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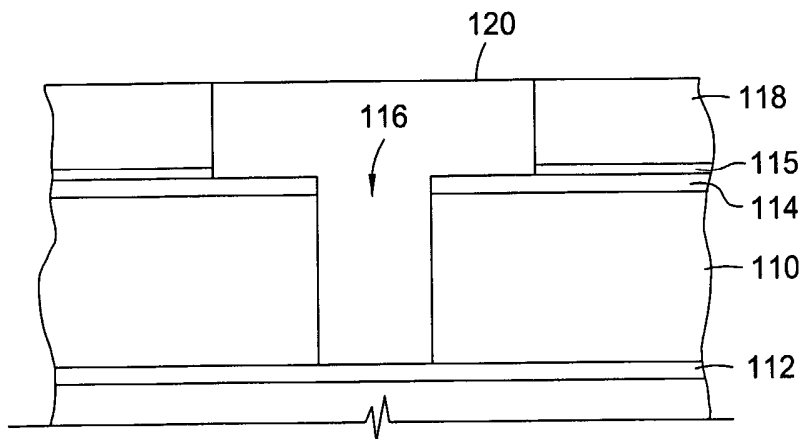
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(54) Title: METHOD OF IMPROVING INTERLAYER ADHESION



(57) Abstract: Methods are provided for processing a substrate for depositing an adhesion layer having a low dielectric constant between two low k dielectric layers. In one aspect, the invention provides a method for processing a substrate including depositing a barrier layer (112) on the substrate, wherein the barrier layer comprises silicon and carbon and has a dielectric constant less than 4, depositing a dielectric initiation layer adjacent the barrier layer, and depositing a first dielectric layer (110) adjacent the dielectric

initiation layer, wherein the dielectric layer comprises silicon, oxygen, and carbon and has a dielectric constant of about 3 or less.

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# INTERNATIONAL SEARCH REPORT

Int. Application No  
PCT/US2004/006849

<b>A. CLASSIFICATION OF SUBJECT MATTER</b> IPC 7 H01L21/31 H01L21/768 C23C16/32 C23C16/40				
According to International Patent Classification (IPC) or to both national classification and IPC				
<b>B. FIELDS SEARCHED</b> Minimum documentation searched (classification system followed by classification symbols) IPC 7 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, WPI Data, PAJ, IBM-TDB				
<b>C. DOCUMENTS CONSIDERED TO BE RELEVANT</b>				
Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.		
X  A  X  A	US 2003/003765 A1 (LYTLE STEVEN ALAN ET AL) 2 January 2003 (2003-01-02) page 2, paragraph 23 page 3, paragraphs 26,27 figure 2  ----- US 6 340 435 B1 (CHAPRA NASREEN GAZALA ET AL) 22 January 2002 (2002-01-22) column 5, line 46 - column 6, line 26 column 9, line 44 - column 11, line 3 column 11, lines 46-51  ----- -/--	1,11, 14-17,20  2-8,12, 13  14-17,20  1-8, 11-13		
<input checked="" type="checkbox"/> Further documents are listed in the continuation of box C.				
<input checked="" type="checkbox"/> Patent family members are listed in annex.				
* Special categories of cited documents :				
<table style="width: 100%; border: none;"> <tr> <td style="width: 50%; border: none; vertical-align: top;">                     "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                 </td> <td style="width: 50%; border: none; vertical-align: top;">                     "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.                      "&amp;" document member of the same patent family                 </td> </tr> </table>			"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
"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;">1 October 2004</p>	Date of mailing of the international search report  <p style="text-align: center;">19. 01. 2005</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;">Ekoué, A</p>			

# INTERNATIONAL SEARCH REPORT

International Application No  
PCT/US2004/006849

**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 6 054 379 A (JENG SHIN-PUU ET AL) 25 April 2000 (2000-04-25) column 10, line 18 - column 11, line 43 column 14, lines 20-23	1,20
A	-----	2-8, 11-18
A	US 6 521 300 B1 (HUANG CHIH-AN ET AL) 18 February 2003 (2003-02-18) column 3, line 23 - column 4, line 26 -----	1-8, 11-18,20

# INTERNATIONAL SEARCH REPORT

International application No.  
PCT/US2004/006849

## Box 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 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 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.:

1 - 8, 11 - 18, 20

Remark on Protest

The additional search fees were accompanied by the applicant's protest.

