BESCHWERDEKAMMERN DES EUROPÄISCHEN PATENTAMTS

BOARDS OF APPEAL OF THE EUROPEAN PATENT OFFICE

CHAMBRES DE RECOURS DE L'OFFICE EUROPEEN DES BREVETS

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File Number: T 787/90 - 3.4.2

Application No.: 83 111 411.1

Publication No.: 0 114 229

Title of invention: Method of forming a lift-off mask with improved oxygen barrier layer

Classification: G03F 7/02

D E C I S I O N
of 19 October 1992

Applicant: International Business Machines Corporation

Headword:

EPC Article 56 EPC

Keyword: "Inventive step (yes)"
"Unexpected effects achieved by the combination of the teachings of two documents"

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Beschwerdekammern | Boards of Appeal | Chambres de recours

Case Number : T 787/90 - 3.4.2

D E C I S I O N
of the Technical Board of Appeal 3.4.2
of 19 October 1992

Appellant : International Business Machines Corporation
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Representative : Kreidler, Eva-Maria, Dr. rer. nat.
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Decision under appeal : **Decision of Examining Division of the European Patent Office dated 31 July 1989 refusing European patent application No. 83 111 411.1 pursuant to Article 97(1) EPC.**

Composition of the Board :

Chairman : E. Turrini
Members : W.W.G. Hofmann
L.C. Mancini

Summary of Facts and Submissions

I. European patent application No. 83 111 411.1 (priority document US-452 549 dated 23 December 1982) (publication number 0 114 229) was refused by decision of the Examining Division.

II. The reason given for the refusal was that the subject-matter of Claim 1 was obvious to the skilled person having regard to the disclosure in the following documents:

(D1) Proceedings of the International Electron Devices Meeting, San Francisco, US, 13 to 15 December 1982, pages 395 to 398 (printed in 1982; the exact day of printing is not given but the Appellant did not object to consider this document as a prior art document); and

(D2) US-A-3 822 928.

The Examining Division held in particular that all the features of the pre-characterising portion of Claim 1 were disclosed in D1; the person skilled in the art knew that spin-coating is not the only possibility of depositing organosilicon polymer layers on a substrate, from D2 he knew in particular that such layers can be deposited by plasma polymerising, and that this deposition is done for forming smooth, pinhole-free and crosslinked films; D2 does not belong to a remote technical field since plasma polymerisation is a generally known deposition technique, D2 is related to thin film fabrication, and the Applicant himself is considering the field of thin film light waveguides in the description of the application; the subject-matter of Claim 1 was therefore merely an obvious application of the teaching of D2 in the method of D1 with an appropriate choice of the temperature range.

III. The Appellant lodged an appeal against the decision.

IV. After two communications from the Board, the Appellant filed a Claim 1 which reads as follows:

"1. Method of forming a lift-off mask with improved oxygen barrier layer of an organosilicon polymer comprising the steps of:

A) blanket depositing a first layer (6) of a solvent soluble organic polymer on substrate (1);

B) depositing on said first layer a second oxygen barrier layer (7);

C) overcoating said second layer (7) with a blanket layer (8) of a radiation sensitive resist and patterning said resist layer using standard lithographic techniques;

D) forming conformal openings (10A, 10B) in said barrier layer (7) by reactive ion etching in a fluorine containing ambient, using the patterned resist (9A, 9B) as a mask;

E) reactive ion etching in an oxygen containing ambient the exposed portions of said first layer (6) to form openings (11A, 11B) therein and extending therethrough to expose corresponding portions of said substrate

characterized in that

said second oxygen barrier layer (7) of an organosilicon polymer is applied by plasma polymerization on said first layer (6) from an ambient containing monomers selected from the group consisting of organosilicones, including

organosilanes, organosilazanes, organosiloxanes, and mixtures thereof; and

heat treating said layer (7) for 10 to 30 minutes at temperatures in the range of 250 to 400°C."

Claims 2 to 9 are dependent on Claim 1.

