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

(19) World Intellectual Property Organization
International Bureau

(43) International Publication Date
20 September 2012 (20.09.2012)

WIPO | PCT

(10) International Publication Number
WO 2012/125656 A3

(51) International Patent Classification:
H01L 21/3065 (2006.01) ***H01L 21/318*** (2006.01)

(21) International Application Number:
PCT/US2012/028957

(22) International Filing Date:
13 March 2012 (13.03.2012)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
61/452,575 14 March 2011 (14.03.2011) US

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(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, 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, 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, MD, 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))*

[Continued on next page]

(54) Title: METHODS FOR ETCH OF SIN FILMS

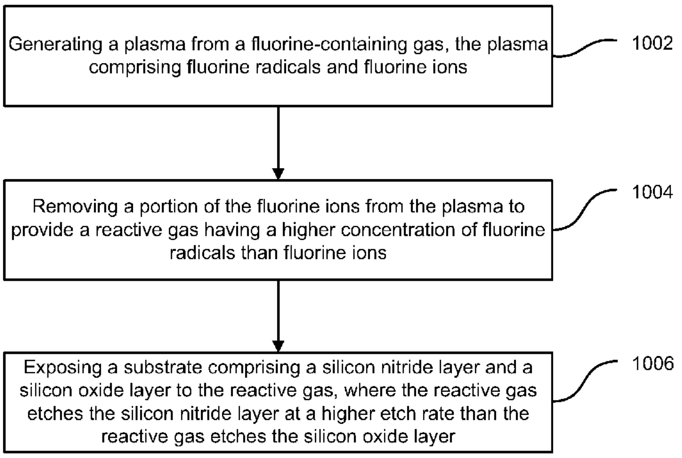

FIG. 10

(57) Abstract: A method of selectively etching silicon nitride from a substrate comprising a silicon nitride layer and a silicon oxide layer includes flowing a fluorine-containing gas into a plasma generation region of a substrate processing chamber and applying energy to the fluorine-containing gas to generate a plasma in the plasma generation region. The plasma comprises fluorine radicals and fluorine ions. The method also includes filtering the plasma to provide a reactive gas having a higher concentration of fluorine radicals than fluorine ions and flowing the reactive gas into a gas reaction region of the substrate processing chamber. The method also includes exposing the substrate to the reactive gas in the gas reaction region of the substrate processing chamber. The reactive gas etches the silicon nitride layer at a higher etch rate than the reactive gas etches the silicon oxide layer.

WO 2012/125656 A3

(88) Date of publication of the international search report:
13 December 2012

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US2012/028957

A. CLASSIFICATION OF SUBJECT MATTER

H01L 21/3065(2006.01)i, H01L 21/318(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)
H01L 21/3065; G06F 19/00; H01L 21/30; B44C 1/22

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:silicon, oxide, etching, nitride, fluorine, gas, plasma, filtering, reactive, ion, radical.

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 2002-0045966 A1 (HEE-TAE LEE et al.) 18 April 2002 See abstract, paragraphs [0033]-[0036],[0050], claims 1-5,15 and figure 2.	1-15
A	US 2009-0104782 A1 (XINLAING LU et al.) 23 April 2009 See abstract, paragraphs [0021]-[0031], claims 1,7,10 and figure 1.	1-15
A	US 2011-0008950 A1 (ZHI XU) 13 January 2011 See abstract, paragraphs [0010]-[0013],[0037]-[0043], claims 1,16 and figures 1,4.	1-15
A	US 2009-0045167 A1 (KOJI MARUYAMA) 19 February 2009 See abstract, paragraphs [0044],[0045] and claims 1,5.	1-15

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

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"&" document member of the same patent family

Date of the actual completion of the international search
16 OCTOBER 2012 (16.10.2012)

Date of mailing of the international search report
18 OCTOBER 2012 (18.10.2012)

Name and mailing address of the ISA/KR
Korean Intellectual Property Office
189 Cheongsa-ro, Seo-gu, Daejeon Metropolitan City, 302-701, Republic of Korea
Facsimile No. 82-42-472-7140

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INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No.

PCT/US2012/028957

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 2002-0045966 A1	18.04.2002	JP 04-070075 B2	02.04.2008
		JP 2002-134490 A	10.05.2002
		KR 10-0375102 B1	08.03.2003
		US 6819969 B2	16.11.2004
US 2009-0104782 A1	23.04.2009	CN 102160154 A	17.08.2011
		JP 2012-505530 A	01.03.2012
		KR 10-2011-0084419 A	22.07.2011
		TW 201025446 A	01.07.2010
		US 8252696 B2	28.08.2012
		WO 2010-042552 A2	15.04.2010
		WO 2010-042552 A3	15.04.2010
US 2011-0008950 A1	13.01.2011	US 8193075 B2	05.06.2012
US 2009-0045167 A1	19.02.2009	JP 2006-278498 A	12.10.2006
		US 2006-0213867 A1	28.09.2006
		US 7442274 B2	28.10.2008
		US 8052886 B2	08.11.2011