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D E C I S I O N
of 25 August 1999

Case Number: T 0444/95 - 3.4.3

Application Number: 88113503.2

Publication Number: 0304077

IPC: H01L 21/00

Language of the proceedings: EN

Title of invention:
Method of forming a fine pattern

Applicant:
Kabushiki Kaisha Toshiba

Opponent:
-

Headword:
Fine pattern with photoresist/TOSHIBA

Relevant legal provisions:
EPC Art. 56

Keyword:
"Inventive step - yes (after amendments)"

Decisions cited:
-

Catchword:
-

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Beschwerdekammern | Boards of Appeal | Chambres de recours

Case Number: T 0444/95 - 3.4.3

D E C I S I O N
of the Technical Board of Appeal 3.4.3
of 25 August 1999

Appellant: Kabushiki Kaisha Toshiba
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Decision under appeal: **Decision of the Examining Division of the European Patent Office posted 18 January 1995 refusing European patent application No. 88 113 503.2 pursuant to Article 97(1) EPC.**

Composition of the Board:

Chairman: R. K. Shukla
Members: G. L. Eliasson
A. C. G. Lindqvist

Summary of Facts and Submissions

I. European patent application No. 88 113 508.2 was refused by a decision of the examining division dated 18 January 1995. The reason for the refusal was that the subject matter of claim 1 according to all the requests lacked an inventive step with respect to the prior art documents

D1: Patent Abstracts of Japan, vol. 10, No. 217 (E-423) [2273] 29 July 1986 & JP-A-61 54 629; and

D2: EP-A-0 151 948.

According to the decision, a skilled person would realize that the second layer 3 in document D1 has to be planar in order to allow an exact pattern replication. The necessity of providing planarized structures in a multilevel metallisation structure is discussed in document D2, and it is suggested therein to form a planar surface by first depositing a further photoresist layer on the non-planar second layer and subsequently etching back both the second photoresist and the second layer.

Furthermore, according to the decision, amendments to claim 1 of all the requests and to claim 5 according to the main request contravened the requirement of Article 123(2) EPC.

II. The appellant (applicant) lodged an appeal on 20 March 1995 paying the appeal fee on 21 March 1995. A statement of grounds of the appeal was filed on 18 May 1995 along with claims forming the basis of a main request and two auxiliary requests.

III. In response to a communication from the Board raising objections of lack of clarity under Article 84 EPC, the appellant filed with its letter dated 16 July 1999 new claims 1 to 7 along with amended description and figures forming a new main request.

IV. With letter of 5 August 1999 the appellant filed a corrected page 1a of the description, and requested that the decision under appeal be set aside and a patent be granted according to one of the following requests:

Main request:

Claims: Nos. 1 to 7 filed with the letter dated 16 July 1999

Description: page 3 as originally filed
pages 1, 2, 4 - 11 filed with the letter dated 16 July 1999
page 1a filed with the letter dated 5 August 1999

Drawings: Sheets 1/5 to 5/5 filed with the letter dated 16 July 1999

First auxiliary request:

Claims: Nos. 1 to 6 of the first auxiliary request filed with the statement of grounds of the appeal

Description and figures as for the main request

Second auxiliary request:

Claims: Nos. 1 to 6 of the first auxiliary request filed with the statement of grounds of the appeal

Description and figures as for the main request

Furthermore, the appellant requested oral proceedings in case none of the above requests was to be granted.

