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SC, SD, SE, SG, SK, SL, SM, ST, SV, SY, TH, TJ, TM,
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(54) Title: ENERGY STORAGE DEVICES BASED ON HYBRID CARBON ELECTRODE SYSTEMS

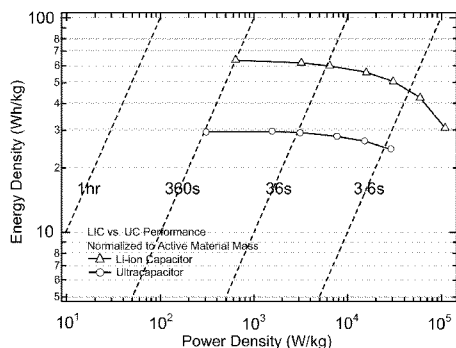


FIG. 28

(57) Abstract: The present application is directed to energy storage materials and devices, e.g. ion capacitors such as Li-ion capacitors, that employ more than one carbon-based electrodes comprising carbons with enhanced purity levels, e.g. below 500 ppm, wherein the carbon based electrodes have different properties, such as different surface areas, and/or different capability to intercalate vs. surface absorb electrolyte ions.

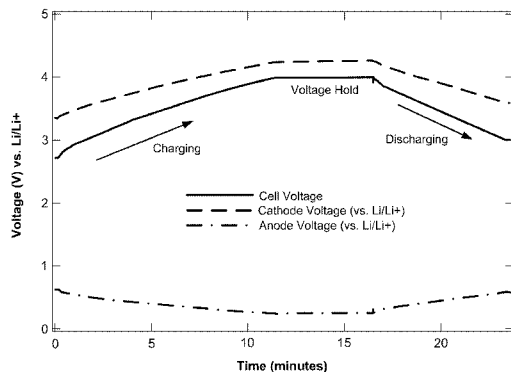


FIG. 29

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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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- *as to the applicant's entitlement to claim the priority of the earlier application (Rule 4.17(iii))*

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ADD.
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B. FIELDS SEARCHED
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H01G C01B

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	WO 2012/045002 A1 (ENERG2 TECHNOLOGIES INC [US]; COSTANTINO HENRY R [US]; GOODWIN CHAD [U] 5 April 2012 (2012-04-05)	1-5, 11-16
Y	page 53, line 18 - page 60, line 24 page 19, line 16 - page 52, line 24; figure 3C	6-10
X	WO 2012/092210 A1 (ENERG2 TECHNOLOGIES INC [US]; CHANG ALAN T [US]; COSTANTINO HENRY R [U] 5 July 2012 (2012-07-05)	1-5, 12-16
Y	page 51, line 12 - page 59, line 17; figure 10 page 26, line 6 - page 50, line 20; figure 10	6-11
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Further documents are listed in the continuation of Box C.

See patent family annex.

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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 Frias Rebelo, Artur
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C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	WO 2011/003033 A1 (ENERG2 INC [US]; FEAVER AARON M [US]; COSTANTINO HENRY R [US]; SCOTT W) 6 January 2011 (2011-01-06)	1-5, 12-16
Y	page 53, line 1 - page 61, line 5 page 20, line 30 - page 48, line 18; figure 1-	6-11
X	----- SIVAKKUMAR S R ET AL: "Evaluation of lithium-ion capacitors assembled with pre-lithiated graphite anode and activated carbon cathode", ELECTROCHIMICA ACTA, ELSEVIER SCIENCE PUBLISHERS, BARKING, GB, vol. 65, 20 January 2012 (2012-01-20), pages 280-287, XP028460172, ISSN: 0013-4686, DOI: 10.1016/J.ELECTACTA.2012.01.076 [retrieved on 2012-01-30]	1,2,5, 11,12,15
Y	*Abstract*; page 280, paragraph 1.Introduction - page 281, paragraph 2.Experimental; figures 1-6	6-11,13
X	----- US 2008/204973 A1 (ZHONG LINDA [US] ET AL) 28 August 2008 (2008-08-28)	1,2,15
Y	page 3, paragraph 28 - page 5, paragraph 52; figures 1-3; table 1	1-3,5 4,6-14, 16
X	----- CAO W J ET AL: "Li-ion capacitors with carbon cathode and hard carbon/stabilized lithium metal powder anode electrodes", JOURNAL OF POWER SOURCES, ELSEVIER SA, CH, vol. 213, 16 April 2012 (2012-04-16), pages 180-185, XP028493458, ISSN: 0378-7753, DOI: 10.1016/J.JPOWSOUR.2012.04.033 [retrieved on 2012-04-21]	1-3
Y	page 181, paragraph 2. Experimental - page 185, paragraph 4. Conclusion; table 1	4-16
Y	----- US 2012/045685 A1 (SEKI DAISUKE [JP] ET AL) 23 February 2012 (2012-02-23) paragraph [0077] - paragraph [0080]	1-16
X	----- KATSUHIKO NAOI ET AL: "Second generation 'nanohybrid supercapacitor': Evolution of capacitive energy storage devices", ENERGY & ENVIRONMENTAL SCIENCE, vol. 5, no. 11, 14 September 2012 (2012-09-14), page 9363, XP055169819, ISSN: 1754-5692, DOI: 10.1039/c2ee21675b page 9367, paragraph 3.2 - page 9369, paragraph 4.3; figure 4	1-6
	----- -/--	

INTERNATIONAL SEARCH REPORT

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C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	<p>TOSHIRO OTOWA ET AL: "Production and adsorption characteristics of MAXSORB: High-surface-area active carbon", GAS SEPARATION & PURIFICATION, vol. 7, no. 4, 1993, pages 241-245, XP055169171, ISSN: 0950-4214, DOI: 10.1016/0950-4214(93)80024-Q page 241 - page 243 -----</p>	1-16

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No PCT/US2014/026460

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
WO 2012045002 A1	05-04-2012	CN 103261090 A	21-08-2013
		US 2012081838 A1	05-04-2012
		US 2014220456 A1	07-08-2014
		WO 2012045002 A1	05-04-2012

WO 2012092210 A1	05-07-2012	CN 103370756 A	23-10-2013
		EP 2659498 A1	06-11-2013
		JP 2014511322 A	15-05-2014
		KR 20140092231 A	23-07-2014
		US 2012202033 A1	09-08-2012
		WO 2012092210 A1	05-07-2012

WO 2011003033 A1	06-01-2011	CN 102481730 A	30-05-2012
		EP 2448748 A1	09-05-2012
		JP 2012532088 A	13-12-2012
		KR 20120068809 A	27-06-2012
		US 2011002086 A1	06-01-2011
		US 2013157151 A1	20-06-2013
		WO 2011003033 A1	06-01-2011

US 2008204973 A1	28-08-2008	US 2008204973 A1	28-08-2008
		US 2010110613 A1	06-05-2010
		WO 2008127790 A1	23-10-2008

US 2012045685 A1	23-02-2012	CN 102379017 A	14-03-2012
		DE 112011100008 T5	28-06-2012
		KR 20140025617 A	05-03-2014
		TW 201208181 A	16-02-2012
		US 2012045685 A1	23-02-2012
		WO 2011125325 A1	13-10-2011
