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D E C I S I O N
of 2 March 2001

Case Number: T 0268/96 - 3.4.3

Application Number: 90303768.7

Publication Number: 0400791

IPC: H01L 31/20

Language of the proceedings: EN

Title of invention:

Electronic device manufacture involving a pattern delineation step

Applicant:

AT&T Corp.

Opponent:

-

Headword:

-

Relevant legal provisions:

EPC Art. 56, 87(1)

Keyword:

"Inventive step (yes) - subsidiary prior art document not relevant for solving the technical problem"

Decisions cited:

-

Catchword:

-



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Boards of Appeal

Chambres de recours

Case Number: T 0268/96 - 3.4.3

D E C I S I O N
of the Technical Board of Appeal 3.4.3
of 2 March 2001

Appellant:

AT&T Corp.
32 Avenue of the Americas
New York
NY 10013-2412 (US)

Representative:

Watts, Christopher Malcolm Kelway, Dr.
Lucent Technologies (UK) Ltd.
5 Mornington Road
Woodford Green
Essex IG8 0TU (GB)

Decision under appeal:

Decision of the Examining Division of the
European Patent Office posted 24 October 1995
refusing European patent application
No. 90 303 768.7 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. 90 303 768.7 claiming the priority dates of 10 April 1989 and 30 November 1989, respectively from the priority documents US 335 626 and US 444 579, was refused in a decision of the examining division dated 24 October 1995. The ground for the refusal was that the subject matter of claims 1 to 3 filed with letter dated 7 September 1995 lacked an inventive step having regard to the prior art documents

D1: Applied Physics Letters, vol. 52, No. 18, 2 May 1988, pages 1478 - 1480; and

D3: EP-A-0 339 771.

II. The reasoning of the examining division in the decision under appeal can be summarized as follows:

The feature "reaction product resulting from reaction ... with oxygen" in claim 1 is not disclosed in the priority document US 335626 of 10 April 1989, but only in US 444 579 of 30 November 1989. Thus, document D3 which was published on 2 November 1989 belongs to the prior art according to Article 54(2) EPC.

The method of claim 1 only differs from that disclosed in document D1 in that the masking layer consists essentially of a reaction product resulting from reaction of the surface of the semiconductor body with oxygen, whereas a thin layer made of InGaAs is used as a mask in the method of document D1. Since the use of thin oxide coating as an etching mask is known from

document D3, and such oxide layers can be conveniently applied, the skilled person would regard the replacement of InGaAs with a thin oxide layer as an obvious alternative.

III. The appellant (applicant) lodged an appeal on 7 December 1995 and paid the appeal fee on 6 December 1995. The statement of the grounds of appeal was filed on 17 February 1996 together with amended claims 1 to 6 and an amended description.

IV. In response to a communication of the Board, the appellant filed with the letter dated 24 August 2000 new claims 1 to 6 amended to comply with the requirement of clarity pursuant to Article 84 EPC.

The appellant requests that the decision under appeal be set aside and that a patent be granted on the basis of the following documents:

Claims: Claims 1 to 6 filed on 29 August 2000 with the letter dated 24 August 2000

Description: Pages 1 and 2a filed with the statement of grounds of the appeal on 17 February 1996; Pages 2, 3 to 19 as originally filed and with the amendments as requested in the statement of the grounds of appeal

Drawings: Sheets 1/4 - 4/4 as originally filed.

V. Claim 1 of the appellant's request reads as follows:

"1. Process for fabricating a semiconductor device, said device being designed using design rules based on a minimum dimension of a maximum of 1 μm , said process comprising:

covering a surface of a semiconductor body (30) comprising device functional material with a masking layer (33), wherein said surface is free of masking material of a thickness greater than 10 nm (100Å);

patterning said surface by selectively irradiating portions (31) of said surface so as to produce an irradiation pattern; and

uniformly exposing at least a region of the irradiation-patterned surface, said region including irradiated as well as unirradiated material, to an ambient, said portions having been altered by the irradiation such that said ambient is effective to selectively remove said irradiated material during said uniform exposure, said patterned masking layer acting as a mask;

CHARACTERISED IN THAT

said masking layer consists essentially of a reaction product resulting from reaction of said surface with oxygen."

Claims 2 to 6 are dependent on claim 1.

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

The process of document D3 is very different from the claimed method and from that of document D1 in that in the method of document D3, the steps of writing a pattern and etching the substrate take place at the same time, whereas in the method of document D1, the writing of the pattern in the etching mask is carried out before the surface is exposed to an etching ambient. Moreover, in contrast to the etching process step in document D1 and claim 1, where the whole substrate is uniformly exposed to an etching ambient, in the method of document D3, the surface is subjected to an etching environment only at the irradiated

regions. As also mentioned in document D3, the oxide only has to protect the surface against low concentrations of diffused active species, and it is even possible to use the process of D3 without the oxide layer. Thus, because of the above differences, the skilled person would not consider combining the teachings of documents D1 and D3.

