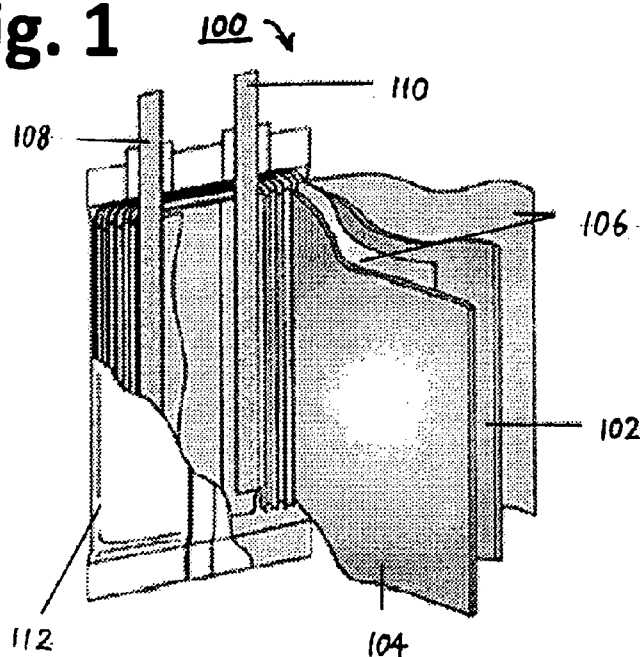
(72) Inventors; and

(75) Inventors/Applicants (for US only): **KUMAR, Sujeet** [US/US]; 39696 Potrero Drive, Newark, CA 94560 (US).
BUCKLEY, James, P. [US/US]; 5495 Makati Circle, San Jose, CA 95123 (US).

[Continued on next page]

(54) Title: HIGH ENERGY LITHIUM ION BATTERIES WITH PARTICULAR NEGATIVE ELECTRODE COMPOSITIONS

Fig. 1



(57) Abstract: Combinations of materials are described in which high energy density active materials for negative electrodes of lithium ion batteries. In general, metal alloy/intermetallic compositions can provide the high energy density. These materials can have moderate volume changes upon cycling in a lithium ion battery. The volume changes can be accommodated with less degradation upon cycling through the combination with highly porous electrically conductive materials, such as highly porous carbon and/or foamed current collectors. Whether or not combined with a highly porous electrically conductive material, metal alloy/intermetallic compositions with an average particle size of no more than a micron can be advantageously used in the negative electrodes to improve cycling properties.

WO 2009/131700 A3



Published:

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

21 January 2010

- *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))*

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US2009/002532**A. CLASSIFICATION OF SUBJECT MATTER***H01M 4/66(2006.01)i, H01M 4/70(2006.01)i, H01M 4/02(2006.01)i*

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)

IPC 9: H01M 4*, H01M 10*

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)

KOMPASS(KIPO internal), keyword: foam*, alloy*, (anode* <or> negative*), (micro* <or> nanometer*)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X --- Y	KR 10-2004-0096381 A (KOREA INSTITUTE OF SCIENCE AND TECHNOLOGY) 16 November 2004 See abstract, claims 1-5 and 8-10	1-2, 4-9 ----- 3
X --- Y	KR 10-2006-0087183 A (SAMSUNG SDI CO., LTD) 2 August 2006 See claims 1-3 and detailed description	1-2, 4-9 ----- 3
X --- Y	KR 10-2006-0087003 A (SAMSUNG SDI CO., LTD.) 2 August 2006 See claims 1, 11, 12, 20 and 21	10-27 ----- 3
X --- Y	KR 10-2004-0100058 A (SAMSUNG SDI CO., LTD.) 2 December 2004 See claims 1-8	10-27 ----- 3

 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 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

30 NOVEMBER 2009 (30.11.2009)

Date of mailing of the international search report

30 NOVEMBER 2009 (30.11.2009)

Name and mailing address of the ISA/KR

Korean Intellectual Property Office
Government Complex-Daejeon, 139 Seonsa-ro, Seo-
gu, Daejeon 302-701, Republic of Korea

Facsimile No. 82-42-472-7140

Authorized officer

BYUN, Sang Hyun

Telephone No. 82-42-481-5618



INTERNATIONAL SEARCH REPORT

International application No.

PCT/US2009/002532**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:

1. Claims 1-9 relate to a negative electrode which comprise a foamed current collector.
2. Claim 10-13 relate to a negative electrode which comprise porous carbon particles with a certain BET surface area.
3. Claims 14-17 and 18-22 relate to a negative electrode which comprise an active material particle with a certain particle size.
4. Claims 23-25 and 26 relate to a method for forming an active material particle by milling.
5. Claims 27 related to a collection of composite particles which comprises a certain particle size and a certain composite weight percentage.

The inventions listed as 1-5, do not relate to a single general inventive concept under PCT Rule 13.1, because, under PCT Rule 13.2 they do not share the same or corresponding technical features.

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 an additional fee, this Authority did not invite payment of any additional fee.
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.:

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

Information on patent family members

International application No.

PCT/US2009/002532

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
KR 10-2004-0096381 A	16. 11. 2004	None	
KR 10-2006-0087183 A	02. 08. 2006	None	
KR 10-2006-0087003 A	02. 08. 2006	None	
KR 10-2004-0100058 A	02. 08. 2004	KR 10-0570637 B1 JP 2004-349253 A US 07452632 B2 US 2004-0234859 A1	12. 04. 2006 09. 12. 2004 18. 11. 2008 25. 11. 2004