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D E C I S I O N
of 4 July 1996

Case Number: T 0988/93 - 3.4.1

Application Number: 88119978.0

Publication Number: 0318954

IPC: H01L 23/52

Language of the proceedings: EN

Title of invention:
Semiconductor device having a composite insulating interlayer

Applicant:
KABUSHIKI KAISHA TOSHIBA

Opponent:
-

Headword:
-

Relevant legal provisions:
EPC Art. 52(1), 56, 123(2)

Keyword:
"Inventive step (yes)"
"Subject-matter extending beyond the content of the application as filed (no)"

Decisions cited:
-

Catchword:
-

Case Number: T 0988/93 - 3.4.1

D E C I S I O N
of the Technical Board of Appeal 3.4.1
of 4 July 1996

Appellant: KABUSHIKI KAISHA TOSHIBA
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Decision under appeal: **Decision of the Examining Division of the European Patent Office dated 9 July 1993 refusing European patent application No. 88 119 978.0 pursuant to Article 97(1) EPC.**

Composition of the Board:

Chairman: G. D. Paterson
Members: Y. J. F. Van Henden
U. G. O. Himmler

Summary of Facts and Submissions

I. During oral proceedings held on 13 May before the Examining Division, the proprietor of European patent application No. 88 119 978.0 (publication number 0 318 954) requested that a European patent be granted on the basis of independent Claim 1 drafted as follows:

"A semiconductor device of a multi-layered interconnection structure comprising:

a semiconductor substrate (21);

at least a first and second patterned interconnection layer (22, 25) subsequently formed over said semiconductor substrate (21);

a first inorganic insulating film (23) formed over said semiconductor substrate (21) and a first interconnection layer (22);

an organic insulating film (24) formed on said first inorganic insulating film (23), said organic insulating film being covered partially by said second interconnection layer (25) and having an eliminated portion (B) spaced apart from an area at which said second interconnection layer (25) is formed; and

a second inorganic insulating film (26) formed on said second interconnection layer (25), said organic insulating film (24) and said first inorganic insulating film, said second inorganic insulating film (26) being in contact with said first inorganic insulating film (23) through said eliminated portion (B) in said organic insulating film (24)."

II. The Examining Division rejected that request setting forth the following reasons:

With respect to a similar semiconductor device described in document

D1: US-A-4 613 888

in relation with Figure 7, the subject-matter of Claim 1 is distinguished in that the organic insulating film (24) is covered partially by the second interconnection layer (25) and has an eliminated portion (B) spaced apart from an area at which said second interconnection layer is formed. This feature does not seem to be disclosed in its generality in the application as filed but, anyway, providing this feature does not require the exercise of inventive ingenuity from a skilled person. Document (D1) copes indeed with the technical problem underlying the present application, namely how to prevent the occurrence of cracks resulting from thermal shocks. Therefore, no inventive step can be perceived in setting this problem. Figure 10 of document (D1) furthermore shows a device in which an organic film (21') is partially covered by the second interconnection layer (16). Providing this feature in a device according to Figure 7 while maintaining a direct contact of the inorganic films (20, 22) would not require the skilled person to display any inventive talent.

III. The Applicant lodged an appeal against the decision of the Examining Division.

With its Statement of Grounds of Appeal, the Appellant filed two sets of claims forming the respective bases of a main and an auxiliary request.

IV. The Board summoned the Appellant to oral proceedings.

V. In response to the summons to attend oral proceedings, the Appellant filed on 4 June 1996 a further set of claims forming the basis of a second auxiliary request.

VI. Oral proceedings were held on 4 July 1996.

During the oral proceedings, the Appellant amended Claim 1 according to the auxiliary request filed with the Statement of Grounds of Appeal and requested that a European patent be granted on the basis of that amended claim.

VII. The claim forming the basis of the Appellant's single request differs from the version of Claim 1 the Examining Division refused in that:

- in the third clause, indefinite article "a" is replaced by definite article "the" before "first interconnection layer (22)", and

- the fourth clause reads "an organic insulating film (24) which is formed on said first inorganic insulating film (23) and on which said second patterned interconnection layer (25) is formed, which has an eliminated position (B) and".

VIII. In support of its request, the Appellant argued in substance as follows:

Document (D1) discloses the most relevant prior art. In the first embodiment described there, the direct contact between the layers (20) and (22) plays a major part. To achieve this contact, the second wiring layer (16) is used as a mask while etching the portions of the silica film (21) it does not cover. The use of the second metal

wiring layer as a mask is also an essential feature of the process for manufacturing a semiconductor device according to the second embodiment described in document (D1). It has the obvious advantage that no separate masking step is necessary, so that the manufacturing process is easier to carry out. Therefore, a person skilled in the art has no reason to deviate from the teachings of document (D1). The latter consequently does not suggest to remove the sub-insulating interlayer only in a limited area such that a protruding portion is formed.

The device known from document (D1) already exhibits a high reliability owing to the direct contact between the silicon nitride film (20) and the final passivation layer (22). The object of the present invention is thus to provide a semiconductor device with a multilayered structure achieving a still higher reliability by preventing the occurrence of cracks caused by thermal shocks.

