

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

(19) World Intellectual Property
Organization
International Bureau



(10) International Publication Number
WO 2013/132260 A3

(43) International Publication Date
12 September 2013 (12.09.2013)

- (51) **International Patent Classification:**
C01B 31/04 (2006.01)
- (21) **International Application Number:**
PCT/GB2013/050571
- (22) **International Filing Date:**
7 March 2013 (07.03.2013)
- (25) **Filing Language:** English
- (26) **Publication Language:** English
- (30) **Priority Data:**
1204170.3 9 March 2012 (09.03.2012) GB
- (71) **Applicants:** **BIO NANO CONSULTING** [GB/GB]; 338 Euston Road, London NW1 3BT (GB). **KING ABDULAZIZ UNIVERSITY** [SA/SA]; P.O.Box 80203, Jeddah, 21859 (SA).
- (72) **Inventors:** **GALLASTEGUI, Ainara Garcia**; Bio Nano Consulting, 338 Euston Road, London, Greater London NW1 3BT (GB). **SHAFFER, Milo**; Department of Chemistry, Imperial College London, South Kensington Campus, London, Greater London SW7 2AZ (GB). **ALYOUBI, Abdulrahman O**; King Abdulaziz University, P.O. Box 80203, Jeddah, 21859 (SA). **ASIRI, Abdullah M**; King Abdulaziz University, PO Box 80203, Jeddah, 21859 (SA).
- (74) **Agent:** **CLARKE, Lionel Paul**; The Broadgate Tower, 20 Primrose Street, London EC2A 2ES (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).

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 December 2013



WO 2013/132260 A3

(54) **Title:** CROSS-LINKED GRAPHENE NETWORKS

(57) **Abstract:** The present invention relates to a method for the production of cross-linked graphene and graphene oxide networks, which are selected from aerogels and xerogels with improved performance and characteristics thereof. The invention is also concerned with graphene and graphene oxide networks, which are selected from aerogels and xerogels produced by such processes and uses thereof.

INTERNATIONAL SEARCH REPORT

International application No
PCT/GB2013/050571

A. CLASSIFICATION OF SUBJECT MATTER
INV. C01B31/04
ADD.

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)
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, INSPEC, COMPENDEX, CHEM ABS Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

| Category* | Citation of document, with indication, where appropriate, of the relevant passages | Relevant to claim No. |
|-----------|---|-----------------------|
| X | US 2011/024376 A1 (HENDRICKS JARED [US] ET AL) 3 February 2011 (2011-02-03) abstract paragraphs [0003], [0007], [0010], [0027], [0034], [0038] claims 1,8,9,13, ----- | 1-31 |
| X | US 2012/034442 A1 (PAUZAUSKIE PETER J [US] ET AL) 9 February 2012 (2012-02-09) claims 1,8,11,30,31-40,49,50 paragraphs [0004], [0032], [0045], [0041] ----- -/-- | 1-18, 20-31 |

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

4 July 2013

Date of mailing of the international search report

22/10/2013

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

Rigondaud, Bernard

INTERNATIONAL SEARCH REPORT

International application No

PCT/GB2013/050571

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

| Category* | Citation of document, with indication, where appropriate, of the relevant passages | Relevant to claim No. |
|-----------|--|-------------------------------|
| X | <p>WORSLEY M A ET AL: "High surface area, sp²-cross-linked three-dimensional graphene monoliths", JOURNAL OF PHYSICAL CHEMISTRY LETTERS 20110421 AMERICAN CHEMICAL SOCIETY USA, vol. 2, no. 8, 21 April 2011 (2011-04-21), pages 921-925, XP008163340, DOI: 10.1021/JZ200223X page 921, right-hand column page 924, left-hand column, table 1; page 924</p> | 1,5,18, 21-23, 25,27,30 |
| X | <p>----- ZHANG X ET AL: "Mechanically strong and highly conductive graphene aerogel and its use as electrodes for electrochemical power sources", JOURNAL OF MATERIALS CHEMISTRY 20110514 ROYAL SOCIETY OF CHEMISTRY GBR, vol. 21, no. 18, 14 May 2011 (2011-05-14), pages 6494-6497, XP002699700, DOI: 10.1039/C1JM10239G the whole document</p> | 21-23,27 |
| X | <p>----- W. CHEN; L.YAN: NANOSCALE, vol. 3, 2011, pages 3132-3137, XP002699704, cited in the application</p> | 21-25, 27,30 |
| A | <p>abstract page 3134, right-hand column</p> | 1 |
| A | <p>----- X. JIANG; Y. MA; J. LI; Q. FAN; W. HUANG: J. PHYS. CHEM. C, vol. 114, 2010, page 22462, XP002699706, cited in the application the whole document</p> | 1,21-24 |
| A | <p>----- WO 2009/085015 A1 (UNIV SINGAPORE [SG]; HO PETER [SG]; CHUA LAY-LAY [SG]; WANG SHUAI [SG]) 9 July 2009 (2009-07-09) claims 1-42</p> | 1,21, 25-31 |
| | <p>-----</p> | |

INTERNATIONAL SEARCH REPORT

International application No.
PCT/GB2013/050571

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.:

1-31, 40, 41

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: 1-31, 40, 41

The problem solved by the first invention is to provide:

- * a method for producing an aerogel or xerogel comprising graphene (claims 1-20)
- * an aerogel or xerogel so-obtained (claims 21-24)
- * a list of different industrial applications comprising an aerogel or xerogel according to this first invention (claims 25-31, 40, 41)

2. claims: 32-39

The problem solved by the second invention is to provide a method of heating a graphene or graphene oxide aerogel or xerogel.

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No

PCT/GB2013/050571

| Patent document cited in search report | Publication date | Patent family member(s) | Publication date |
|--|------------------|-------------------------|-----------------------------|
| US 2011024376 | A1 | 03-02-2011 | NONE |
| ----- | | | |
| US 2012034442 | A1 | 09-02-2012 | NONE |
| ----- | | | |
| WO 2009085015 | A1 | 09-07-2009 | KR 20100117570 A 03-11-2010 |
| | | | US 2011052813 A1 03-03-2011 |
| | | | WO 2009085015 A1 09-07-2009 |
| ----- | | | |