

(51) International Patent Classification:  
C07F 7/21 (2006.01)(21) International Application Number:  
PCT/US2008/065554(22) International Filing Date:  
2 June 2008 (02.06.2008)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:  
60/944,115 15 June 2007 (15.06.2007) US(71) Applicant (for all designated States except US): **MAYATERIALS, INC.** [US/US]; 1375 Folkstone Ct., Ann Arbor, MI 48105 (US).

(72) Inventors; and

(75) Inventors/Applicants (for US only): **LAINE, Richard, M.** [US/US]; 1375 Folkstone Court, Ann Arbor, MI 48105 (US). **POPOVA-GUEORGUEVA, Vera, N.** [US/US]; 7020 Berwick Ct., Ypsilanti, MI 48197 (US). **BARTZ, Daniel, W.** [BG/US]; 771 Valley Circle Dr., Saline, MI 48176 (US). **ASUNCION, Michael, Z.** [US/US]; 555 E. William #12b, Ann Arbor, MI 48104 (US). **KRUG, David, J.** [US/US]; 2884 Hawks Ave, Ann Arbor, MI 48108 (US).(74) Agent: **DOBRUSIN, Eric, M.**; Dobrusin & Thennisch PC, 29 W. Lawrence Street, Suite 210, Pontiac, MI 48342 (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, 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, PG, PH, PL, PT, RO, RS, RU, SC, SD, SE, SG, SK, SL, SM, SV, SY, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW.

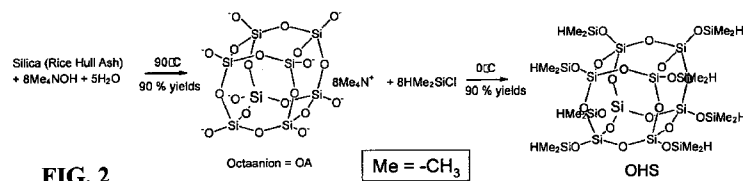
(84) Designated States (unless otherwise indicated, for every kind of regional protection available): ARIPO (BW, GH, GM, KE, LS, MW, MZ, NA, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European (AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV, MC, MT, NL, NO, PL, PT, RO, SE, SI, SK, 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:  
24 September 2009

(54) Title: MULTI-FUNCTIONAL SILSESQUIOXANES FOR NOVEL COATING APPLICATIONS



(57) **Abstract:** A multi-functional silsesquioxane, method of making the same, and coatings incorporating the same, including a polyhedral silsesquioxane including at least one first face and at least one second face that is spaced apart from the at least one first face; at least one first functionality bonded to the at least one first face; and at least one second functionality different from the first functionality, and being bonded to the at least one second face. In one particular respect, silica for the silsesquioxane may be derived from rice hull ash via an octa(tetramethylammonium)silsesquioxane octaanion.

# INTERNATIONAL SEARCH REPORT

International application No  
PCT/US2008/065554

**A. CLASSIFICATION OF SUBJECT MATTER**  
INV. C07F7/21

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)  
C07F

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 practical, search terms used)

EP0-Internal

**C. DOCUMENTS CONSIDERED TO BE RELEVANT**

| Category* | Citation of document, with indication, where appropriate, of the relevant passages                                                                      | Relevant to claim No.   |
|-----------|---------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------|
| X         | US 6 100 417 A (LICHTENHAN JOSEPH D [US] ET AL) 8 August 2000 (2000-08-08)<br>claims 2,6-19; examples 1-3                                               | 1-5,7,9,<br>10          |
| X         | WO 2004/038769 A (INTEL CORP [US])<br>6 May 2004 (2004-05-06)<br>page 9 - page 11                                                                       | 1-7,23,<br>29-31        |
| X         | US 2006/040103 A1 (WHITEFORD JEFFERY A [US] ET AL WHITEFORD JEFFERY A [US] ET AL)<br>23 February 2006 (2006-02-23)<br>claim 20; figures 5c,6; example 2 | 1-7,<br>21-23,<br>29-32 |
| X         | paragraph [0154]                                                                                                                                        | 9                       |
| X         | example 5                                                                                                                                               | 11                      |
| X         | paragraphs [0012], [0015], [0044]                                                                                                                       | 13,14,<br>34-36         |
|           | -----<br>-/--                                                                                                                                           |                         |

