BESCHWERDEKAMMERN DES EUROPÄISCHEN PATENTAMTS | BOARDS OF APPEAL OF THE EUROPEAN PATENT OFFICE | CHAMBRES DE RECOURS DE L'OFFICE EUROPEEN DES BREVETS

Internal distribution code:
(A) [ ] Publication in OJ
(B) [ ] To Chairmen and Members
(C) [X] To Chairmen

D E C I S I O N
of 2 July 1996

Case Number: T 0313/94 - 3.4.1

Application Number: 87113097.7

Publication Number: 0265638

IPC: H01L 21/308

Language of the proceedings: EN

Title of invention:
Lithographic image size reduction

Applicant:
International Business Machines Corporation

Opponent:
-

Headword:
-

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

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

Decisions cited:
-

Catchword:
-

Europäisches Patentamt | European Patent Office | Office européen des brevets

Beschwerdekammern | Boards of Appeal | Chambres de recours

Case Number: T 0313/94 - 3.4.1

D E C I S I O N
of the Technical Board of Appeal 3.4.1
of 2 July 1996

Appellant: International Business Machines Corporation
Armonk
New York 10504 (US)

Representative: Klein, Daniel
IBM France
France Intellectual Property Department
F-06610 La Gaude (FR)

Decision under appeal: **Decision of the Examining Division of the European Patent Office dated 10 November 1993 refusing European patent application No. 87 113 097.7 pursuant to Article 97(1) EPC.**

Composition of the Board:

Chairman: G. D. Paterson
Members: Y. van Henden
U. Himmler

Summary of Facts and Submissions

I. In response to the first action of the Examining Division, the applicant filed on 26 October 1990 a set of eleven claims annexed to a letter dated 18 October 1990.

Claims 1 and 7 of this set are independent claims reading:

"1. Process for forming a mask having an opening of a size smaller than obtainable by lithography, including the steps of:

providing a substrate (10);
depositing a layer (14) of photoresist material onto said substrate layer;
patterning the photoresist material to form an opening (16') therein, said opening having substantially vertical walls (20) and minimum size dictated by resolution limit of lithography;
forming a conformal layer (22) of a conformal material of a different nature with respect to said photoresist material on the resulting structure including said vertical walls; and
anisotropically etching said conformal layer (22) to provide sidewalls (24) of said conformal layer material located only on said vertical walls whereby the size of said opening (16') is reduced to produce a new opening (16).

7. A lithographic mask formed onto a substrate (10) comprising:

a radiation-sensitive imaging layer (14) formed on the release layer and having at least one first opening (16') extending therethrough, and having substantially vertical walls; and
inorganic sidewalls (24) of a common and uniform thickness formed on the interior surface of said walls, defining a second opening (16) concentric with said first opening and having therefore a smaller size."

To these claims were respectively appended the remaining claims 2 to 6 and 8 to 11.

II. In a second communication issued on 19 February 1991, the Examining Division took the view that independent claims 1 and 7 of the new set offended against Article 123(2) EPC and, furthermore, that no claim of this set covered inventive subject-matter.

III. In response to said second communication of the Examining Division, the applicant performed in dependent claim 2 an amendment of no substantial consequence, but maintained all other claims of the set received on 26 October 1990.

IV. The Examining Division refused the European patent application in its decision dated 10 November 1993, on the ground that the wording of the amended claim 1 was inconsistent with the original disclosure, and therefore contravened Article 123(2) EPC. The decision also set out reasons why claim 1 did not satisfy the requirement for an inventive step - Articles 52(1) and 56 EPC - having regard to the cited prior art documents:

D1: Patent Abstracts of Japan, volume 9, No. 15 (E-291)[1738], 22 January 1985 & JP-A-59/163829,

D2: EP-A-0 010 596 and

D3: Patent Abstracts of Japan, volume 9, No. 56 (E-302)[1779], 12 March 1985 & JP-A-59/197137.

Its reasoning may be summarized as follows:

(a) Article 123(2) EPC.

The amended feature of claim 1 "forming a conformal layer (22) of a conformal material of a different nature with respect to said photoresist material" was not disclosed in the original application as filed.

According to the description of the application in suit as filed, the material chosen for making the conformal layer (22) shall simply be such that it can be deposited at a temperature low enough not to cause degradation of the patterned photoresist layer (14). This includes the provision of a conformal layer made of the same material as said photoresist layer.

Specific inorganic materials are mentioned on page 7 of the original application only by way of example for making the conformal layer (22), and the such conformal layer is therefore not necessarily made of an inorganic material.

The amended claim thus contravenes the requirement of Article 123(2) EPC and the application has to be refused.

In its communication dated 19 February 1991 which preceded its decision, the Examining Division stated that "a conformal layer of **inorganic material** (claims 3 and 7) was also not disclosed in the original application.

(b) Article 56 EPC - inventive step.