V. In the statement of grounds filed in support of the appeal, the Appellant argued in substance as follows: The oxygen RIE barrier layers achieved by plasma polymerisation of organosilicon monomers according to the present application are advantageous as compared with the known silicon oxide and silicon nitride barrier films as well as the solution coated or cast polydimethylsiloxane barrier films disclosed in D1. The oxygen barrier layers achieved according to the dry process of Claim 1 are pinhole-free and eliminate the problems of spin coated polyorganosilicon layers which, on the soluble underlayers necessary for lift-off masks, generally result in cracking or solvent induced crazing due to interfacial mixing and polymer polymer incompatibility.

D2 is a publication in the field of thin film light guides which is remote from the field of oxygen barrier layers for the production of lift-off masks used in integrated circuit technology. A person skilled in the field of the present invention would not have followed developments in such a remote technical field as that of D2. The fact that prior art relating to thin film light wave guides is mentioned in the description of the application is no proof for an objectively existing relationship between the two fields (cf. decision T 28/87, OJ 1989, 383). The teaching of the present invention therefore involves an inventive step.

VI. The Appellant requested that the decision of the Examining Division be set aside and a patent be granted for the application at issue.

Reasons for the Decision

1. The appeal is admissible.

2. The present Claim 1 is based on the original Claim 1, in which features have been rearranged without changing their sense. The fact that the last feature now mentions "temperatures" instead of "a temperature" (original feature C), does not change the sense since it was evident from the beginning that an elevated temperature could not be reached without passing through intermediate temperatures, and that "at a temperature in the range of ..." was not meant in the sense of "only one constant temperature".

Apart from the correction of a few obvious errors, Claims 2 to 9 correspond to original Claims 2 to 9. The description has, in substance, only been amended by a further indication of relevant prior art.

The Board is therefore satisfied that the present application documents do not contain subject-matter extending beyond the content of the application as filed (Article 123(2) EPC).

3. <u>Novelty</u>

3.1 D1 (considered prior art document - see point II of the present decision) discloses a method for forming a mask with an organosilicon oxygen barrier layer, comprising the steps A) to E) defined in Claim 1 (cf. in particular "Abstract"; page 396, first paragraph; and Figure 3). It

is self-evident and has not been contested by the Appellant that this known tri-level mask to be formed is a lift-off mask and that the organosilicon is a polymer.

The subject-matter of Claim 1 differs from the known method by the fact that the organosilicon layer is applied by plasma polymerisation from an ambient containing monomers selected from the group consisting of organosilicones, including organosilanes, organosilazanes, organosiloxanes and mixtures thereof (instead of spin-coating according to D1), and by the fact that the layer is heat treated for 10 to 30 minutes at temperatures in the range of 250 to 400°C (instead of 200°C for 30 minutes).

3.2 IBM Technical Disclosure Bulletin, Vol. 24 (April 1982), pages 5538 and 5539 (D4) also discloses a method of forming a tri-level structure, evidently serving as a lift-off mask, having all the steps A) to E) of the present Claim 1.

However, the oxygen barrier layer is not made of plasma polymerised organosilicon polymer, but consists of plasma deposited silicon oxide. Heat treatment is not mentioned.

3.3 D2 relates to applying on a substrate a layer of an organosilicon polymer by plasma polymerisation from an ambient containing organosilanes, organosiloxanes or mixtures thereof (cf. in particular column 2, lines 47 to 50; column 4, line 48 to column 5, line 12; column 6, lines 3 to 9; and Claims 1, 3 and 4).

The method according to Claim 1 differs from this known method by the fact that a lift-off mask is formed, in which mask the organosilicon polymer serves as an oxygen barrier layer, and that consequently the steps A) to E) are provided. Whereas D2 mentions a heat treatment of

140°C for up to 180 minutes (column 6, lines 28 to 34), the method of Claim 1 comprises a heat treating step of 250 to 400°C for 10 to 30 minutes.

3.4 The teaching of US-A-3 310 424 (D3) is more remote from the subject-matter of Claim 1.

3.5 The method according to Claim 1 is therefore novel in the sense of Article 54 EPC.

4. Inventive step

4.1 D1 is the document closest to the present subject-matter since it also relates to the production of tri-level mask structures comprising an organosilicon polymer as an oxygen RIE barrier layer.

