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D E C I S I O N
of 17 July 2002

Case Number: T 1098/98 - 3.4.3

Application Number: 90122969.0

Publication Number: 0430280

IPC: H01L 21/20

Language of the proceedings: EN

Title of invention:

Selective and non-selective deposition of Si_{1-x} Ge_x on a Si substrate that is partially masked with SiO₂

Applicant:

Hewlett-Packard Company, A Delaware Corporation

Opponent:

-

Headword:

-

Relevant legal provisions:

EPC Art. 56, 84, 123(2)

Keyword:

"Clarity (yes - after amendments)"

"Inventive step (yes - after amendments)"

Decisions cited:

-

Catchword:

-



Case Number: T 1098/98 - 3.4.3

D E C I S I O N
of the Technical Board of Appeal 3.4.3
of 17 July 2002

Appellant: Hewlett-Packard Company
A Delaware Corporation
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Palo Alto
CA 94304 (US)

Representative: Liesegang, Roland, Dr.-Ing.
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Decision under appeal: Decision of the Examining Division of the
European Patent Office posted 7 July 1998
refusing European patent application
No. 90 122 969.0 pursuant to Article 97(1) EPC.

Composition of the Board:

Chairman: R. K. Shukla
Members: G. L. Eliasson
J. H. Van Moer

Summary of Facts and Submissions

I. European patent application No. 90 122 969.0 was refused in a decision of 7 July 1998. The ground for the refusal was that the subject matter of claim 1 according to a main request and an auxiliary request did not involve an inventive step with respect to the documents:

D1: Applied Physics Letters, vol. 52, no. 11, 14 March 1988, pages 895 to 897;

D3: 3rd international Symposium on Silicon Molecular Beam Epitaxy, E-MRS Conference, Strasbourg, 30 May to 2 June 1989, Part II, published in Thin Solid Films, vol. 184, January 1990, pages 93 to 106;
and

D5: US-A-4 579 621.

Furthermore, it was held in the decision under appeal that claims 1 and 2 according to both the main and auxiliary requests did not meet the requirements of Article 84 EPC.

II. Claim 1 according to the main request under consideration in the decision under appeal reads as follows:

"1. A method of depositing a silicon-germanium layer on a silicon substrate masked with silicon dioxide, the method comprising:

growing a silicon dioxide layer on a silicon substrate;

preparing a pattern of windows to be etched through the silicon dioxide layer such that the total area of the windows to be etched is larger than the total area of the silicon dioxide layer to be left after the etching process; etching windows through the silicon dioxide layer according to the pattern to expose the silicon substrate, and selectively depositing a silicon-germanium layer on the exposed substrate in the window by chemical vapour deposition."

III. The reasons given in the decision under appeal can be summarized as follows:

- (a) Document D5 discloses a selective CVD epitaxial growth method of silicon on a patterned silicon substrate using a mask formed of silicon oxide. It is also stated therein that the teaching can be applied to other material systems as well.
- (b) The method of claim 1 according to the main request differs from that of document D5 in that (i) a pattern of windows is etched through the silicon dioxide layer such that the total area of the windows is larger than the total area of the silicon dioxide layer to be left after the etching process; and (ii) that a silicon-germanium layer is deposited instead of a silicon layer.
- (c) A skilled person wishing to optimize the use of the silicon wafer, while at the same time, improving the carrier mobility would automatically seek to form the area of the windows larger than the total area of silicon oxide left. Furthermore, as taught in document D1, silicon-germanium offers

improved carrier mobility. Therefore, the skilled person would consider selective deposition of silicon-germanium using the process parameters known from document D3.

- (d) Claim 1 does not contain all essential features, since the deposition parameters, which were considered essential, are not included in claim 1. Moreover, the claimed pattern of silicon dioxide windows appears to be in contradiction with the subject matter of the original claim 4 and the original description.

IV. The appellant (applicant) lodged an appeal was filed on 4 September 1998, paying the appeal fee the same day. A statement of the grounds of appeal was filed on 6 November 1998. The appellant requested the grant of a patent on the basis of the main request, auxiliary request 1 or auxiliary request 2 as set out in the statement of the grounds of appeal.

V. In its communication accompanying summons for oral proceedings, the Board informed the appellant of the provisional view that claim 1 was not clear and that independent claim 2 of the appellant's requests did not appear to involve an inventive step.

