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— *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:
3 June 2010

(54) Title: NANOSTRUCTURED SUPERHYDROPHOBIC, SUPEROLEOPHOBIC AND/OR SUPEROMNIPHOBIC COATINGS, METHODS FOR FABRICATION, AND APPLICATIONS THEREOF

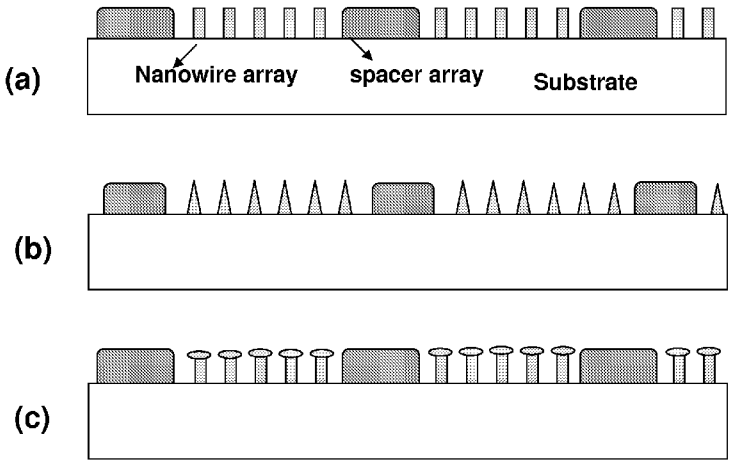

Fig. 26

(57) Abstract: Systems, techniques and applications for nanoscale coating structures and materials that are superhydrophobic with a water contact angle greater than about 140° or 160° and/or superoleophobic with an oil contact angle greater than about 140° or 160°. The nanostructured coatings can include Si or metallic, ceramic or polymeric nanowires that may have a re-entrant or mushroom-like tip geometry. The nanowired coatings can be used in various self-cleaning applications ranging from glass windows for high-rise buildings and non-wash automobiles to pipeline inner surface coatings and surface coatings for biomedical implants.

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INTERNATIONAL SEARCH REPORT

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A. CLASSIFICATION OF SUBJECT MATTER

B05D 5/00(2006.01)i, B05D 1/36(2006.01)i, C09D 5/00(2006.01)i, B05D 7/00(2006.01)i, B82B 3/00(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)

B05D, B32B, C03C, C08J, C08K, B82B

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: (hydrophobic, omniphobic, amphiphobic, liqudiphobic), (nanowire, nanostructure, nanosize), (coat, etch, form), (silic*, aluminum), contact, angle, Lotus

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 2005-0181195 A1 (ROBERT DUBROW) 18 August 2005 See [0001] - [0044]; [0085] - [0100]; claims	1-11
X	WO 2007-126432 A1 (GEORGIA TECH RESEARCH CORPORATION) 08 November 2007 See abstract and claims	1-11
Y	US 2006-0024504 A1 (CURTIS NELSON et al.) 02 February 2006 See figures and claims	1-11
Y	US 2006-0029808 A1 (LEI ZHAI et al.) 09 February 2006 See abstract and claims	1-11
Y	US 2006-0128239 A1 (EDWIN NUN et al.) 15 June 2006 See [0046] - [0052]	1-11
A	US 2007-0026193 A1 (LUZINOV et al.) 01 February 2007 See [0003] - [0033]	1-11
A	WO 2007-102960 A2 (ASHLAND LICENSING AND INTELLECTUAL PROPERTY LLC) 13 September 2007 See claims	1-11

☒ 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	Date of mailing of the international search report
02 APRIL 2010 (02.04.2010)	**08 APRIL 2010 (08.04.2010)**
Name and mailing address of the ISA/KR Korean Intellectual Property Office Government Complex-Daejeon, 139 Seonsa-ro, Seo-gu, Daejeon 302-701, Republic of Korea Facsimile No. 82-42-472-7140	Authorized officer BYUN, Sang Hyun Telephone No. 82-42-481-5618

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PCT/US2009/054235

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	WO 2002-49980 A1 (FERRO GMBH) 27 June 2002 See abstract and claims	1-11
A	WO 2007-054649 A1 (COMMISSARIAT A L'ENERGIE ATOMIQUE et al.) 18 May 2007 See abstract and claims	1-11

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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 extra sheet.

1. ☐ As all required addtional 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.: 1-11

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.

