

(19) World Intellectual Property Organization
International Bureau



(43) International Publication Date
21 February 2008 (21.02.2008)

PCT

(10) International Publication Number
WO 2008/020403 A3

(51) International Patent Classification:
H01L 21/318 (2006.01) *H01L 21/28* (2006.01)
H01L 21/314 (2006.01)

(21) International Application Number:
PCT/IB2007/053240

(22) International Filing Date: 14 August 2007 (14.08.2007)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
102006038076.2 16 August 2006 (16.08.2006) DE
102007023258.8 18 May 2007 (18.05.2007) DE
102007035990.1 1 August 2007 (01.08.2007) DE

(71) Applicant (for all designated States except US): **MATTSON TECHNOLOGY, INC.** [US/US]; 47131 Bayside Parkway, Fremont, California 94538 (US).

(72) Inventors; and

(75) Inventors/Applicants (for US only): **NENYEL, Zsolt** [DE/DE]; Sperberweg 4, 89134 Blaustein (DE). **THEILER, Thomas** [DE/DE]; Am Hochstraess 4, 89081 Ulm (DE). **ROTTERS, Georg** [DE/DE]; Weseler Strasse 37, 48249 Dulmen (DE). **MEYER, Hans-Joachim** [DE/DE]; Markusstrasse 3, 01127 Dresden (DE).

(74) Agent: **CASSIDY, Timothy, A.**; Dority & Manning, P.A., P.O.Box 1449, Greenville, South Carolina 29602-1449 (US).

(81) Designated States (unless otherwise indicated, for every kind of national protection available): AE, AG, AL, AM, 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, 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).

Published:

- with international search report
- before the expiration of the time limit for amending the claims and to be republished in the event of receipt of amendments

(88) Date of publication of the international search report:
30 October 2008

(54) Title: METHOD FOR IMPROVING INTERFACE REACTIONS AT SEMICONDUCTOR SURFACES

(57) Abstract: The present invention describes a method for producing ultra-thin thermally stoichiometric or almost stoichiometric nitrides on semiconductor wafers. The method according to the invention includes the H⁺- or D⁺-passivation of the free semiconductor surface, followed by nitriding either in an RTP system, an oven or in plasma. Compounds containing deuterium are preferred in all of the method steps of the invention in order to passivate the interface layer between the silicon surface and the dielectric.



WO 2008/020403 A3

INTERNATIONAL SEARCH REPORT

International application No
PCT/IB2007/053240

A. CLASSIFICATION OF SUBJECT MATTER INV. H01L21/318 H01L21/314 ADD. H01L21/28		
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) H01L C23C		
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) EPO-Internal, INSPEC		
C. DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 2004/094809 A1 (FRANK MARTIN MICHAEL [US] ET AL) 20 May 2004 (2004-05-20) the whole document -----	1, 2, 31, 55-57
Y	US 2003/027392 A1 (GOUSEV EVGENI [US] ET AL) 6 February 2003 (2003-02-06) paragraphs [0019], [0020]; figures 3, 4 -----	1, 11, 18, 19
X	US 6 020 243 A (WALLACE ROBERT M [US] ET AL) 1 February 2000 (2000-02-01) column 4, line 37 - column 5, line 49; figures 3-5 -----	31, 37, 38, 41-45
Y	US 2004/110325 A1 (YOO JAE-YOON [KR] ET AL) 10 June 2004 (2004-06-10) paragraph [0017] - paragraph [0022]; figure 1 -----	1, 11, 18, 19
X	US 2004/110325 A1 (YOO JAE-YOON [KR] ET AL) 10 June 2004 (2004-06-10) paragraph [0017] - paragraph [0022]; figure 1 -----	2, 3, 9, 10