VI. In response, the appellant filed with the letter dated 17 June 2002 a further auxiliary request 3.

VII. Following the discussion of the issues of clarity and inventive step at the oral proceedings held on 17 July 2002, the Board informed the appellant that the appellant's requests were not allowable for lack of inventive step and lack of clarity. Consequently, the

appellant withdrew all its previous requests and requested that the decision under appeal be set aside and that a patent be granted with the following documents:

Claims: 1 to 3 submitted during the oral proceedings;

Description: page 1 filed with the letter of 17 June 2002,
pages 1a, 2, and 7 filed at the oral proceedings,
pages 5, 11, and 12 as originally filed,
pages 3, 4, 6 and 8 through 10 filed with the letter of 27 February 1995;

Drawings as originally filed.

VIII. Claim 1 according to the appellant's request differs from claim 1 according to the main request under consideration in the decision under appeal in that the following paragraph is added at the end:

"so that the number of defects in said silicon-germanium layer is reduced as compared to the case where the major portion of said substrate is covered by silicon dioxide."

Claims 2 and 3 are dependent claims.

IX. The arguments of the appellant in support of the above request can be summarized as follows:

(a) None of the available prior art documents discloses the selective growth of silicon-

germanium on silicon. Furthermore, there is no hint given in the prior art that a large area of silicon oxide mask material may be the cause of producing defects in a selectively grown silicon-germanium layer.

- (b) As to the clarity objections raised in the decision under appeal, details of the selective deposition are not essential to the invention, as the reduction of defects is not achieved by choosing special process conditions, but by choosing an appropriate pattern of the windows.

- (c) Regarding the alleged contradiction between claim 1 and original claim 4, original claim 4 is no longer part of the claims according to the requests made. The passages of the description referred to in the decision under appeal merely set out different embodiments of the invention.

Reason for the Decision

- 1. The appeal complies with Articles 106 to 108 and Rule 64 EPC and is therefore admissible.

- 2. *Amendments*

Claim 1 is based on claims 1 and 3 and page 4, lines 12 to 28 of the application as filed. Claim 2 is based on page 4, lines 29 to 34 and page 10, lines 6 to 10 of the application as filed, and claim 3 is based on claim 2 as filed. The requirements of Article 123(2) EPC are therefore met.

3. *Clarity*

The Board is satisfied that claim 1 is clear and contains all essential features. In particular, the Board agrees with the appellant that the term "selective deposition" is well-established in the technical field of the application in suit, and that the specific process parameters for attaining selective growth of silicon-germanium are not considered essential (cf. items III(d) and VIII(b), (c) above). The essential feature for avoiding defects in the silicon-germanium layer is to keep the total area of windows larger than that of the remaining silicon oxide mask layer.

The Board is furthermore unable to see any contradiction between claim 1 as amended and the description.

Therefore, in the Board's judgement, the requirements of Article 84 EPC are met.

4. *Inventive step*

4.1 The subject matter of claim 1 is new, since none of the available prior art discloses selective growth of silicon-germanium on silicon using a mask of silicon oxide. Novelty of the subject matter of claim 1 was also not disputed in the decision under appeal. Moreover, as the appellant convincingly argued, none of the available prior art documents suggests that a reaction between the mask material and the species present during deposition takes place and generates defects in the selectively grown semiconductor layers.

- 4.2 In the decision under appeal, the examining division held that a skilled person would arrive at the claimed ratio of total window area over total mask area by simply optimizing the use of wafer surface (cf. items III(a) and (b) above). Claim 1 as amended, however, now makes it clear that the claimed ratio of areas is in the range where a reduction of defects in the silicon-germanium layer takes place. Therefore, a skilled person who was completely unaware of the problem of defects induced by the mask would, in the Board's view, not arrive at the claimed subject matter.
- 4.3 The Board is also not convinced that a skilled person would seek to maximize the area of deposited silicon-germanium, as argued in the decision under appeal (cf. item III(c) above), since, at the priority date of the application in suit, silicon-germanium layers formed on silicon were only used on a limited part of a device, such as a base region in an NPN-bipolar transistor (cf. documents D1 and D3). Therefore, the skilled person having such applications in mind, would rather choose a window pattern where the total area of windows is smaller than the area of the remaining silicon dioxide mask, i.e. a situation contrary to that specified in claim 1.
- 4.4 Therefore, in the Board's judgement, the subject matter of claim 1 involves an inventive step within the meaning of Article 56 EPC.

Order

For these reasons it is decided:

1. The decision under appeal is set aside.
2. The case is remitted to the first instance with the order to grant a patent with the documents forming the appellant's request specified above.

The Registrar:

The Chairman:

D. Spigarelli

R. K. Shukla