None of the claims involves an inventive step. The process described in document (D1) aims at forming a mask with an opening of a size smaller than achievable by lithography. While carrying out that process, the conformal film (3) is removed from all areas except the sidewalls of the openings in the resist layer, whereby new openings with reduced size are produced. Besides, documents D2 and D3 relate to similar methods in which a conformal layer of silicon dioxide is deposited on a mask and anisotropically etched so that it remains only on the sidewalls of the openings provided in said mask. A limitation to the use of silicon dioxide for making the conformal layer would thus not confer inventive merit upon the claimed subject-matter. The applicant submitted that the use of inorganic conformal coatings would be advantageous because, after removal of the resist, "stand-alone" sidewalls are left. A restriction of claim 1 to the conformal layer materials listed on page 7 of the description would not be regarded as inventive, either. The properties of organic and inorganic materials regarding etching selectively and resistance to high temperatures are well known to the skilled person, so that he would anyway select an inorganic material if faced with the problem of providing "stand-alone" side walls with a thickness smaller than obtainable by lithography.

The remaining claims do not involve an inventive step either. The use of the so called "release layer" corresponds to the lift-off technique disclosed in S.M. Sze's handbook headed "Semiconductor Devices: Physics and Technology" (J. Wiley & Sons, New York, 1985), page 441. From document (D2), it is known to use conformal layers of silicon dioxide, silicon nitride or polycrystalline silicon to reduce line widths. Hardening the photoresist material prior to forming the conformal layer is obviously necessary to preclude degradation of the pattern. Finally, the use of the claimed mask structure for standard applications such as etching trenches in a substrate is not inventive.

V. The applicant lodged an appeal against the decision of the Examining Division.

VI. With its statement of grounds of appeal, the appellant filed a new set of eleven claims requesting that a European patent be granted on this basis.

With respect to the version filed on 26 October 1990, claim 1 of this new set differs in that:

- it mentions the step of "coating the substrate with a releasable layer (12);" after that of "providing a substrate (30)";

- "an organic" was inserted between "a layer of" and "photoresist material" in the specification of the next following step;

- in the last but one clause, "of a different nature with respect to said photoresist material" was deleted and "of any inorganic material which can be deposited at a temperature low enough as not to cause degradation with respect to said photoresist material" was inserted after "vertical walls".

To this claim are appended the claims numbered 2 to 6, claim 6 being drafted as follows:

"The process as in any above claims further including the step of: removing the said release layer leaving sidewalls".

Finally, claims 7 to 11 of the new set are identical to those of the set received on 26 October 1990.

VII. In its statement of grounds of appeal, the appellant did not refer to the objections to patentability the Examining Division had raised under Article 123(2) EPC and argued in relation to inventive step substantially as follows:

Documents (D1) and (D3) relate to processes comprising the successive depositions of a masking layer and a conformal layer made of materials having the same nature, whereby it is likely that the contours of the first layer soften as the second layer is being deposited. No selectivity between the layers is thus available and, if no special care is taken, the structure can get planarized. Document (D1) shows a mask in which the underlayer (2) - which is also the imaging layer - and thus the conformal layer (3) are made of organic materials, namely a photoresist and polyethylene or PMMA, respectively. The technique disclosed there should suffer in terms of resolution, for the trench forming step in a RIE or plasma etch equipment requires

more resistant spacers. According to document (D3), in a similar process, the underlying layer (22) - which is not an imaging layer - and the conformal layer (26) are made of silicon dioxide, i.e. an inorganic material. The patterned masking layer (22) and spacers (23) are intended to remain over the structure whereas, according to the invention, they can be eliminated if so required. The claimed process furthermore offers the possibility of leaving stand alone spacers for potential subsequent use if needed. Such minute sidewalls are now known to be of great interest in the manufacture of IGFETs with very short channels. Moreover, according to a preferred embodiment of the invention, the release layer (12) is made of silicon dioxide and thus cooperates with the spacers (24) to provide an excellent resolution of the trench. Its purpose is not to produce a patterned layer as in the case of a lift-off process. Finally, the Examining Division did not discuss the difficulty to be overcome in depositing an inorganic material such as silicon dioxide on an organic material, nor the technical prejudice it would have represented to the skilled person. Such deposition is seldom performed because it would obviously result in a low quality oxide and outgassing effects liable to deteriorate the sidewalls.

VIII. In connection with the requirement of Article 123(2) EPC which was first raised by the Examining Division in its communication dated 19 February 1991, the appellant submitted the following arguments in its response of 20 June 1991:

According to the invention, the material forming the conformal layer (22) may be selected among: polysilicon, Si_xO_y, silicon dioxide, silicon nitride and silicon oxynitride, which all are inorganic materials. It is therefore clear that the materials of the conformal

layer and of the underlying photoresist layer (15) are of different natures. It is consequently suggested to introduce the word "inorganic" in front of the list of inorganic materials suitable for making the conformal layer, and also to mention that said list is not limitative.

Reasons for the Decision

1. *Article 123(2) EPC*

The amended claim 1 which was filed with the statement of grounds of appeal includes the feature that the conformal layer (22) is formed "of a conformal material on the resulting structure including said vertical walls of any inorganic material which can be deposited at a temperature low enough as not to cause degradation with respect to said photoresist material".