Continuation of Box No. III

1. Claims 1-11 relate to an article comprising a substrate and a plurality of nanowires formed on the substrate.
2. Claims 12-16 relate to a method of making an article.
3. Claims 17-20 relate to a method of making an article.
4. Claims 21-25 relate to a method of making an article.
5. Claims 26-38 relate to an article comprising a substrate and a plurality of nanowires formed on the substrate.
6. Claims 39-42 relate to a method of making an article.
7. Claims 43-44 relate to a method of making an article.
8. Claims 45-49 relate to a method of making an article.
9. Claim 50 relates to a method of making an article.
10. Claim 51 relates to a method of making an article.
11. Claims 52-56 relate to a method of making an article.
12. Claims 57-64 relate to a method of making an article.
13. Claims 65 relates to a method of making an article.
14. Claim 66 relates to a method of making an article.
15. Claim 67 relates to a method of making an article.
16. Claim 68 relates to a method of making an article.

The inventions listed as 1-16 do not relate to a single general inventive concept under PCT Rule 13.1, because, under PCT Rule 13.2 they do not share the same or corresponding technical features.

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No.

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Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 2005-0181195 A1	18.08.2005	AU 2004-233002 A1	04.11.2004
		AU 2004-236260 A1	18.11.2004
		AU 2005-218592 A1	15.09.2005
		CA 2522678-A1	04.11.2004
		CA 2522872-A1	18.11.2004
		CA 2557757-A1	15.09.2005
		EP 1617769 A2	25.01.2006
		EP 1620256 A2	01.02.2006
		EP 1725189 A1	29.11.2006
		EP 1869237 A2	26.12.2007
		EP 2114299 A1	11.11.2009
		JP 2006-526059 A	16.11.2006
		JP 2007-526439 A	13.09.2007
		JP 2007-533371 A	22.11.2007
		US 2004-0206448 A1	21.10.2004
		US 2004-0250950 A1	16.12.2004
		US 2005-0038498 A1	17.02.2005
		US 2005-0221072 A1	06.10.2005
		US 2005-0289084 A1	29.12.2005
		US 2005-181195 A1	18.08.2005
		US 2006-0031492 A1	09.02.2006
		US 2006-0122596 A1	08.06.2006
		US 2006-0159916 A1	20.07.2006
		US 2006-0161644 A1	20.07.2006
		US 2006-0165952 A1	27.07.2006
		US 2006-0168116 A1	27.07.2006
		US 2006-0168161 A1	27.07.2006
		US 2006-0204738 A1	14.09.2006
		US 2007-0275232 A1	29.11.2007
		US 2007-0282247 A1	06.12.2007
		US 7056409 B2	06.06.2006
		US 7074294 B2	11.07.2006
		US 7344617 B2	18.03.2008
		US 7579077 B2	25.08.2009
		US 7651769 B2	26.01.2010
		WO 2004-094303 A2	04.11.2004
		WO 2004-094303 A3	04.11.2004
		WO 2004-099068 A2	18.11.2004
		WO 2004-099068 A3	18.11.2004
		WO 2005-084582 A1	15.09.2005
		WO 2007-078304 A2	12.07.2007
		WO 2007-078304 A3	12.07.2007
		WO 2008-103464 A1	28.08.2008
WO 2007-126432 A1	08.11.2007	CA 2647714-A1	08.11.2007
		CN 101448591 A	03.06.2009
		EP 2004353 A1	24.12.2008
		US 2009-0011222 A1	08.01.2009
US 2006-0024504 A1	02.02.2006	None	

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No.

PCT/US2009/054235

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 2006-0029808 A1	09.02.2006	None	
US 2006-0128239 A1	15.06.2006	AU 2003-253339 A1	04.05.2004
		DE 10242560 A1	25.03.2004
		DE 10393372 D2	06.10.2005
		JP 2005-538271 A	15.12.2005
		US 2009-137169 A1	28.05.2009
		US 7517428 B2	14.04.2009
		WO 2004-033788 A1	22.04.2004
US 2007-0026193 A1	01.02.2007	None	
WO 2007-102960 A2	13.09.2007	US 2008-0221009 A1	11.09.2008
		US 2009-0018249 A1	15.01.2009
WO 2002-49980 A1	27.06.2002	AU 2002-35752 A1	01.07.2002
		CA 2429866-A1	27.06.2002
		CN 1481342 A	10.03.2004
		DE 10063739 A1	27.06.2002
		EP 1347948 A1	01.10.2003
		JP 2004-516216 A	03.06.2004
		KR 10-2003-0069186 A	25.08.2003
		US 2002-0142150 A1	03.10.2002
		US 6800354 B2	05.10.2004
WO 2007-054649 A1	18.05.2007	CN 101370859 A	18.02.2009
		CN 101370859 A	18.02.2009
		EP 1948719 A1	30.07.2008
		FR 2893266 B1	21.12.2007
		JP 2009-515728 A	16.04.2009
		US 2008-0199657 A1	21.08.2008