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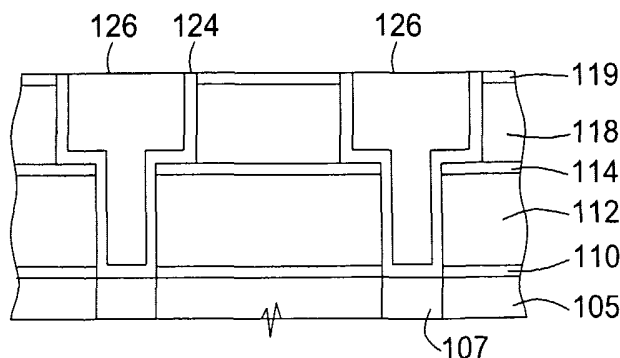
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(54) Title: DIELECTRIC MATERIALS TO PREVENT PHOTORESIST POISONING



(57) Abstract: Methods are provided for depositing a dielectric material for use as an anti-reflective coating and sacrificial dielectric material in damascene formation. In one aspect, a process is provided for processing a substrate including depositing an acidic dielectric layer on the substrate by reacting an oxygen-containing organosilicon compound and an acidic compound, depositing a photoresist material on the acidic dielectric layer, and patterning the photoresist layer. The acidic dielectric layer may be used as a sacrificial layer in forming a feature definition by etching a partial feature definition, depositing the acidic dielectric material, etching the remainder of the feature definition, and then removing the acidic dielectric material to form a feature definition.

## INTERNATIONAL SEARCH REPORT

 International Application No  
 PCT/US2004/015531

 A. CLASSIFICATION OF SUBJECT MATTER  
 IPC 7 H01L21/316 H01L21/027

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 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	US 6 506 497 B1 (SPEAR RICHARD ET AL) 14 January 2003 (2003-01-14) column 6, lines 17-34; figure 3 column 7, line 45 - column 8, line 5 column 8, lines 35,36 column 9; example 2	1,3-7
X	US 6 209 484 B1 (YANG CHAN-LON ET AL) 3 April 2001 (2001-04-03) figure 3	1-3

☐ Further documents are listed in the continuation of box C.

☒ 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

"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

26 October 2004

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05/01/2005

Name and mailing address of the ISA

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# INTERNATIONAL SEARCH REPORT

International application No.  
PCT/US2004/015531

## 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.:

1-7

### 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: 1-7

1. A method of processing a substrate, comprising:  
depositing a dielectric layer on a surface of the substrate;  
depositing an anti-reflective coating on the dielectric layer by reacting an oxygen-containing organosilicon compound and an acidic compound to deposit an acidic dielectric material on the substrate;  
depositing a photoresist material on the anti-reflective coating; and  
patterning the photoresist layer.
2. The method of claim 1, further comprising:  
etching the anti-reflective coating and any underlying dielectric material to define an interconnect opening therethrough; and  
depositing one or more conductive materials to fill the interconnect opening.
3. The method of claim 1, wherein the oxygen-containing organosilicon compound is a siloxane selected from the group of tetraethoxysilane (TEOS), triethoxyfluorosilane (TEFS), 1,3,5, 7-tetramethylcyclotetrasiloxane (TMCTS), dimethyldiethoxy silane (DMDE), octomethylcyclotetrasiloxane (OMCTS), and combinations thereof.
4. The method of claim 1, wherein the acidic compound is an organic acid having one or more carboxylate groups.
5. The method of claim 4, wherein the organic acid is selected from the group of citric acid, acetic acid, formic acid, and combinations thereof.
6. The method of claim 1, wherein the ratio of the oxygen-containing organosilicon compound to acidic compound is between about 5:1 and about 200:1.
7. The method of claim 1, wherein the etch selectivity of acidic dielectric material and dielectric layer is about 1:1.

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2. claims: 8-14

## FURTHER INFORMATION CONTINUED FROM PCT/ISA/ 210

- 8.A method for processing a substrate, comprising:  
depositing a barrier layer on a substrate surface;  
depositing at least one dielectric layer on a substrate surface;  
depositing a first photoresist material on the at least one dielectric layer; patterning the first photoresist layer to define a via for a feature definition; etching the at least one dielectric layer to define a via definition;  
depositing an acidic opaque material in the via definition by reacting an oxygen-containing organosilicon compound and an acidic compound;  
depositing a second photoresist material on the at least one dielectric layer and acidic opaque material;  
patterning the second photoresist layer to define a trench for the feature definition;  
etching the at least one dielectric layer and acidic opaque material to define a trench definition; and  
removing any remaining acidic opaque material and second photoresist material from the feature definition.
- 9.The method of claim 8, further comprising:  
depositing one or more conductive materials; and  
planarizing the one or more conductive materials and at one dielectric material.
- 10.The method of claim 8, wherein the oxygen-containing organosilicon compound is a siloxane selected from the group of tetraethoxysilane (TEOS), triethoxyfluorosilane (TEFS), 1,3,5,7-tetramethylcyclotetrasiloxane (TMCTS), dimethyldiethoxy silane (DMDE), octomethylcyclotetrasiloxane (OMCTS), and combinations thereof.
- 11.The method of claim 8, wherein the acidic compound is an organic acid having one or more carboxylate groups.
- 12.The method of claim 11, wherein the organic acid is selected from the group of citric acid, acetic acid, formic acid, and combinations thereof.
- 13.The method of claim 8, wherein the ratio of the oxygen-containing organosilicon compound to acidic compound is between about 5:1 and about 200:1.
- 14.The method of claim 8, wherein the etch selectivity of acidic opaque material and dielectric layer is about 1:1.
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3. claims: 15-21

## FURTHER INFORMATION CONTINUED FROM PCT/ISA/ 210

15. A method for processing a substrate, comprising:  
depositing a barrier layer on a substrate surface;  
depositing at least one dielectric layer on a substrate surface;  
depositing a first photoresist material on the at least one dielectric layer;  
patterning the first photoresist layer to define a trench for a feature definition; etching the at least one dielectric layer to define a trench definition;  
depositing an acidic opaque material in the trench definition by reacting an oxygen-containing organosilicon compound and an acidic compound; .....  
depositing a second photoresist material on the at least one dielectric layer and opaque material;  
patterning the first photoresist layer to define a via for the feature definition;  
etching the at least one dielectric layer and acidic opaque layer to define a via definition; and  
removing any remaining acidic opaque material and second photoresist material from the feature definition.

16. The method of claim 15, further comprising:  
depositing one or more conductive materials; and  
planarizing the one or more conductive materials and at one dielectric material.

17. The method of claim 15, wherein the oxygen-containing organosilicon compound is a siloxane selected from the group of tetraethoxysilane (TEOS), triethoxyfluorosilane (TEFS), 1,3,5,7-tetramethylcyclotetrasiloxane (TMCTS), dimethyldiethoxy silane (DMDE), octamethylcyclotetrasiloxane (OMCTS), and combinations thereof.

18. The method of claim 15, wherein the acidic compound is an organic acid having one or more carboxylate groups.

19. The method of claim 18, wherein the organic acid is selected from the group of citric acid, acetic acid, formic acid, and combinations thereof.

20. The method of claim 15, wherein the ratio of the oxygen-containing organosilicon compound to acidic compound is between about 5:1 and about 200:1.

21. The method of claim 15, wherein the etch selectivity of acidic opaque material and dielectric layer is about 1:1.

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