Starting from this prior art, the problem underlying the claimed method is to be seen in improving uniformity, thickness control and shelf life of the oxygen barrier layer (cf. page 4, line 25 to page 5, line 4 of the application in suit). Moreover, a low defect (pinhole) density is desired (page 1, lines 9 and 10, and page 4, lines 21 to 24 of the application in suit).

4.2 According to Claim 1, this problem is solved by using plasma polymerisation from an ambient containing organosilicon monomers for applying the organosilicon barrier layer, assisted by a particular subsequent heat treatment. The Board is convinced that the structure of plasma polymerised polyorganosilicon is different from spin-coated polyorganosilicon, that by the claimed method the properties of better uniformity, thickness control, shelf life and low defect rate are achieved, and that moreover, as the Appellant has pointed out, cracking and crazing of the layers (caused by the application of spin-

coating solution on a solvent soluble lift-off mask base layer) is avoided.

4.3 This method of forming organosilicon polymer layers by plasma polymerisation is already known per se (see document D2). However, the layers produced according to D2 are light guide films having a thickness of about 3 μm (column 6, line 14) whereas layers suitable for acting as oxygen RIE barriers in lift-off masks typically have a thickness of 0.1 to 0.3 μm (cf. D1, page 396, first paragraph, line 8, and present application, page 19, lines 9 and 23). A person skilled in the art would (and could) not deduce from D2 that the film material advantageous for guiding light would form an efficient and advantageous oxygen barrier layer in a lift-off mask structure as described in D1: He could not deduce that cracking would be avoided since a light guiding layer does not require a solvent soluble base layer. From the mention of a smooth and pinhole-free film (column 1, line 47 of D2), he could not deduce that the plasma polymerized film, when adapted to form part of the lift-off mask according to D1, would be "uniform" and free of "defects" in the sense of the present application since the meaning of the term "smooth" (or "uniform") depends very much on the absolute thickness of the layer and on the intended use; i.e., a material which is "pinhole-free" in the sense that it does not scatter light to a considerable degree in a 3 μm thick film, might still have defects in the sense that, as a 0.3 μm thick layer, it does not shield the base layer homogeneously enough from the active particles of the oxygen RIE etching process. The effects achieved by the subject-matter of the present Claim 1 must therefore be regarded as surprising.

4.4 Since the above-mentioned combination of features from D2 with features from D1 leads to an unexpected effect, this combination cannot be considered obvious.

Moreover, even a combination of the teachings of D1 and D2 would not have led directly to the subject-matter of Claim 1 since the parameters of the heat treatment according to Claim 1 are suggested neither in D1 nor in D2.

4.5 Under these circumstances it need not be investigated whether, as the Appellant has claimed, the technical field of D2 is too remote from the technical field of D1 for the skilled person in the one field to follow the developments in the other field. The Board wishes, however, to point out that the fact that prior art corresponding to D2 is cited in the description of the present application, provides no indication in either direction regarding the question of remoteness of said prior art since such judgment has to be performed objectively and not from the subjective point of view of the Applicant formulating the application documents (corresponding to decision T 28/87, OJ EPO 1989, 383, cited by the Appellant).

4.6 The Board therefore comes to the conclusion that the subject-matter of Claim 1 involves an inventive step in the sense of Article 56 EPC and that this claim is therefore allowable under Article 52(1) EPC.

5. The dependent claims are also allowable under Article 52(1) EPC by virtue of their dependence on Claim 1.

6. In Claims 4, 8 and 9, the reference sign (B) (originally relating to feature B. of Claim 1) is no longer correct. On page 4, line 12, a typing error has to be corrected.

Order

For these reasons, it is decided that:

1. The decision under appeal is set aside.

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

Description: pages 1, 2, 5, 8, 9, 12, 13, 16, 17, 20 as originally filed;

pages 3, 4, 6, 7, 10, 11, 15, 18, 19, filed on 6 April 1992, with the word "materials" corrected at line 12 of page 4;

pages 3a, 3b, 14, filed on 19 September 1992;

Claims: 1 filed on 19 September 1992;
2 to 9 filed on 6 April 1992, with the reference sign "(B)" deleted in Claims 4, 8 and 9;

Drawings: Figures 1A to 2B (sheets 1/3 to 3/3) as originally filed.

The Registrar: The Chairman:

P. Martorana E. Turrini