

(19) World Intellectual Property Organization
International Bureau



(43) International Publication Date
20 September 2007 (20.09.2007)

PCT

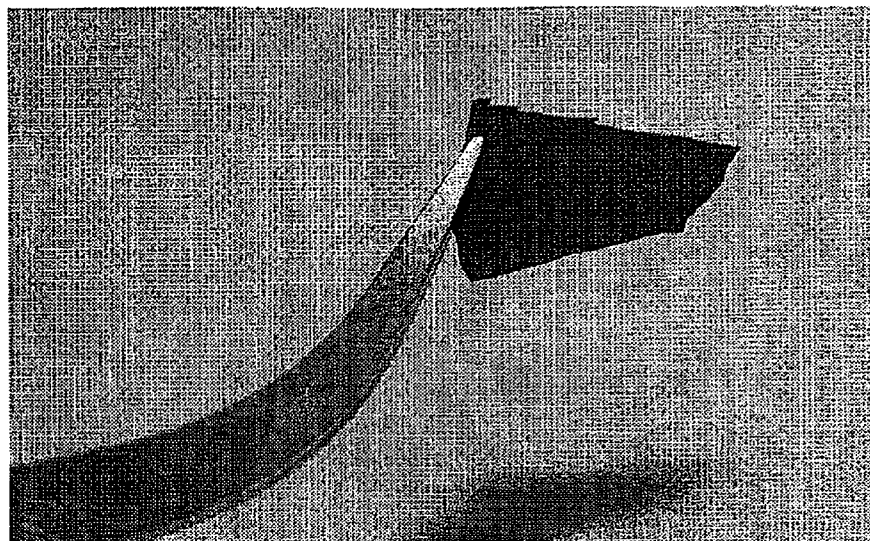
(10) International Publication Number
WO 2007/106502 A3

- (51) International Patent Classification:
H01L 21/20 (2006.01) H01L 21/205 (2006.01)
H01L 21/31 (2006.01)
- (21) International Application Number:
PCT/US2007/006357
- (22) International Filing Date: 13 March 2007 (13.03.2007)
- (25) Filing Language: English
- (26) Publication Language: English
- (30) Priority Data:
60/782,115 13 March 2006 (13.03.2006) US
- (71) Applicant (for all designated States except US):
NANOGRAM CORPORATION [US/US]; 165 Topaz
Street, Milpitas, CA 95035 (US).
- (72) Inventors; and
- (75) Inventors/Applicants (for US only): HIESMAIR,
Henry [US/US]; 100 North Whisman Road #3721,
Mountain View, CA 94043 (US). MOSSO, Ronald, J.
[US/US]; 46553 Chaparral Drive, Fremont, CA 94539
(US). LYNCH, Robert, B. [US/US]; 1229 Murdell Lane,
Livermore, CA 94550 (US). CHIRUVOLU, Shivkumar

- [US/US]; 1065 Marilla Avenue, San Jose, CA 95129
(US). MCGOVERN, William, E. [US/US]; 1346 Martino
Road, Lafayette, CA 94549 (US). HORNE, Craig, R.
[US/US]; 545 Dawn Drive, Sunnydale, CA 94087 (US).
SOLAYAPPAN, Narayan [US/US]; 19766 Drake Drive,
Cupertino, CA 95014 (US). CORNELL, Ronald, M.
[US/US]; 654 Zircon Way, Livermore, CA 94550 (US).
- (74) Agents: DARDI, Peter, S. et al.; Dardi & Associates,
PLLC, Us Bank Plaza, Suite 2000, 220 South 6th Street,
Minneapolis, MN 55402 (US).
- (81) Designated States (unless otherwise indicated, for every
kind of national protection available): AE, AG, AL, AM,
AT, AU, AZ, BA, BB, BG, BR, BW, BY, BZ, CA, CH, CN,
CO, CR, CU, CZ, DE, DK, DM, 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, 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),

[Continued on next page]

(54) Title: THIN SILICON OR GERMANIUM SHEETS AND PHOTOVOLTAICS FORMED FROM THIN SHEETS



(57) Abstract: Thin semiconductor foils can be formed using light reactive deposition. These foils can have an average thickness of less than 100 microns. In some embodiments, the semiconductor foils can have a large surface area, such as greater than about 900 square centimeters. The foil can be free standing or releasably held on one surface. The semiconductor foil can comprise elemental silicon, elemental germanium, silicon carbide, doped forms thereof, alloys thereof or mixtures thereof. The foils can be formed using a release layer that can release the foil after its deposition. The foils can be patterned, cut and processed in other ways for the formation of devices. Suitable devices that can be formed from the foils include, for example, photovoltaic modules and display control circuits.