V. Claim 1 according to the main request reads as follows:

"A method of forming a fine pattern, comprising:

a first step of forming a first film (8;20) on a substrate (1);

a second step of coating a first photoresist (9;21) on the surface of said first film (8;20);

a third step of forming raised and recessed portions (10-12; 23, 22) defining a predetermined fine pattern in the top surface of said first photoresist (9;21) so that said recessed portions (10-12;22) are exposed to the outside;

a fourth step of depositing a second film (13;24) of a material on said first photoresist (9;21) and said recessed portions (22), the second film having a non-planarized exposed surface;

a fifth step of coating a second photoresist (15;25) on said second film (13;24), whereby the second photoresist has a planar exposed surface;

a sixth step of etching back said second photoresist (15;25) and said second film (13;24) above the level of the raised portions (23) in the top surface of the first photoresist (9;21) to expose the raised portions, the etching rates for the second photoresist and the material of the second film being nearly equal; and

a seventh step of removing exposed portions of said first photoresist (9;21) by anisotropic etching having an etching rate for the material of the second film which is different from that for the first photoresist so that said material of said second film (16;18;26) deposited within said recessed portions (10-12;22) acts as a mask."

VI. The appellant presented essentially the following arguments in support of his requests:

Document D1 teaches that the photoresist layer is **rotary-coated** (also known in the art as spin-coated) with SiO_2 to provide a flat upper surface. Referring to column 6, lines 6 to 10 of the application, it was pointed out that spin-coating, or rotary-coating, is a well-known technique in the art for forming layers with a planar upper surface. Thus, the skilled person would know that with a sufficiently thick SiO_2 layer, the top surface would be substantially flat. There would therefore be no need to consider the teaching of document D2 in connection with the method of document D1.

Reasons for the Decision

1. The appeal is admissible.

2. *Amendments (Article 123(2) EPC)*

2.1 Claim 1 is based on original claims 1, 3, and 4 together with the features of column 6, lines 1 to 10, 14 to 16 and column 7, lines 7 to 14 of the application as filed (the quoted passages relate to the application as published).

2.2 Although the objections pursuant to Article 123(2) EPC did not form part of the reasons for the refusal of the application in suit, the examining division stated in its decision that the feature "anisotropic etching" in claim 1 was not originally disclosed in this generality, so that the claim did not comply with Article 123(2) EPC. The term "RIE method using an etching gas containing O_2 as its major component" is however consistently mentioned in the description for the etching step corresponding to step seven of claim 1 (cf. Figures 2(e) and 3(d); column 6, lines 21 to 27; column 7, lines 19 to 22), and there were no indications in the description that other anisotropic etching methods would be detrimental to the device.

As the appellant noted in the statement of grounds of the appeal, original claim 1 contains the feature "anisotropic etching." Thus, the Board finds that contrary to the findings of the examining division, the term "anisotropic etching" is originally disclosed in its generality. Moreover, the passages of the description quoted above also state that "anisotropic etching of the photoresist is carried out", and thereby convey the teaching to the skilled person that the anisotropic nature of the etching process is essential. Therefore, the Board is satisfied that the requirements of Article 123(2) EPC are met.

3. *Clarity*

The claims are considered by the Board to be clear and therefore meet the requirements of Article 84 EPC.

4. *Prior art*

4.1 Document D1 which is considered the closest prior art discloses a method of forming a fine pattern, comprising the steps of (cf abstract):

(i) coating a first photoresist 2 on the surface of a silicon substrate 1;

(ii) forming raised and recessed portions defining a predetermined fine pattern in the top surface of the first photoresist;

(iii) depositing a second layer 3 (called SiO_2 layer in D1) over the first photoresist 2 and the recessed portions;

(iv) etching back the second layer 3 above the level of the photoresist 3 to expose the raised portions; and

(v) removing the exposed portions of the photoresist 3 using anisotropic etching using the portions of the second layer 3 left in the recesses as mask.

4.2 Document D2 discloses a method of forming a planar surface on a level of conductive wires, so-called wiring layers. The wire level 10 is covered by an oxide layer 12 which is not planar (cf. D2, Figure 1). The oxide layer 12 is covered with a photoresist 14 having a planar surface. The photoresist and oxide are etched back to form the desired planar structure, where special attention is paid to the problem of controlling the etch process so that the photoresist and the oxide etch simultaneously (D2, Figure 2).