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: 1-8, 11-18, 20

Method for processing a substrate comprising a dielectric initiation layer between two low-k dielectric layers wherein the dielectric layer is deposited by introducing a processing gas comprising an organosilicon compound, a carbon-containing oxidizing compound, and a nitrating compound into a processing chamber, and reacting the processing gas to deposit the dielectric initiation layer.

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2. claims: 9, 10, 19, 21-23

Method for processing a substrate comprising a dielectric initiation layer between two low-k dielectric layers wherein the dielectric layer(s) is/are cured using an e-beam technique or exposed to a nitrogen-free oxidizing plasma prior to subsequent processing.

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# INTERNATIONAL SEARCH REPORT

Information on patent family members

In	Application No
PCT/US2004/006849	

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 2003003765	A1	02-01-2003 GB 2387027 A	01-10-2003
		JP 2003243505 A	29-08-2003
		US 2003001273 A1	02-01-2003
-----			
US 6340435	B1	22-01-2002 US 6287990 B1	11-09-2001
		US 6054379 A	25-04-2000
		EP 1059664 A2	13-12-2000
		JP 2001110789 A	20-04-2001
		TW 473870 B	21-01-2002
		US 2002074309 A1	20-06-2002
		US 2002084257 A1	04-07-2002
		US 2003197077 A1	23-10-2003
		US 6499679 B1	31-12-2002
		US 2002014545 A1	07-02-2002
		US 2002045361 A1	18-04-2002
		EP 1055012 A2	29-11-2000
		JP 2002503879 T	05-02-2002
		TW 408369 B	11-10-2000
		WO 9941423 A2	19-08-1999
		US 2001004479 A1	21-06-2001
		US 2003064610 A1	03-04-2003
		US 2001005546 A1	28-06-2001
		US 2003124859 A1	03-07-2003
		US 2003162410 A1	28-08-2003
		US 6593247 B1	15-07-2003
		US 6660663 B1	09-12-2003
		US 6537929 B1	25-03-2003
		US 6562690 B1	13-05-2003
		US 6541282 B1	01-04-2003
		US 2004029400 A1	12-02-2004
		US 2004082199 A1	29-04-2004
		US 2004038545 A1	26-02-2004
		US 6627532 B1	30-09-2003
		US 2004166665 A1	26-08-2004
		US 6596655 B1	22-07-2003
US 6072227 A	06-06-2000		
US 2003113992 A1	19-06-2003		
US 6413583 B1	02-07-2002		
US 6511909 B1	28-01-2003		
US 6511903 B1	28-01-2003		
US 2002000670 A1	03-01-2002		
US 2004147109 A1	29-07-2004		
US 2004201103 A1	14-10-2004		
US 2002111042 A1	15-08-2002		
-----			
US 6054379	A	25-04-2000 EP 1055012 A2	29-11-2000
		JP 2002503879 T	05-02-2002
		TW 408369 B	11-10-2000
		US 2002074309 A1	20-06-2002
		US 2002084257 A1	04-07-2002
		WO 9941423 A2	19-08-1999
		US 6072227 A	06-06-2000
		US 6287990 B1	11-09-2001
		US 2001004479 A1	21-06-2001
		US 2003064610 A1	03-04-2003
		US 2001005546 A1	28-06-2001
		US 2003113992 A1	19-06-2003
		US 6340435 B1	22-01-2002

# INTERNATIONAL SEARCH REPORT

Information on patent family members

International Application No  
PCT/US2004/006849

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 6054379	A	US 6413583 B1	02-07-2002
		US 6511909 B1	28-01-2003
		US 2003162410 A1	28-08-2003
		US 6511903 B1	28-01-2003
		US 2002000670 A1	03-01-2002
		US 6593247 B1	15-07-2003
		US 6660663 B1	09-12-2003
		US 6537929 B1	25-03-2003
		US 6562690 B1	13-05-2003
		US 6541282 B1	01-04-2003
		US 2004029400 A1	12-02-2004
		US 2004082199 A1	29-04-2004
		US 2004038545 A1	26-02-2004
		US 6627532 B1	30-09-2003
		US 2004147109 A1	29-07-2004
		US 2004166665 A1	26-08-2004
		US 2004201103 A1	14-10-2004
		US 2002045361 A1	18-04-2002
		US 6596655 B1	22-07-2003
		US 2002111042 A1	15-08-2002
-----			
US 6521300	B1	20-02-2003	US 2003035904 A1
			20-02-2003
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