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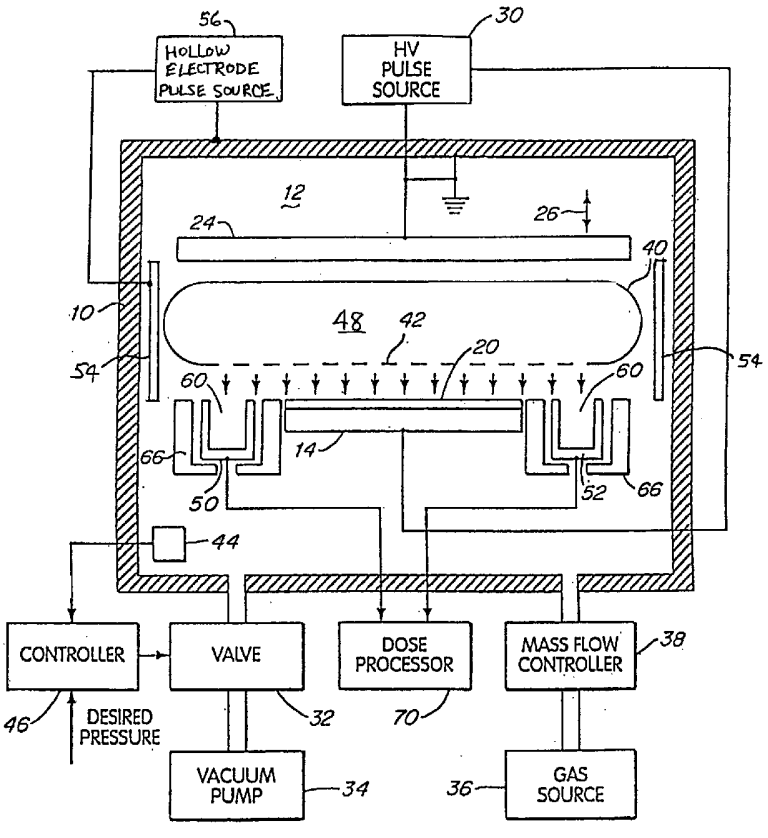
For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

(54) Title: METHOD AND APPARATUS FOR PLASMA IMPLANTATION WITHOUT DEPOSITION OF A LAYER OF BYPRODUCT



(57) Abstract: A method for limiting the formation of a deposited surface layer on a workpiece, such as a semiconductor wafer, during plasma implantation includes introducing a dopant gas and a dilution gas into a plasma doping chamber for ionization to form dopant gas ions and dilution gas ions, and accelerating the dopant gas ions and the dilution gas ions toward the workpiece. The dopant gas ions are implanted into the workpiece, and the dilution gas ions remove a deposited surface layer from the workpiece. The atomic masses of the dopant gas and the dilution gas may be similar to achieve efficient removal of the deposited surface layer.

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INTERNATIONAL SEARCH REPORT

International Application No
PCT/US 03/24158

A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 C23C8/36 C23C14/48 H01J37/32 H01L21/223

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)
IPC 7 C23C H01J H01L

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, PAJ

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	PATENT ABSTRACTS OF JAPAN vol. 2000, no. 03, 30 March 2000 (2000-03-30) & JP 11 354068 A (SEIKO EPSON CORP), 24 December 1999 (1999-12-24) abstract	1-4,6-9, 11,20, 21,24
X	GB 2 336 603 A (METALTECH LIMITED) 27 October 1999 (1999-10-27) page 9; example claims	1,4,6,7, 9
X	PATENT ABSTRACTS OF JAPAN vol. 1997, no. 08, 29 August 1997 (1997-08-29) & JP 09 092804 A (NEC CORP;NISSIN ELECTRIC CO LTD), 4 April 1997 (1997-04-04) abstract	1,4,6, 20,21,24

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[X] Further documents are listed in the continuation of box C.

[X] Patent family members are listed in 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

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"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	Date of mailing of the international search report
22 July 2004	29.08.04

Name and mailing address of the ISA	Authorized officer
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	Brisson, O

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Form PCT/ISA/210 (second sheet) (January 2004)

INTERNATIONAL SEARCH REPORT

International Application No
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C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 5 571 576 A (QIAN LINGQIAN ET AL) 5 November 1996 (1996-11-05) claims; figures 1,2	1,4,6, 10, 17-21,24
X	EP 1 073 087 A (NISSIN ELECTRIC CO LTD) 31 January 2001 (2001-01-31) paragraphs '0032! - '0040!	1,4,6, 10,11, 20,21,24
X	US 4 496 843 A (KOIKE KATUO ET AL) 29 January 1985 (1985-01-29) column 2, line 27 - column 4, line 48	1,3,10, 12-16, 20,21,24
A	US 2001/042827 A1 (FANG ZIWEI ET AL) 22 November 2001 (2001-11-22)	1-16
X	the whole document	17-21,24
X	EP 1 156 511 A (APPLIED MATERIALS INC) 21 November 2001 (2001-11-21) figure 11	20,25

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INTERNATIONAL SEARCH REPORT

International application No.
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Box I Observations where certain claims were found unsearchable (Continuation of item 1 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 II Observations where unity of invention is lacking (Continuation of item 2 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

see additional sheet

1. [X] 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.

[X] 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: 1-6, 8, 11

A method of plasma implantation limiting the formation of a deposited surface layer comprising the use of a dilution gas in additional to the dopant gas

1.1. claims: 1-2

wherein the atomic masses of the dopant gas and the diluant gas are approximatly equal

1.2. claims: 1, 3

wherein the ratio of dilution gas to dopant gas is selected to remove deposited surface layers as they are formed

1.3. claims: 1, 4-5

wherein the ratio of dilution gas to dopant gas is relatively high

1.4. claims: 1, 6, 8

wherein the dopant gas is phosphine and the dilution gas is argon

1.5. claims: 1, 11

wherein the dopant gas and the dilution gas are provided separately to the plasma doping chamber

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2. claims: 1, 6, 7

A method of plasma implantation limiting the formation of a deposited surface layer comprising the use of arsine as dopant gas and krypton or xenon as dilution gas.

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3. claims: 1, 6, 9

A method of plasma implantation limiting the formation of a deposited surface layer comprising the use of B2H6 as dopant gas and neon as dilution gas.

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4. claims: 1, 10

A method of plasma implantation limiting the formation of a deposited surface layer comprising the use in addition to a dopant gas, of a dilution gas wherein the gas are introduced separately in the plasma chamber

FURTHER INFORMATION CONTINUED FROM PCT/ISA/ 210

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5. claims: 1, 12-16

A method of plasma implantation limiting the formation of a deposited surface layer comprising the use in addition to a dopant gas, of a dilution gas including a chemically active component.

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6. claims: 17-19

A plasma doping apparatus suitable for carrying out the process of claim 1, comprising a pulse source for accelerating ions from the plasma toward the workpiece

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7. claims: 20-25

A method of plasma implantation limiting the formation of a deposited surface layer comprising the ionization of a dopant gas in a first chamber and the ionization of a dilution gas in a second chamber.

INTERNATIONAL SEARCH REPORT

Information on patent family members

International Application No
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