5. *Novelty and Inventive step*

5.1 The process of claim 1 differs from that of document D1 in that it further specifies:

(a) the formation of a first film on the substrate;

(b) the deposition of a **non-planar** second film (13, 24) on the first photoresist;

(c) the coating of a second photoresist over the second film; and

(d) a step of etching back the second photoresist and the second film above the level of the raised portions in the top surface of the first photoresist, using an etching process where the etch rates of the second photoresist and of the second layer are about the same.

Thus, the subject matter of claim 1 is new (Article 54 EPC).

5.2 As stated in the decision under appeal, the technical problem addressed by the present application is to ensure the planarity of a film acting as an etching mask in the formation of a fine pattern from an underlying film (first film (8, 20)) and thereby avoiding any distortion in the pattern replication (cf. also the application as published, column 3, lines 36 to 43).

5.3 In support of inventive step of the claimed subject-matter, it was submitted by the appellant that a skilled person faced with the above problem when carrying out the method of document D1 would never consider the teaching of document D2, since the spin-

coating method used in document D1 to deposit the second layer made of SiO_2 is a well-known technique in the art for forming layers with a planar upper surface. Therefore, the skilled person using the method of document D1 would merely have to form the second layer sufficiently thick in order to guarantee the planarity of the second layer.

The examining division had in its decision however reasoned that since document D1 dealt with recesses having "small step differences" compared to the thickness of the resist, the deposition solely of SiO_2 of reasonable thickness wold probably be sufficient to planarise the surface. Under the conditions given in the application, however, it was argued, such a SiO_2 coating would become unreasonably thick. Thus, according to the decision, the spin-coating step "to flatten the surface" in document D1 does not apply to structures where the recesses are deep.

5.5 Contrary to the above view of the examining division, the Board is of the view that a spin-coating method of the kind used in document D1 is capable of forming a second layer with a sufficiently planar upper surface required under the conditions specified in the application. This is supported by the following document which was cited in the European search report:

D4: Extended Abstracts, vol. 87-1, No. 1, 1987, pages 236 and 237.

Document D4 concerns a method of the same kind as shown in Figure 6 of the application as filed: An oxide deposited using spin-coating is formed on a patterned photoresist where the depth of the recesses is about 0.5 μm (cf. D4, "Results and Discussions", Figure 1(c), as well as, the application in suit, Figure 6b). The oxide is etched back so that it only remains in the

openings of the photoresist (D4, Figure 1(d); application, Figure 6c). As in document D1, the deposited oxide layer must be sufficiently planar so that the etch-back step can be carried out successfully. In document D4 this problem is recognized, and, as a solution, an improved spin-coating process is suggested (cf. D4, Figure 2). Thus, a skilled person having problems with planarity when using the method of document D1 would consult document D4 and not document D2, to provide a planar oxide layer, since this would merely entail an optimization of the spin-coating step.

5.6 Furthermore, although planarization is discussed in document D2, the problem of forming a fine pattern is not addressed therein, since the conductive wires are already patterned. The planarization is achieved in document D2 with a view to forming further planar metalization layers. Thus, a skilled person faced with the above-stated technical problem when carrying out the method of document D1 would also for this reason not consider document D2, since it is not concerned with the problem of forming fine patterns.

5.7 For the foregoing reasons, the subject matter of claim 1 according to the main request is not obvious having regard to the cited prior art, and accordingly involves an inventive step as required by Article 52(1) EPC.

Claims 2 to 7 are dependent on claim 1, and therefore involve an inventive step.

Order

For these reasons it is decided that:

1. The decision under appeal is set aside.

2. The case is remitted to the department of the first instance to grant a patent on the basis of the following documents:

Claims: No. 1 -to 7 filed with the letter dated 16 July 1999

Description: page 3 as originally filed
pages 1, 2, 4 to 11 filed with the letter dated 16 July 1999
page 1a filed with the letter dated 5 August 1999

Drawings: Sheets 1/5 to 5/5 filed with the letter dated 16 July 1999

The Registrar: The Chairman:

D. Spigarelli R. K. Shukla