In the achievement of this purpose, the protruding portion of the organic layer (24) not covered by the second interconnection layer (25) is of particular importance. The gist of the invention is indeed to be seen not only in the provision of a direct contact between the inorganic insulating films (23, 26), but also in that the interconnection layer (25) has no contact with the eliminated portion (B), since said portion must be distinct from the bonding pad area. Contrary to what is shown in the Figures 7 and 10 of document (D1), no steep step is thus formed at the eliminated portion of the organic insulating layer, whereby cracks prevention is improved. The surprisingly high efficiency of the proposed measure is evidenced by the diagram annexed to the Statement of Grounds of Appeal and in which the curves A, B and C respectively

relate to a conventional semiconductor device according to Figure 2A of the patent application, to the first embodiment disclosed in document (D1) and to a device embodying the invention. The latter device is clearly superior to both known devices.

IX. After deliberation by the Board, the decision was announced that the decision under appeal is set aside and that the case is remitted to the Examining Division with order to grant a European patent with Claim 1 as filed during the oral proceedings and description to be adapted accordingly.

Reasons for the Decision

1. *Interpretation of the claim*

Claim 1 of the application as filed states that the organic film (24) is eliminated at a portion (B) through which the second inorganic insulating film (26) is formed on said organic insulating film (24). It is however clear that only a portion of the organic film (24) not covered by the second interconnection layer (25) can be eliminated. Furthermore, for a film to be formed **on** another film **through** an eliminated portion of said other film, a requirement to be met is that the free surface of the other film exhibits at least a portion which is not vertical with respect to the original surface of that film, before a portion thereof was eliminated. As a matter of fact, all embodiments of the invention represented in the figures comprise portions of the organic layer (24) protruding from beneath the second interconnection layer (25). Besides, since parts of the organic layer (24) of which the thickness has been reduced also correspond to an

"eliminated portion" of that layer, said eliminated portion is not necessarily "spaced apart from the area at which the second interconnection layer (25) is formed". Therefore, the objections raised by the Examining Division regarding that point do not apply to the claim filed during the oral proceedings of 4 July 1996, which claim shall be interpreted as stating that a portion of the second inorganic film (26) covers a portion of the organic film (24) protruding from beneath the second interconnection layer (25).

2. *Requirement of Article 123(2) EPC*

With consideration to the preceding and to the relevant passages of the application as filed, namely Claim 1 and page 3, lines 16 to 33, the Board is thus satisfied that the subject-matter of the claim filed during the oral proceedings of 4 July 1996 does not extend beyond the content of said application as filed.

Therefore, this claim complies with the requirement of Article 123(2) EPC.

3. *Novelty*

3.1 Keeping the terminology of the claim, document (D1) discloses in connection with the Figures 4 to 7 a process for making a semiconductor device of multilayered interconnection structure - see the title -, which semiconductor device comprises

- a semiconductor substrate (11) - see column 3, line 45;

- a first and a second patterned interconnection layer (13, 16) subsequently formed over said semiconductor substrate - see column 3, lines 46 to 49, and column 4, lines 33 to 35;

- a first inorganic insulating film (20) formed over said semiconductor substrate (11) and the first interconnection layer (13) - see column 3, lines 46 to 58;

- an organic insulating film (21) which is formed on said first inorganic insulating film (20) and on which said second patterned interconnection layer (16) is formed, which has an eliminated portion - see: from column 3, line 58, to column 4, line 11; column 4, lines 33 to 39 - and

- a second inorganic insulating film (22) formed on said second interconnection layer (16) and said first inorganic insulating film (20), said second inorganic insulating film (22) being in contact with said first inorganic insulating film (20) through said eliminated portion in said organic insulating film (21) - see Figure 7 and column 5, lines 15 to 25.

3.2 The claimed subject-matter is thus distinguished over the prior art which can be derived from document (D1) in that the second inorganic insulating film (26) is also formed on the organic insulating film (24), this being construed as meaning that the second inorganic film (26) covers a portion of the organic film (24) protruding from beneath the second interconnection layer (25).

The Appellant did not contest that.

4. *Inventive step*

None of the documents cited in the European Search Report gives an incentive or even a suggestion to modify a semiconductor device according to Figure 7 of document (D1) in such a way that a portion of the organic film (21) protrudes from beneath the second interconnection layer (16) and is covered by the second inorganic film (22). Contrary to the reasoning that the Examining Division expressed, Figure 10 of document (D1) is of no relevance, since any contact between the inorganic insulating films is excluded there. Finally, the Board has no reason to question the validity of the Appellant's experimental results, of which the curves of the diagram annexed to the Statement of Grounds of Appeal give account.

In the Board's judgment, therefore, the claim filed during the oral proceedings of 4 July 1996 involves an inventive step.

5. Therefore, said claim is allowable - Article 52(1) EPC in conjunction with Article 56 EPC.

Order

For these reasons it is decided that:

1. The decision of the Examining Division is set aside.

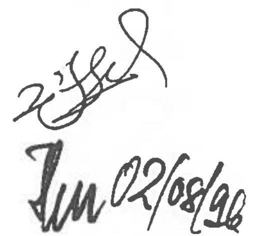
2. The case is remitted to the first instance with an order to grant a patent with Claim 1 as filed during the oral proceedings, and description to be adapted accordingly.

The Registrar:

M. Beer

The Chairman:

G. D. Paterson



Order

For these reasons it is decided that:

1. The decision of the Examining Division is set aside.

2. The case is remitted to the first instance with an order to grant a patent with Claim 1 as filed during the oral proceedings, and description to be adapted accordingly.

The Registrar: The Chairman:

M. Beer G. D. Paterson