



(51) International Patent Classification:

H01M 10/05 (2010.01) *H01M 10/0566* (2010.01)
H01M 6/14 (2006.01) *H01M 2/16* (2006.01)
H01M 2/02 (2006.01)

(21) International Application Number:

PCT/US2011/031397

(22) International Filing Date:

6 April 2011 (06.04.2011)

(25) Filing Language:

English

(26) Publication Language:

English

(30) Priority Data:

61/321,309 6 April 2010 (06.04.2010) US

(71) Applicant (for CA only): **SCHLUMBERGER CANADA LIMITED** [CA/CA]; 525 3rd Avenue SW, Calgary Alberta, T2P0G4 (CA).

(71) Applicant (for AL, AU, AZ, BG, CO, CZ, DE, DK, GR, HU, ID, IE, IL, IT, KZ, LT, MX, MY, NO, NZ, OM, PL, RO, RU, SI, SK, TM, TN, TR, TT, UA, UZ, ZA only): **SCHLUMBERGER TECHNOLOGY B.V.** [NL/NL]; Parkstraat 83-89, NL-2514 JG The Hague (NL).

(71) Applicant (for all designated States except AL, AU, AZ, BG, CA, CO, CZ, DE, DK, FR, GB, GR, HU, ID, IE, IL, IT, JP, KZ, LT, MX, MY, NL, NO, NZ, OM, PL, RO, RU,

SI, SK, TM, TN, TR, TT, UA, UZ, ZA): **PRAD RESEARCH AND DEVELOPMENT LIMITED**; PO Box 71, Craigmuir Chambers, Road Town Tortola (VG).

(71) Applicant (for FR only): **SERVICES PETROLIERS SCHLUMBERGER** [FR/FR]; 42, Rue Saint-Dominique, F-75007 Paris (FR).

(71) Applicant (for GB, JP, NL only): **SCHLUMBERGER HOLDINGS LIMITED**; PO Box 71, Craigmuir Chambers, Roadtown Tortola (VG).

(72) Inventors; and

(75) Inventors/Applicants (for US only): **ZHANG, Wenlin** [US/GB]; 1 Silverwood Way, Up Hatherley, Cheltenham GL51 3TW (GB). **BUSSER, Catherine** [FR/GB]; 100 Cirencester Road, Charlton Kings, Cheltenham GL53 8DG (GB). **FREKER, Rick** [US/GB]; 38 Merlin Way, Cheltenham GL53 0LU (GB). **COOPER, Iain** [GB/US]; 1410 Timbertrail Drive, Sugar Land, TX 77479 (US). **TIRUVANNAMALAI, Arunkumar** [IN/US]; 1300 W. Optical Drive #300, Azusa, CA 91702 (US). **CHENG, Jason, Hsu-Feng** [CA/US]; 1300 W. Optical Drive #300, Azusa, CA 19702 (US). **WONG, Joseph, Ralph** [US/US]; 1300 W. Optical Drive #300, Azusa, CA 91702 (US). **JONES, Simon** [GB/US]; 1300 W. Optical Drive #300, Azusa, CA 91702 (US).

[Continued on next page]

(54) Title: ELECTROCHEMICAL DEVICES FOR USE IN EXTREME CONDITIONS

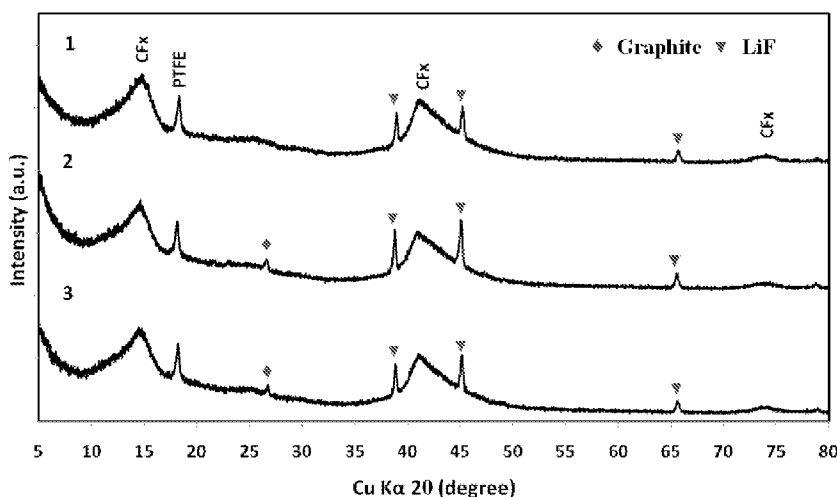


FIGURE 1
X-RAY DIFFRACTION ANALYSIS OF CF_x CATHODE MATERIAL AFTER HIGH-TEMPERATURE EXPOSURE IN CONTACT WITH CARBON-COATED TITANIUM

(57) Abstract: An electrochemical device, such as a battery or power source, provides improved performance under stringent or extreme conditions. Such an electrochemical device for use in high temperature conditions may include at least a cathode, a lithium-based anode, a separator, and an ionic liquid electrolyte. This device also may include a current collector and housing that are electrochemically inert with respect to other components of the device. This electrochemical device may operate at temperatures ranging from 0 to 180, 200, 220, 240, and 260°C.