-/--		
<input checked="" type="checkbox"/> Further documents are listed in the continuation of Box C		
<input checked="" type="checkbox"/> 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 <p style="text-align: center; font-weight: bold;">3 March 2008</p>	Date of mailing of the international search report <p style="text-align: center; font-weight: bold;">18/08/2008</p>	
Name and mailing address of the ISA/ European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Tx. 31 651 epo nl. Fax: (+31-70) 340-3016	Authorized officer <p style="text-align: center; font-weight: bold;">Bakker, Jeroen</p>	

INTERNATIONAL SEARCH REPORT

International application No

PCT/IB2007/053240

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	KINOSHITA K ET AL: "Thermal desorption spectroscopy study of HF/DF-treated Si(100) surfaces" JOURNAL OF VACUUM SCIENCE & TECHNOLOGY A (VACUUM, SURFACES, AND FILMS) AIP FOR AMERICAN VACUUM SOC USA, vol. 13, no. 6, November 1995 (1995-11), pages 2709-2714, XP002471286 ISSN: 0734-2101	20, 22, 24, 26-30
A	the whole document	4-8
X	CHENG KANGGUO ET AL: "On the mechanism of interface trap generation under nonuniform channel-hot-electron stress and uniform carrier-injection stress in metal-oxide-semiconductor field-effect transistors" APPLIED PHYSICS LETTERS, AIP, AMERICAN INSTITUTE OF PHYSICS, MELVILLE, NY, US, vol. 79, no. 6, 6 August 2001 (2001-08-06), pages 863-865, XP012030012 ISSN: 0003-6951 page 864, column 2 - page 865, column 1	31
X	US 2005/106894 A1 (AOKI NOBUTOSHI [JP] ET AL) 19 May 2005 (2005-05-19) paragraph [0023] - paragraph [0029]	31, 37, 40, 44, 45
A	US 6 670 241 B1 (KAMAL TAZRIEN [US] ET AL) 30 December 2003 (2003-12-30) column 4, line 20 - column 5, line 21	
A	US 2005/170666 A1 (SEKINE KATSUYUKI [JP] ET AL) 4 August 2005 (2005-08-04) paragraph [0038] - paragraph [0058]; figure 3	1-19
A	US 2002/132493 A1 (WATT VICTOR [US] ET AL) 19 September 2002 (2002-09-19) cited in the application paragraph [0008] - paragraph [0011]	1, 9
A	CLARK W F ET AL: "Improved Hot-Electron Reliability in High-Performance, Multilevel-Metal CMOS Using Deuterated Barrier-Nitride Processing" IEEE ELECTRON DEVICE LETTERS, IEEE SERVICE CENTER, NEW YORK, NY, US, vol. 20, no. 10, October 1999 (1999-10), XP011018666 ISSN: 0741-3106 the whole document	

INTERNATIONAL SEARCH REPORT

International application No.
PCT/IB2007/053240

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 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, 35-45 insofar they depend on claim 31 and 55-57

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, 35-45 insofar they depend on claim 31 and 55-57

Method for producing silicon nitride layers on semiconductor wafers

2. claims: 46-54, claims 32 to 34 and claims 35 to 45 insofar they depend on 32 to 34

Controlled thermal treatment to selectively remove the hydrogen from a semiconductor wafer overlaid with deuterium and hydrogen

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No PCT/IB2007/053240
--

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 2004094809	A1	20-05-2004	NONE
US 2003027392	A1	06-02-2003	JP 3593340 B2 24-11-2004 JP 2003142483 A 16-05-2003
US 6020243	A	01-02-2000	US 6291867 B1 18-09-2001
US 2004110325	A1	10-06-2004	KR 20040048483 A 10-06-2004
US 2005106894	A1	19-05-2005	US 2006105582 A1 18-05-2006
US 6670241	B1	30-12-2003	US 6884681 B1 26-04-2005
US 2005170666	A1	04-08-2005	JP 4073393 B2 09-04-2008 JP 2005166929 A 23-06-2005
US 2002132493	A1	19-09-2002	NONE