WO 2007/106502 A3



European (AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HU, IE, IS, IT, LT, LU, LV, MC, MT, NL, PL, PT, RO, SE, SI, SK, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

(88) Date of publication of the international search report:
29 November 2007

Published:

— *with international search report*

For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US2007/006357

A. CLASSIFICATION OF SUBJECT MATTER
H01L 21/20(2006.01)i, H01L 21/31(2006.01)i, H01L 21/205(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)
IPC8 B32B, B01J, C30B, H01L

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 since 1975
Japanese Utility models and applications for Utility models since 1975

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
eKIPASS(KIPO internal) "sheet" "surface" "thickness" "reactive flow" "porosity" "inorganic" "light receiving"



C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	WO 03/035945 A2 (AMMONO SP. ZO.O. et al) 01 May 2003 see the abstract and claim 1	1- 9
A	WO 98/37961 A1 (NANOGRAM CORPORATION) 03 September 1998 see the abstract, claim 1 & 12, Figs. 1 & 2	10 - 13
A	US 6,183,880 B1 (Mitsui Mining & Smelting Co., Ltd.) 06 February 2001 see the abstract, claim 16	14 - 16
X A	US 2005/0037278 A1 (Jun Koishikawa et al) 17 February 2005 see the claim 2 & 3, Fig 1 & 2	17 - 19 25 - 27
X A	US 5,589,403 A (Canon Kabushiki Kaisha) 31 December 1996 see the abstract, claim 1 & 2, Figs. 1 & 2	20, 21, 24 22, 23

Further documents are listed in the continuation of Box C. See patent family annex.

* Special categories of cited documents:	"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
"A" document defining the general state of the art which is not considered to be of particular relevance	"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
"E" earlier application or patent but published on or after the international filing date	"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
"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)	"&" document member of the same patent family
"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	

Date of the actual completion of the international search 12 SEPTEMBER 2007 (12.09.2007)	Date of mailing of the international search report 12 SEPTEMBER 2007 (12.09.2007)
---	---

Name and mailing address of the ISA/KR  Korean Intellectual Property Office 920 Dunsan-dong, Seo-gu, Daejeon 302-701, Republic of Korea Facsimile No. 82-42-472-7140	Authorized officer LEE, SI GEUN Telephone No. 82-42-481-8491 
---	---

INTERNATIONAL SEARCH REPORT

International application No.

PCT/US2007/006357

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 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

International application No.

PCT/US2007/006357

This International Searching Authority found multiple (groups of) inventions in this international application, as follows:

1. claims : 1 - 9

Claims 1 - 9 are directed to a sheet comprising crystalline silicon, germanium, silicon carbide, silicon nitride, doped materials thereof or alloys thereof having an average thickness of no more than about 100 microns and a surface area of at least about 900 square centimeters, wherein the sheet is free or free along one surface while being releasably bound to a substrate along the opposite surface.

2. claims : 10 - 13

Claims 10 - 13 are directed to a method of forming a separable inorganic layer, the method comprising depositing an inorganic material from a reactive flow over an inorganic underlayer on a substrate wherein the underlayer material is soluble in a solvent that does not dissolve the inorganic material.

3. claims : 14 - 16

Claims 14 - 16 are directed to a method for forming a separable inorganic layer, the method comprising depositing an inorganic material over an underlayer material having a porosity of at least about 40 percent.

4. claims : 17 - 19, 25, 26

Claims 17 - 19 are directed to a structure comprising a plurality of patterned islands of a first inorganic material with an average thickness of no more than about 100 microns, the patterned islands being located on top of a layer of a second inorganic material wherein the second inorganic material comprises a transparent substrate or a release layer.

Claims 25 is directed to a method for forming discrete islands of a selected area and an average thickness of no more than about 100 microns, the method comprising cutting a larger sheet secured onto a substrate to form the islands with the selected area, wherein the sheet comprises a crystalline inorganic material, and claim 26 is directed to a photovoltaic module comprising discrete islands formed by the method of claim 25.

5. claims : 20 - 24

Claims 20 - 24 are directed to a method for forming a light receiving structure comprising depositing a semiconductor material onto a textured surface of a transparent substrate.

6. claims : 27

Claims 27 is directed to a display comprising a control element and a plurality of light emitting elements with light emission of each element being under the control of the control element, the control element comprising a sheet of silicon/germanium-based semiconductor having an average thickness of no more than about 100 microns wherein the sheet is patterned with transistors operably interfacing with the sheet.

Since the above mentioned groups of claims do not share any of the technical features identified, a technical relationship between the inventions does not exist.

Accordingly the claims do not relate to one invention or to a single inventive concept, a priori.

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No.

