

(19) World Intellectual Property Organization  
International Bureau



(43) International Publication Date  
28 September 2006 (28.09.2006)

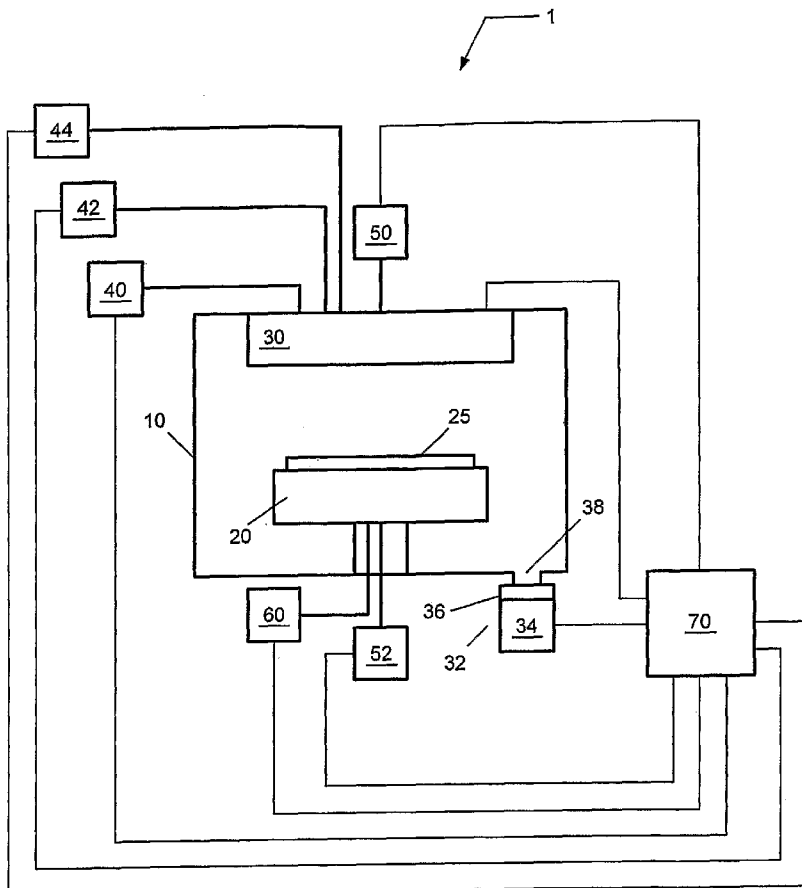
PCT

(10) International Publication Number  
WO 2006/101857 A3

- (51) International Patent Classification: H01L 21/44 (2006.01)
- (21) International Application Number: PCT/US2006/009190
- (22) International Filing Date: 15 March 2006 (15.03.2006)
- (25) Filing Language: English
- (26) Publication Language: English
- (30) Priority Data: 11/083,899 21 March 2005 (21.03.2005) US
- (71) Applicant (for all designated States except US): TOKYO ELECTRON LIMITED [JP/JP]; 3-6, Akasaka 5-chome, Minato-ku, Tokyo, 1078481 (JP).
- (72) Inventors; and
- (75) Inventors/Applicants (for US only): ISHIZAKA, Tadahiro [JP/US]; 15C Candlelight Court, Clifton Park, New York 12065 (US). YAMAMOTO, Kaoru [JP/US]; 64 Mansion Boulevard, Apt. H, Delmar, New York 12054 (US).
- (74) Agent: MAIER, Gregory, J.; Oblon, Spivak, McClelland, Maier & Neustadt, P.C., 1940 Duke Street, Alexandria, Virginia 22314 (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, HR, HU, ID, IL, IN, IS, JP, KE, KG, KM, KN, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, LY, MA, MD, MG, MK, MN, MW, MX, MZ, NA, NG, NI, NO, NZ, OM, PG, PH, PL, PT, RO, RU, SC, SD, SE, SG, SK, SL, SM, SY, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, YU, 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,

[Continued on next page]

(54) Title: A PLASMA ENHANCED ATOMIC LAYER DEPOSITION SYSTEM AND METHOD



(57) Abstract: A method for depositing a film on a substrate using a plasma enhanced atomic layer deposition (PEALD) process includes disposing the substrate in a process chamber configured to facilitate the PEALD process. A first process material is introduced within the process chamber, and a second process material is introduced within the process chamber. Electromagnetic power of more than 600W is coupled to the process chamber during introduction of the second process material in order to generate a plasma that accelerates a reduction reaction between the first and second process materials at a surface of the substrate. The film is formed on the substrate by alternatingly introducing the first process material and the second process material.

WO 2006/101857 A3



FR, GB, GR, HU, IE, IS, IT, LT, LU, LV, MC, 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).

*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.*

**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:**

26 July 2007

# INTERNATIONAL SEARCH REPORT

International application No.  
PCT/US06/09190

**A. CLASSIFICATION OF SUBJECT MATTER**  
 IPC: **H01L 21/44( 2006.01)**

USPC: 438/685

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)  
 U.S. : 438/685, 758; 257/E21.461

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 practicable, search terms used)  
 Please See Continuation Sheet

**C. DOCUMENTS CONSIDERED TO BE RELEVANT**

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X --- Y	US 2004/0151844 A1 (ZHANG et al.) 05 August 2004 (05.08.2004), entire document.	1, 5-10, 13, 14 and 16 ----- 11, 12, and 20
Y, E --- A, E	US 2006/0177579 A1 (SHIN et al.) 10 August 2006 (10.08.2006), entire document.	11, 12 and 20 ----- 2-4, 15 and 17-19

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 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 30 May 2007 (30.05.2007)	Date of mailing of the international search report <div style="text-align: center; font-size: 1.2em; font-weight: bold;">07 JUN 2007</div>
Name and mailing address of the ISA/US Mail Stop PCT, Attn: ISA/US Commissioner for Patents P.O. Box 1450 Alexandria, Virginia 22313-1450 Facsimile No. (571) 273-3201	Authorized officer William Dixon <i>Felicia D. Roberts</i> Telephone No. (571) 272-1600 <i>for</i>

**INTERNATIONAL SEARCH REPORT**

International application No.  
PCT/US06/09190

Continuation of B. FIELDS SEARCHED Item 3:

EAST: US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM\_TDB

Search terms: peald, inert, purge, gas, hydrogen, plasma, enhanced atomic layer deposition, 600w, 700w, 800w, 900w, 1000w, 2000w, 3000w, 4000w, 5000w, 6000w