Reasons for the Decision

1. The appeal complies with Articles 106 to 108 and Rule 64 EPC is therefore admissible.
2. *Amendments and clarity*

Claim 1 contains the features of claims 1 and 8 as filed and further specifies that the process is for fabricating a semiconductor device, and that the masking layer is a reaction product of the surface with oxygen. The latter features are disclosed on page 13, lines 2 to 9 and page 7, lines 3 to 12, respectively, of the application as filed. Claims 2 and 3 are based on the disclosure on page 5, line 29 to page 6, lines 1 and claims 4 to 6 are based on the disclosure on page 10, lines 13 to 20 of the application as filed.

Therefore, in the Board's judgment, the requirements of Article 123(2) EPC are met. The Board furthermore considers the claims to be clear, as required by Article 84 EPC.

3. *Priority*

The application in suit claims two priorities: 10 April 1989 (P1) from US 335626, and 30 November 1989 (P2) from US 444 579. Since the priority document P1 does

not disclose a masking layer, let alone a masking layer formed of a reaction product resulting from a reaction of a surface of a semiconductor body with oxygen, the application in suit does not relate to the "same invention" as required by Article 87(1) EPC, a finding that has not been contested by the appellant.

Therefore, the claimed priority date of 10 April 1989 is not valid. The priority date of 30 November 1989 is however valid, since document P2 discloses the above-mentioned feature on e.g. page 9, lines 10 to 17.

4. *Inventive step*

- 4.1 The application in suit relates to a process for fabricating a semiconductor device according to a design rule based on a minimum dimension of one micrometer or less. The application starts from the well-known problem in the art that for such small features, the conventional patterning techniques using photoresist layers are at their limit of performance. The applicants have developed a process where first a native oxide is formed on the semiconductor substrate, i.e. an oxide layer formed by simply exposing the substrate to air. This native oxide is at most 10 nanometers thick, i.e. several tens of atom layers thick. The patterning of the native oxide layer is carried out using irradiating ions on selected areas of the oxide. The irradiated areas are damaged which make them more susceptible to etching. After the etching step, only the native oxide which was not irradiated remains and the substrate is exposed in the selected areas.
- 4.2 Document D1 which is regarded the closest prior art, discloses a process where a mask made of InGaAs with a thickness of about 3 nm is formed on an InP substrate which allows the patterning of features having a line width smaller than a micro meter (cf. abstract;

Figure 1). A pattern is written in the InGaAs mask by irradiating Ga-ions on selected regions of the mask. The irradiated regions are damaged which are subsequently etched using a 3:1 solution of HCl:H₂O which selectively etches the irradiated, damaged InGaAs regions and the exposed InP substrate (cf. page 1479; left hand column, last paragraph).

4.3 The method of claim 1 thus differs from that of document D1 in that the mask is made of a reaction product resulting from a reaction of the surface of the semiconductor body with oxygen, whereas in the method of document D1, the mask is made of InGaAs which is epitaxially deposited on the InP surface.

4.4 In the light of the above difference with respect to the method of document D1, the objective technical problem addressed by the application in suit therefore relates to finding an alternative mask layer which does not require epitaxial deposition.

4.5 Document D3 belongs to the prior art pursuant to Article 54(2) EPC, since it was published on 2 November 1989 which is before the valid priority date of 30 November 1989 (cf. item 3 above). It discloses a method of etching a substrate covered with a native oxide layer using a photo etching process (cf. D3, column 3, lines 11 to 34 and column 4, lines 40 to 41). The substrate surface is selectively exposed using a laser beam which evaporates the native oxide layer on the substrate, and at the same time, the laser light activates gaseous species present in the ambient atmosphere which in the activated state etch the exposed substrate regions.

4.6 Thus, in contrast to the method of document D1, as well as that of the application in suit, where the step of patterning the mask layer by ion-irradiation precedes

the step of etching the irradiated regions of the mask and the exposed substrate regions, the method of document D3 carries out both steps simultaneously. Furthermore, since the etchant used in the process of document D3 is activated by the narrow laser beam which also patterns the native oxide layer, the remaining native oxide layer covering the regions of the substrate not to be etched is barely exposed to the etching ambient, so that selective etching is even possible without any mask layer (cf. D3, column 3, lines 10 to 21).

In the method of document D1, on the other hand, the exposed substrate surface as well as the remaining mask layer are uniformly exposed to an etching agent (wet etch). This requires that the mask layer, despite being thinner than 10 nm, must remain intact during the entire etching process. In other words, the process of document D1 requires that etchant used for etching the substrate has an extremely high selectivity with respect to the material chosen for the mask layer, in order to enable the use of a very thin mask layer. Thus, a skilled person seeking an alternative to GaInAs for a masking layer in the process of document D1 would at the same time have to find a suitable etching agent for InP which is highly selective over the alternative material of the mask layer. Since, however, document D3 does not provide any help in this respect, in the Board's opinion, the skilled person would not consider document D3 to be relevant for solving the technical problem stated above.

- 4.7 For the foregoing reasons, in the Board's judgement, the subject matter of claim 1 involves an inventive step as required by Article 56(1) EPC. Claim 1 therefore meets the requirements of Article 52(1) EPC.

Dependent claims 2 to 6 also therefore comply with the requirements of Article 52(1) EPC.

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 with the order to grant a patent on the basis of the documents as specified under item IV above.

The Registrar:

The Chairman:

L. Martinuzzi

R. K. Shukla