



(51) International Patent Classification:

H01M 4/58 (2010.01) *G02F 1/155* (2006.01)
C01G 45/00 (2006.01) *H01M 10/052* (2010.01)
C01G 49/00 (2006.01) *H01M 10/054* (2010.01)
C01G 53/00 (2006.01)

(21) International Application Number:

PCT/GB2013/050736

(22) International Filing Date:

21 March 2013 (21.03.2013)

(25) Filing Language:

English

(26) Publication Language:

English

(30) Priority Data:

1205170.2 23 March 2012 (23.03.2012) GB

(71) Applicant: **FARADION LTD** [GB/GB]; Electric Works
 Sheffield Digital Campus, 3 Concourse Way, Sheffield
 South Yorkshire S1 2BJ (GB).

(72) Inventors: **BARKER, Jeremy**; 10 Home Farm Close,
 Shipton-under-Wychwood, Chipping Norton, Oxford Ox-
 fordshire OX7 6EH (GB). **HEAP, Richard**; 98 West Way,
 Botley, Cumnor, Oxford Oxfordshire OX2 9JU (GB).

(74) Agent: **BINGHAM, Ian**; IP ASSET LLP, Prama House,
 267 Banbury Road, Summertown, Oxford Oxfordshire
 OX2 7HT (GB).

(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, BN, BR, BW, BY,
 BZ, CA, CH, CL, 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, PA, PE, PG, PH, PL, PT, QA, RO, RS, RU,
 RW, 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.

(84) Designated States (*unless otherwise indicated, for every
 kind of regional protection available*): ARIPO (BW, GH,
 GM, KE, LR, LS, MW, MZ, NA, RW, SD, SL, 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,
 ML, MR, NE, SN, TD, TG).

[Continued on next page]

(54) Title: METALLATE ELECTRODES

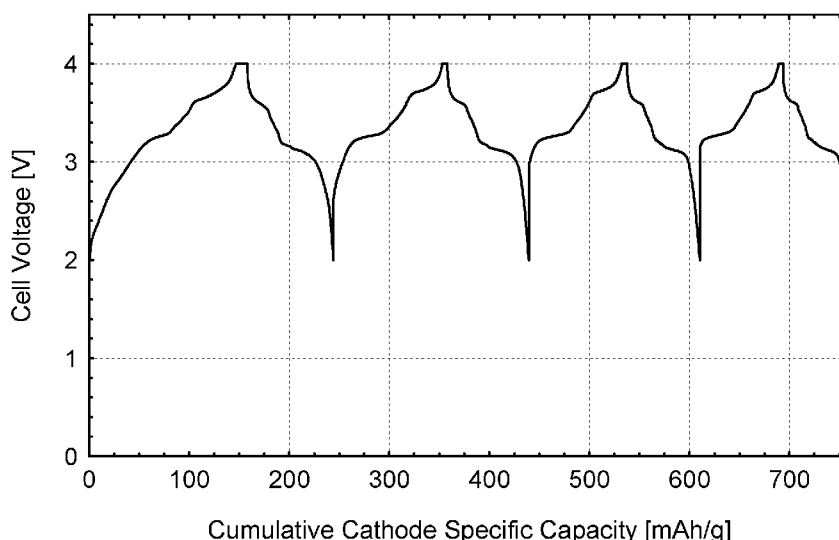


FIGURE 1B

(57) Abstract: The invention relates to electrodes that contain active materials of the formula: $A_aM_bX_xO_y$ wherein A is one or more alkali metals selected from lithium, sodium and potassium; M is selected from one or more transition metals and/or one or more non-transition metals and/or one or more metalloids; X comprises one or more atoms selected from niobium, antimony, tellurium, tantalum, bismuth and selenium; and further wherein $0 < a \leq 6$; b is in the range: $0 < b \leq 4$; x is in the range $0 < x \leq 1$ and y is in the range $2 \leq y \leq 10$. Such electrodes are useful in, for example, sodium and/or lithium ion battery applications.

**Declarations under Rule 4.17:**

- *as to the identity of the inventor (Rule 4.17(i))*
- *as to applicant's entitlement to apply for and be granted a patent (Rule 4.17(ii))*
- *as to the applicant's entitlement to claim the priority of the earlier application (Rule 4.17(iii))*
- *of inventorship (Rule 4.17(iv))*

Published:

- *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))*

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

9 January 2014

INTERNATIONAL SEARCH REPORT

International application No
PCT/GB2013/050736

A. CLASSIFICATION OF SUBJECT MATTER INV. H01M4/58 C01G45/00 C01G49/00 C01G53/00 G02F1/155 ADD. H01M10/052 H01M10/054		
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 C01G G02F		
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, INSPEC, COMPENDEX		
C. DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	CN 101 219 811 B (UNIV NANJING [CN] UNIV NANJING) 9 June 2010 (2010-06-09)	1-6,8-17
Y	the whole document -----	18
X	JP 2009 295290 A (PANASONIC CORP) 17 December 2009 (2009-12-17)	1-5, 8-12, 14-17
Y	paragraph [0039] - paragraph [0060] -----	18
X	EP 2 328 215 A2 (KOREA BASIC SCIENCE INST [KR]) 1 June 2011 (2011-06-01)	1-5, 8-12, 14-17
Y	paragraphs [0061] - [0071], [0077] -----	18
X	JP 2007 258094 A (SONY CORP) 4 October 2007 (2007-10-04)	1-5, 10-12, 14-17
Y	paragraph [0070] - paragraph [0089] -----	18
-/-		
☒ 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 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
20 June 2013		20/11/2013
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 Langouët, Sylvain

INTERNATIONAL SEARCH REPORT

International application No
PCT/GB2013/050736

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	JP 2002 050401 A (NISSAN MOTOR) 15 February 2002 (2002-02-15)	1-5, 10-12, 14-17 18
Y	paragraphs [0037] - [0039], [0057], [0058] -----	
X	US 2007/218370 A1 (DEGUCHI MASAKI [JP] ET AL) 20 September 2007 (2007-09-20)	1-6, 10-12, 14-17 18
Y	paragraphs [0048] - [0053], [0062]; table 2 -----	
X	EP 0 583 772 A1 (HITACHI MAXELL [JP]) 23 February 1994 (1994-02-23)	1-5, 7-12, 14-17 18
Y	page 2, line 40 - line 55; example 1 -----	
X	EP 1 708 296 A1 (MATSUSHITA ELECTRIC IND CO LTD [JP]) 4 October 2006 (2006-10-04)	1-5, 8-12, 14-17 18
Y	paragraphs [0012], [0044] - [0047], [0082]; table 2 -----	
Y	US 2011/086273 A1 (RAVET NATHALIE [CA] ET AL) 14 April 2011 (2011-04-14) paragraphs [0002], [0015] - [0020], [0027] - [0034] -----	18

INTERNATIONAL SEARCH REPORT

International application No.
PCT/GB2013/050736

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 all searchable 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 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.:

1-18

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: 1-18

an electrode which contains an active material of the formula $AaMbXxOy$ as defined in the independent claim 1

2. claim: 19

a material of the formula $A_3Ni_{2-z}MgSbO_6$ where A is one or more alkali metals selected from the lithium and sodium and $z =]0-2]$

3. claim: 20

a material of formula $Na_3Mn_2SbO_6$

4. claim: 21

a material of formula $Na_3Fe_2SbO_6$

5. claim: 22

a material of formula Na_4FeSbO_6

6. claim: 23

a material of formula Li_4FeSbO_6

7. claim: 24

a material of formula Na_4MnSbO_6

8. claim: 25

a material of formula Li_4MnSbO_6

9. claim: 26

a material of formula Na_4NiTeO_6

10. claim: 27

a material of formula Li_4NiTeO_6

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No

PCT/GB2013/050736

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
CN 101219811	B	09-06-2010	NONE
JP 2009295290	A	17-12-2009	NONE
EP 2328215	A2	01-06-2011	CN 102232253 A 02-11-2011 EP 2328215 A2 01-06-2011 JP 2012503293 A 02-02-2012 KR 20100034693 A 01-04-2010 US 2011294020 A1 01-12-2011 WO 2010035950 A2 01-04-2010
JP 2007258094	A	04-10-2007	NONE
JP 2002050401	A	15-02-2002	NONE
US 2007218370	A1	20-09-2007	CN 1943072 A 04-04-2007 JP 4781262 B2 28-09-2011 KR 20060132037 A 20-12-2006 US 2007218370 A1 20-09-2007 WO 2005099023 A1 20-10-2005
EP 0583772	A1	23-02-1994	DE 69302341 D1 30-05-1996 DE 69302341 T2 05-12-1996 EP 0583772 A1 23-02-1994 US 5470678 A 28-11-1995 US 5547785 A 20-08-1996
EP 1708296	A1	04-10-2006	CN 1841816 A 04-10-2006 EP 1708296 A1 04-10-2006 JP 2006286599 A 19-10-2006 KR 20060106622 A 12-10-2006 US 2006222950 A1 05-10-2006
US 2011086273	A1	14-04-2011	CA 2270771 A1 30-10-2000 DE 60037609 T2 08-01-2009 EP 1049182 A2 02-11-2000 EP 1796189 A2 13-06-2007 JP 5175011 B2 03-04-2013 JP 2001015111 A 19-01-2001 JP 2008186807 A 14-08-2008 US 2002195591 A1 26-12-2002 US 2004140458 A1 22-07-2004 US 2006060827 A1 23-03-2006 US 2008257721 A1 23-10-2008 US 2011086273 A1 14-04-2011 US 2011097479 A1 28-04-2011 US 2012213919 A1 23-08-2012 US 2012214072 A1 23-08-2012