As discussed in paragraph IV above, the application as filed simply states that the material of the conformal layer (22) is such that it can be deposited at a temperature low enough not to cause degradation of the photoresist layer. Page 7 of the description identifies a number of suitable materials, which are all in fact inorganic materials. However, as correctly pointed out by the Examining Division in its communication dated 19 February 1991, the originally filed application does not disclose the use of "an inorganic material" (in general) as the conformal layer. Thus in the Board's judgement, the amended claim 1 includes the feature which is set out above and which was not disclosed in the application as filed. Consequently the amended claim 1 violates Article 123(2) EPC. The same conclusion applies mutatis mutandis to the amended claim 7.

Thus the set of claims filed with the statement of grounds of appeal is contrary to Article 123(2) EPC and not allowable.

2. The Board cannot accept the appellant's submission that, since no organic materials were mentioned by way of example for making the conformal layer, said layer should necessarily be made of an inorganic material. Having regard to the last paragraph of the description, it is indeed clear that SiO_2, Si_xO_y, Si_3N_4, silicon oxynitride and polysilicon are preferred materials for that purpose, but no conclusion can be inferred therefrom as regards the suitability of other materials - either organic or inorganic - which can be deposited at a temperature low enough to preclude degradations of a patterned layer of photoresist.

3. *Article 56 EPC - inventive step*

For the reasons hereinafter explained, the Board is furthermore of the opinion that none of the claims received with the statement of grounds of appeal involves an inventive step within the meaning of Article 56 EPC.

3.1 According to document (D1), the layer (2) of photoresist is patterned using exposure to light. The orientation of the resulting walls is consequently that of the incident light rays. Furthermore, it is general practice to provide normal incidence of said light rays for otherwise the resolution of the lithographic step would be low. It is therefore beyond any doubt that, as suggested by the figures of document (D1), the opening in the photoresist layer (2) has "substantially vertical walls". Likewise, it is just as clear that the process known from document (D1) is suitable for producing a mask having "an opening of a size smaller than

obtainable by lithography". As a matter of fact, despite the conciseness of the disclosure, a skilled person reading document (D1) would understand that the opening formed in the photoresist layer (2) before deposition of the conformal layer (3) has "the minimum size dictated by resolution limit of lithography". Otherwise, the process would indeed be deprived of any interest. Finally, at least as far as polyethylene is used for making the conformal layer, it may not be denied that the latter is made of "a material which can be deposited at a temperature low enough as not to cause degradation with respect to the photoresist material".

The subject-matter of claim 1 is thus distinguished over the process disclosed in document (D1) in that the substrate (10) is coated with a releasable layer (12) and in that the material forming the conformal layer (22) is inorganic.

3.2 The Board concurs with the Examining Division that lift-off is widespread practice in the technical field of the invention. Furthermore, a skilled person knows that the achievement of the result expected from the lift-off process is not dependent upon a particular application thereof, as the appellant nonetheless submits - see the statement of grounds of appeal, second paragraph of the last sheet. Likewise, the argument that the releasable layer (12) would cooperate with the spacers (24) to improve the resolution of a trench - second sheet of the statement of grounds of appeal, third paragraph - is irrelevant, for it is nowhere claimed that said layer should be made of silicon dioxide.

The Board also concurs with the Examining Division that a skilled person does not need to display inventiveness to make a choice among materials liable to form the successive layers of a mask structure. Besides, the

alleged prejudice against the deposition of silicon dioxide - see the paragraph bridging the second and third sheets of the Statement of Grounds of Appeal - may not be considered as evidence of an inventive step in itself. The appellant acknowledged indeed that such measure results in obvious contamination of the oxide sidewalls, resulting in a low quality oxide and well known outgassing effects that could deteriorate said sidewalls, but did not supply evidence that this did not occur, nor tried to explain why this should not occur when carrying out the invention.

3.3 In the Board's judgement, therefore, claim 1 does not involve an inventive step and, for the same reasons, claims 3 and 7 do not involve an inventive step either.

3.4 As regards the remaining claims, it is obvious to remove, after completion of any subsequent step in a process of making integrated circuits, layers which are no longer needed, for instance a layer of photoresist - cf. claim 2. Furthermore, if claim 2 is to be interpreted as meaning that only the photoresist layer is removed, thus leaving the sidewalls, then it offends against the requirement of Article 123(2) EPC as explained under 3 above. Besides, no unexpected advantages can result from compliance with the conditions set to the thicknesses of the various layers, nor from the provision of a thick underlayer if a non erodable mask is needed.

In paragraph 5 of its communication dated 19 February 1991 the Examining Division had taken the view that forming a non stoichiometric layer of silicon oxide by plasma deposition from hexamethyldisilazane might involve an inventive step. Nevertheless, the Board does not share this opinion. Hexanethyldisilazane is indeed a compound which is liquid at room temperature, hence

liable to vaporize, and which, when reacted with oxygen, gives only silicon oxide as solid product. To a person skilled in the art of making integrated circuits, it was thus obvious to produce a layer of silicon oxide by plasma deposition from hexamethyldisilazane.

4. Under these circumstances, the Board decides to dismiss the appeal.

Order

For these reasons it is decided that:

The appeal is dismissed.

The Registrar: The Chairman:

M. Beer G. D. Paterson