PCT/US2007/006357

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
W003035945A2	01.05.2003	AU2002328130A2	23.12.2002
		AU2002347692BB	02.08.2007
		AU2003238980A1	19.01.2004
		AU2003258919A1	19.01.2004
		CA2449714AA	19.12.2002
		CA2464083A1	01.05.2003
		CN1263206C	05.07.2006
		CN1300901C	14.02.2007
		CN1316070C	16.05.2007
		CN1463309A	24.12.2003
		CN1526037A	01.09.2004
		CN1575357A	02.02.2005
		CN1663088A	31.08.2005
		CN1681974A	12.10.2005
		CZ20033564A3	16.06.2004
		EP01453158A1	01.09.2004
		EP01518009A1	30.03.2005
		EP01770189A2	04.04.2007
		EP1432853A2	30.06.2004
		EP1442162A2	04.08.2004
		EP1453159A1	01.09.2004
		EP1518009A1	30.03.2005
		EP1520329A2	06.04.2005
		HU200401866AB	28.12.2004
		IL159165A0	01.06.2004
		IL161420A0	27.09.2004
		JP15040699	13.02.2003
		JP16168656	17.06.2004
		JP16533391	04.11.2004
		JP17506271	03.03.2005
		JP17530674	13.10.2005
		JP17531154	13.10.2005
		KR1020030036675	09.05.2003
		KR1020030095388	18.12.2003
		KR1020040047968	05.06.2004
		KR1020040049323	11.06.2004
		KR1020040049324	11.06.2004
		KR1020050016907	21.02.2005
		KR1020050054482	10.06.2005
		N020035437A0	05.12.2003
		N020042119A	24.05.2004
		PL354740A1	29.12.2003
		PL370418A1	30.05.2005
PL373986A1	19.09.2005		
PL374180A1	03.10.2005		
PL374184A1	03.10.2005		
PL376672A1	09.01.2006		
PL377151A1	23.01.2006		

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No.

PCT/US2007/006357

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
		RU2004100115A	10.04.2005
		RU2004116073A	10.04.2005
		RU2296189C2	27.03.2007
		TW231321B	21.04.2005
		TW263387B	01.10.2006
		TW546272B	11.08.2003
		TW569471B	01.01.2004
		TW588016B	21.05.2004
		US20020189531A1	19.12.2002
		US20020192507A1	19.12.2002
		US2002189531A1	19.12.2002
		US2002189531AA	19.12.2002
		US2002192507AA	19.12.2002
		US20040089221A1	13.05.2004
		US20040139912A1	22.07.2004
		US20040238810A1	02.12.2004
		US20040251471A1	16.12.2004
		US20040255840A1	23.12.2004
		US20040261692A1	30.12.2004
		US2004089221AA	13.05.2004
		US2004261692A1	30.12.2004
		US2005249255AA	10.11.2005
		US2006032428AA	16.02.2006
		US2007040240AA	22.02.2007
		US6656615BB	02.12.2003
		US7057211BB	06.06.2006
		US7132730BB	07.11.2006
		US7160388BB	09.01.2007
		US7252712BB	07.08.2007
		W02002101120A2	19.12.2002
		W02002101126A1	19.12.2002
		W02003036771A1	01.05.2003
		W02003043150A1	22.05.2003
		W02004003261A1	08.01.2004
		W02004004085A2	08.01.2004
W09837961A1	03.09.1998	AU6056998A1	18.09.1998
		CN1100601B	. .B
		CN1217672	26.05.1999
		DE69813986T2	11.03.2004
		EP907410A1	14.04.1999
		JP11509476	24.08.1999
		JP3159992B2	23.04.2001
		KR1020000065036	06.11.2000
		TW478965A	11.03.2002
		US5958348A	28.09.1999
		US6248216B1	19.06.2001

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No.

PCT/US2007/006357

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US06183880	06.02.2001	CN1179611C	08.12.2004
		CN1244460	16.02.2000
		EP0987931A2	22.03.2000
		JP12059035	25.02.2000
		JP2000059035A2	25.02.2000
		JP3180101B2	25.06.2001
		KR1020000017134	25.03.2000
		SG77265A1	19.12.2000
		TW489139A	01.06.2002
US2005037278AA	17.02.2005	CN1620245A	25.05.2005
		EP1507169A1	16.02.2005
		JP17173551	30.06.2005
		JP2005173551A2	30.06.2005
		KR1020050019058	28.02.2005
US05589403	31.12.1996	AT166184E	15.05.1998
		AU3280993A1	12.08.1993
		AU667071B2	07.03.1996
		DE69318435T2	05.11.1998
		DK554877T3	07.10.1998
		EP0554877A1	11.08.1993
		EP554877B1	13.05.1998
		JP05218469	27.08.1993
		JP2974485B2	10.11.1999
		KR1019930018761	22.09.1993
		KR960001188B1	19.01.1996
		US5500055A	19.03.1996
		US5589403A	31.12.1996
		US5885725A	23.03.1999
		US5981867A	09.11.1999
US6061977A	16.05.2000		