

(43) International Publication Date
7 September 2012 (07.09.2012)(51) International Patent Classification:
H01L 21/205 (2006.01)(21) International Application Number:
PCT/US2012/027238(22) International Filing Date:
1 March 2012 (01.03.2012)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
13/037,992 1 March 2011 (01.03.2011) US
13/189,692 25 July 2011 (25.07.2011) US(71) Applicant (for all designated States except US): **APPLIED MATERIALS, INC.** [US/US]; 3050 Bowers Avenue, Santa Clara, California 95054 (US).

(72) Inventors; and

(75) Inventors/Applicants (for US only): **YUDOVSKY, Joseph** [US/US]; 594 Smokey Court, Campbell, California 95008 (US). **KWONG, Garry K.** [US/US]; 1386 S. Blaney Avenue, San Jose, California 95129 (US). **CHANG, Mei** [US/US]; 12881 Corte de Arguello, Saratoga, California 95070 (US). **NGUYEN, Anh N.** [US/US]; 1075 Columbus Drive, Milpitas, California 95035 (US). **THOMPSON, David** [CA/US]; 2590 New Jersey Avenue, San Jose, California 95124 (US).(74) Agent: **BLANKMAN, Jeffrey L.**; Diehl Servilla LLC, 33 Wood Avenue South, Second Floor, Suite 210, Iselin, New Jersey 08830 (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, 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.

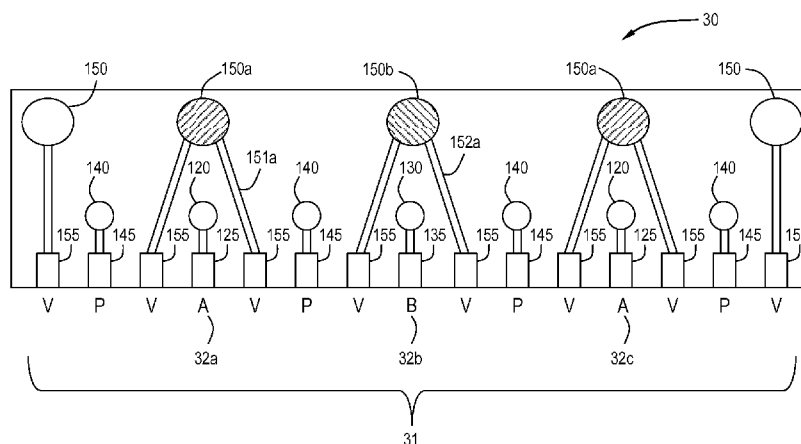
(84) Designated States (unless otherwise indicated, for every kind of regional protection available): ARIPO (BW, GH, GM, KE, LR, LS, MW, MZ, NA, RW, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European (AL, AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HR, HU, 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))

(88) Date of publication of the international search report:
29 November 2012

(54) Title: APPARATUS AND PROCESS FOR ATOMIC LAYER DEPOSITION

**FIG. 13**

(57) Abstract: Provided are atomic layer deposition apparatus and methods including a gas distribution plate comprising at least one gas injector unit. Each gas injector unit comprises a plurality of elongate gas injectors including at least two first reactive gas injectors and at least one second reactive gas injector, the at least two first reactive gas injectors surrounding the at least one second reactive gas injector. Also provided are atomic layer deposition apparatuses and methods including a gas distribution plate with a plurality of gas injector units.

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US2012/027238**A. CLASSIFICATION OF SUBJECT MATTER****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)

H01L 21/205; H01L 21/469; H01L 21/46; B05C 11/10; C23C 16/453; C23C 16/00

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: ALD,reciprocal,repeat,gas distribution,gas injection

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 2004-0067641 A1 (JOSEPH YUDOVSKY) 08 April 2004 See abstract; figures 1-3; paragraphs [0024]-[0053]	1-4, 7-15
A	US 2009-0130858 A1 (LEVY DAVID H.) 21 May 2009 See abstract; figures 1-3B; paragraphs [0082]-[0089], [0125], [0143]-[0162]	1-4, 7-15
A	US 2002-0100418 A1 (GURTEJ SANDHU et al.) 01 August 2002 See abstract; figures 3-6; paragraphs [0029]-[0053]	1-4, 7-15
A	US 2008-0075858 A1 (KOH WON YONG) 27 March 2008 See figures 2-4C; paragraphs [0052]-[0093]	1-4, 7-15

☐ 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

25 SEPTEMBER 2012 (25.09.2012)

Date of mailing of the international search report

25 SEPTEMBER 2012 (25.09.2012)

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

Authorized officer

Kim, Young Jin

Telephone No. 042 481 5771



INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No.

PCT/US2012/027238

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 2004-0067641 A1	08.04.2004	US 6821563 B2	23.11.2004
US 2009-0130858 A1	21.05.2009	CN 101578391 A	11.11.2009
		EP 2122005 A1	25.11.2009
		JP 2010-515821 A	13.05.2010
		JP 2010-515821 T	13.05.2010
		KR 10-2009-0101918 A	29.09.2009
		TW 200837214 A	16.09.2008
		WO 2008-085467 A1	17.07.2008
US 2002-0100418 A1	01.08.2002	US 2002-0195056 A1	26.12.2002
US 2008-0075858 A1	27.03.2008	KR 10-2008-0027009 A	26.03.2008

INTERNATIONAL SEARCH REPORT

International application No.

PCT/US2012/027238**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.: 5-6
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:

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.