(74) **Agents:** FONSECA, Darla, P. et al.; Schlumberger Technology Corporation, Office Of IP Counsel, 200 Gillingham Lane MD 200-9, Sugar Land, TX 77478 (US).

(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, 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, PE, PG, PH, PL, PT, RO, RS, RU, 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, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, MD, 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).

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:**
5 January 2012

A. CLASSIFICATION OF SUBJECT MATTER**H01M 10/05(2010.01)i, H01M 6/14(2006.01)i, H01M 2/02(2006.01)i, H01M 10/0566(2010.01)i, H01M 2/16(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)

H01M 10/05; H01M 10/40; H01M 6/36; H01M 10/39; H01M 6/18; C07C 215/40; H01M 4/62; H01M 6/16

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Korean utility models and applications for utility models

Japanese utility models and applications for utility models

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

eKOMPASS(KIPO internal) & Keywords: CFx, MnO₂, FeS₂, temperature Li-Mg battery, 180 degree, ionic liquid**C. DOCUMENTS CONSIDERED TO BE RELEVANT**

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 2007-0254213 A1 (BEST, ADAM SAMUEL et al.) 01 November 2007 See abstract, paragraphs [0015]-[0117], claims 1-26, figures 1A-9.	1-3, 11-14
A	US 2008-0268348 A1 (KATOH, TAKASHI) 30 October 2008 See abstract, paragraphs [0093]-[0122], claims 1-6.	1-3, 11-14
A	US 2005-0118513 A1 (UGAWA, SHINSAKU) 02 June 2005 See abstract, paragraphs [0007]-[0063], claims 1-10.	1-3, 11-14
A	US 2007-0099080 A1 (PICKETT, DAVID FRANKLIN JR. et al.) 03 May 2007 See abstract, paragraphs [0010]-[0068], claims 1-20, figures 1-13.	1-3, 11-14
A	US 2004-0199015 A1 (YUYAMA, KANAKO et al.) 07 October 2004 See abstract, paragraphs [0043]-[0127], claims 1-16.	1-3, 11-14

 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

07 NOVEMBER 2011 (07.11.2011)

Date of mailing of the international search report

07 NOVEMBER 2011 (07.11.2011)

Name and mailing address of the ISA/KR

Korean Intellectual Property Office
Government Complex-Daejeon, 189 Cheongsa-ro,
Seo-gu, Daejeon 302-701, Republic of Korea

Facsimile No. 82-42-472-7140

Authorized officer

Cho Ki Yun

Telephone No.



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.: 4-10
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. 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/US2011/031397

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 2007-0254213 A1	01.11.2007	AU 2004-309904 A1	14.07.2005
		AU 2004-309904 B2	03.04.2008
		BR P10418225A	27.04.2007
		CA 2552230 A1	14.07.2005
		CN 100468856 C	11.03.2009
		CN 1906795 A	31.01.2007
		GB 0612515 D0	16.08.2006
		GB 2424751 A	04.10.2006
		GB 2424751 B	06.06.2007
		JP 2007-517364 A	28.06.2007
		JP 2007-517364 T	28.06.2007
		KR 10-2007-0001118 A	03.01.2007
		WO 2005-064733 A1	14.07.2005
		US 2008-0268348 A1	30.10.2008
US 2005-0118513 A1	02.06.2005	CN 1622386 A	01.06.2005
		CN 1622386 C0	01.06.2005
		JP 2005-166290 A	23.06.2005
US 2007-0099080 A1	03.05.2007	None	
US 2004-0199015 A1	07.10.2004	AU 2003-235119 A1	10.11.2003
		CA 2454305 A1	06.11.2003
		CN 1564805 A	12.01.2005
		CN 1564805 C0	12.01.2005
		EP 1498409 A1	19.01.2005
		JP W020-03091198 A1	06.11.2003
		KR 10-0970918 B1	16.07.2010
		US 7167353 B2	23.01.2007
		WO 03-091198 A1	06.11.2003