☒ 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 document 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

16 February 2009

Date of mailing of the international search report

04/08/2009

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

Richter, Herbert

## INTERNATIONAL SEARCH REPORT

International application No

PCT/US2008/065554

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 02/100867 A (UNIV MICHIGAN [US]; LAINE RICHARD M [US]; TAMAKI RYO [US]; CHOI JIWON) 19 December 2002 (2002-12-19)<br><br>page 12, line 22 - page 13, line 14<br>page 15, paragraph 2; figures 15,16 | 1,3-7,<br>9-19,21,<br>23,<br>31-35,<br>38,39 |
| X         | page 7, line 19 - line 29<br>porosity: page 10, paragraph 1 and page 11, line 29<br>page 11, line 30                                                                                                   | 2                                            |
| A         | page 10, lines 29-30,<br>page 13, paragraph 1                                                                                                                                                          | 20,22                                        |
| X         | -----<br>US 2007/045619 A1 (PARK JONG-JIN [KR] ET AL) 1 March 2007 (2007-03-01)<br>intermediate B,<br>paragraphs [0047], [0050]; claims 5,7,13,14; example 1; compounds 6,7                            | 1,3-7,9,<br>23,31,37                         |
| X         | -----<br>US 2005/033077 A1 (YAMAHIRO MIKIO [JP] ET AL) 10 February 2005 (2005-02-10)<br>paragraph [0001]; examples 37,54,65,69-74                                                                      | 1-5,7,23                                     |
| A         | -----<br>WO 2006/132656 A (HYBRID PLASTICS INC) 14 December 2006 (2006-12-14)<br><br>page 1, line 14; figure 10; example 8<br>-----                                                                    | 1-12,23,<br>31-33,<br>41-46                  |

# INTERNATIONAL SEARCH REPORT

International application No.  
PCT/US2008/065554

## 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 allsearchable 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 reportcovers 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.:

1-40, partially 41-79

### 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: 1-40, partially 41-79

Multifunctional silsesquioxane wherein at least one first functional group is different from an at least second functional group and preparation thereof.  
Use of the compounds for coating.

---

2. claims: partially 41-61

Use of partly known multifunctional silsesquioxanes wherein the first functional group(s) are the same as the second functional group(s) for coating.

---

3. claims: partially 62-79

Preparation of partly known multifunctional silsesquioxanes wherein the first functional group(s) are the same as the second functional group(s)

---

# INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No

PCT/US2008/065554

| Patent document<br>cited in search report |    | Publication<br>date | Patent family<br>member(s)                                                                  | Publication<br>date                                                |
|-------------------------------------------|----|---------------------|---------------------------------------------------------------------------------------------|--------------------------------------------------------------------|
| US 6100417                                | A  | 08-08-2000          | NONE                                                                                        |                                                                    |
| WO 2004038769                             | A  | 06-05-2004          | AU 2003284901 A1<br>CN 101061577 A<br>KR 20050047138 A<br>US 6724091 B1<br>US 2004185603 A1 | 13-05-2004<br>24-10-2007<br>19-05-2005<br>20-04-2004<br>23-09-2004 |
| US 2006040103                             | A1 | 23-02-2006          | US 2008032134 A1                                                                            | 07-02-2008                                                         |
| WO 02100867                               | A  | 19-12-2002          | DE 60125969 T2<br>EP 1328529 A1<br>JP 2004529984 T                                          | 25-10-2007<br>23-07-2003<br>30-09-2004                             |
| US 2007045619                             | A1 | 01-03-2007          | KR 20070023991 A                                                                            | 02-03-2007                                                         |
| US 2005033077                             | A1 | 10-02-2005          | US 2007004932 A1                                                                            | 04-01-2007                                                         |
| WO 2006132656                             | A  | 14-12-2006          | CN 101142332 A<br>EP 1789254 A2<br>JP 2008512559 T<br>KR 20070110254 A                      | 12-03-2008<br>30-05-2007<br>24-04-2008<br>16-11-2007               |