(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization

International Bureau





(10) International Publication Number WO 2012/078627 A3

(43) International Publication Date 14 June 2012 (14.06.2012)

(21) International Application Number:

PCT/US2011/063526

(22) International Filing Date:

6 December 2011 (06.12.2011)

(25) Filing Language:

English

(26) Publication Language:

English

US

(30) Priority Data:

12/963,962 9 December 2010 (09.12.2010)

.

- (71) Applicant (for all designated States except US): E. I. DU PONT DE NEMOURS AND COMPANY [US/US]; 1007 Market Street, Wilmington, Delaware 19898 (US).
- (72) Inventors; and
- (75) Inventors/Applicants (for US only): DENNES, T. Joseph [US/US]; 425 West Eighth Avenue, Parkesburg, Pennsylvania 19365 (US). MAZUR, Stephen [US/US]; 4601 Weldin Road, Wilmington, Delaware 19803 (US).
- (74) Agent: LANGWORTHY, John, A.; E. I. du Pont de Nemours and Company, Legal Patent Records Center, 4417 Lancaster Pike, Wilmington, Delaware 19805 (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, QA, RO, RS, RU, RW, SC, SD, SE, SG, SK, SL, SM, ST, SV, SY, TH, TJ, TM, TN, 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, 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).

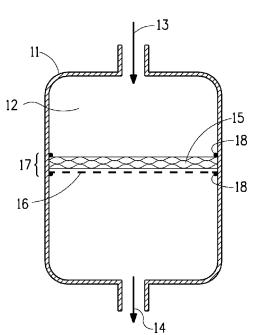
Published:

- 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))

[Continued on next page]

(54) Title: FILTRATION METHOD USING POLYIMIDE NANOWEB WITH AMIDIZED SURFACE AND APPARATUS THEREFOR





(57) Abstract: The present invention is directed to the preparation and use of aromatic polyimide nanowebs with amide-modified surfaces. Uses include as a filtration medium, and as a separator in batteries, particularly lithium-ion batteries. The invention is also directed to a method comprising the aromatic polyimide nanoweb with amide-modified surface. The invention is further directed to a multi-layer article comprising the aromatic polyimide nanoweb with amide-modified surface, and to an electrochemical cell comprising the multi-layer article.

(88) Date of publication of the international search report: 4 October 2012

International application No. **PCT/US2011/063526**

A. CLASSIFICATION OF SUBJECT MATTER

B01D 61/00(2006.01)i, B01D 71/64(2006.01)i, H01M 10/02(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)

B01D 61/00; H01M 2/16; D02G 3/02; B01D 61/18; B01D 71/64; B01D 67/00

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:nano fiber, nanoweb, polyimide, amide, funtional group, hydrocarbon, modified

C. DOCUMENTS CONSIDERED TO BE RELEVANT

| Category* | Citation of document, with indication, where appropriate, of the relevant passages | Relevant to claim No. | |
|-----------|--|-----------------------|--|
| Y | EP 0401005 A1 (E.I. DU PONT DE NEMOURS AND COMPANY) 05 December 1990 See the abstract, summery of invention, page 2 line 40 | 1-15 | |
| Y | US 2010-0151333 A1 (NAKAMORI MASAHIKO et al.) 17 June 2010 See the abstract, claim 13 | 1-15 | |
| Y | US 05976380A (MOYA; WILSON) 02 November 1999 | 11-15 | |
| A | See the whole document See the whole document | 1-10 | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |

| * | Special categories of cited documents: | "T" | later document published after the international filing date or priority |
|-----|---|-----|--|
| "A" | document defining the general state of the art which is not considered | | date and not in conflict with the application but cited to understand |
| | to be of particular relevance | | the principle or theory underlying the invention |
| "E" | earlier application or patent but published on or after the international | "X" | document of particular relevance; the claimed invention cannot be |
| | filing date | | considered novel or cannot be considered to involve an inventive |
| "L" | document which may throw doubts on priority claim(s) or which is | | step when the document is taken alone |
| | cited to establish the publication date of citation or other | "Y" | document of particular relevance; the claimed invention cannot be |
| | special reason (as specified) | | considered to involve an inventive step when the document is |
| "O" | document referring to an oral disclosure, use, exhibition or other | | combined with one or more other such documents, such combination |
| | means | | being obvious to a person skilled in the art |
| "P" | document published prior to the international filing date but later | "&" | document member of the same patent family |
| | than the priority date claimed | | |

| Date of the actual completion of the international search | Date of mailing of the international search report |
|---|--|
| 31 JULY 2012 (31.07.2012) | 01 AUGUST 2012 (01.08.2012) |

Name and mailing address of the ISA/KR



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

Further documents are listed in the continuation of Box C.

Facsimile No. 82-42-472-7140

Authorized officer

JO Soo Ik

Telephone No. 82-42-481-5893

See patent family annex.



INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No.

PCT/US2011/063526

| Patent document sited in search report | | _ | |
|--|---------------------|--|--|
| | Publication date | Patent family member(s) | Publication date |
| EP 0401005 A1 | 05.12.1990 | CA 2017831 A1 DE 69015445 D1 DE 69015445 T2 EP 0401005 B1 JP 02-888606 B2 JP 03-021336 A JP 2888606 B2 US 04981497A A | 01. 12. 1990 09.02. 1995 24.05. 1995 28. 12. 1994 19.02. 1999 30.01. 1991 10.05. 1999 01.01. 1991 |
| JS 2010-0151333 A1 | 17.06.2010 | CN 101228303 A CN 101228303 CO EP 1911864 A1 EP 1911864 A4 JP 04-797863 B2 JP 2007-056440 A JP 2007-059388 A JP 4797863 B2 KR 10-2008-0033444 A KR20080033444A WO 2007-013552 A1 | 23.07.2008 23.07.2008 16.04.2008 31.03.2010 12.08.2011 08.03.2007 08.03.2007 19.10.2011 16.04.2008 16.04.2008 01.02.2007 |
| IS 05976380 A | 02.11.1999 | CN 1136034 C0 CN 1254299 A0 EP 0977624 A1 JP 03-497176 B2 JP 2000-512902 A KR 10-0341260 B1 WO 98-48927 A1 | 28.01.2004 24.05.2000 09.02.2000 28.11.2003 03.10.2000 22.06.2002 05.11.1998 |