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D E C I S I O N
of 18 July 2001

Case Number: T 0699/96 - 3.4.3

Application Number: 90309073.6

Publication Number: 0414457

IPC: H01L 21/306

Language of the proceedings: EN

Title of invention:
Selective etching process

Applicant:
AT&T Corp.

Opponent:
-

Headword:
-

Relevant legal provisions:
EPC Art. 56

Keyword:
"Inventive step (yes)"
"No reasonable expectation of success"

Decisions cited:
-

Catchword:
-

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Beschwerdekammern | Boards of Appeal | Chambres de recours

Case Number: T 0699/96 - 3.4.3

D E C I S I O N
of the Technical Board of Appeal 3.4.3
of 18 July 2001

Appellant: AT&T Corp.
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Representative: Williams, David John
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Decision under appeal: **Decision of the Examining Division of the European Patent Office posted 4 March 1996 refusing European patent application No. 90 309 073.6 pursuant to Article 97(1) EPC.**

Composition of the Board:

Chairman: R. K. Shukla
Members: V. L. P. Frank
M. B. Günzel

Summary of Facts and Submissions

I. European patent application No. 90 309 073.6 was refused by the decision of the examining division dated 4 March 1996. The ground for the refusal was that the subject-matter of claim 1 as amended according to the request dated 21 July 1995 did not involve an inventive step (Article 56 EPC), having regard to the prior art document

D1: Journal of Materials Science, vol. 16, 1981, pages 2449-2456

II. Independent claim 1 on which the decision was based reads as follows:

"1. A process of fabricating a device comprising a III-V semiconductor compound, which comprises the step of etching the III-V semiconductor compound in an acidic aqueous solution comprising dichromate ion,

CHARACTERIZED IN THAT

said III-V semiconductor compound comprises aluminum, said etching is conducted in an aqueous etching solution consisting of dichromate ion and phosphoric acid, the concentration of said dichromate ion being between 0.0001 M and 0.1 M and the concentration of said phosphoric acid being between 0.1 and 10 M."

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

(a) Document D1, which represents the closest prior art, discloses a process according to the preamble of claim 1. The claimed process differs from this

known process in that:

(i) the III-V semiconductor compound comprises aluminum,

(ii) the etching solution contains only phosphoric acid besides the dichromate ion ($K_2Cr_2O_7$), and in that

(iii) the concentration ranges of the constituents are specified.

(b) The objective problem addressed by the invention is to provide an etching solution for etching an Al containing III-V compound.

(c) Document D1 suggests (page 2453, right-hand column, first paragraph) to use a $K_2Cr_2O_7$-H_2SO_4-HCl etchant system for etching vertical mirror lasers in the GaAlAs/GaAs system. It would have been obvious to a skilled person to investigate the effect of the etchant on GaAlAs without the use of HCl, as such an investigation in respect of GaAs is already disclosed in the document (Table I). He would have recognized that the presence of HCl is not required for etching GaAlAs and that a high selectivity can be obtained with respect to GaAs in this case. The necessary optimization of the respective concentrations is only a routine task for the skilled person.

IV. The appellant (applicant) lodged an appeal on 1 May 1996. The appeal fee was paid the same day. The statement setting out the grounds of appeal was filed on 10 July 1996.

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

Claims: 1 to 7 filed with the letter dated 21 July 1995

Description: pages 1, 4 to 8 as originally filed
page 2 as filed with letter of 12 September 1994
page 3 as filed with letter of 30 May 2001

Drawings: Sheet 1/1 as originally filed

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

Document D1 relates only to the etching of GaAs and InP and discloses that the quality of the GaAs etched surface decreases with decrease of the proportion of dichromate ion (cf. page 2450, left-hand column, second full paragraph). However, the concentration of dichromate ion specified in claim 1 is about one order of magnitude lower than the one taught in document D1. It is further disclosed in this document that removal of HCl from the etchant solution results in unacceptable slow etch rates and surface quality.

Reasons for the Decision

1. The appeal is admissible.

2. The only issue in the appeal is that of inventive step (Article 56 EPC).

2.1 Document D1, which is the only document cited in the decision under appeal, discloses (cf. D1, Abstract) an etching system for GaAs and InP consisting of a $K_2Cr_2O_7$-H_2SO_4-HCl aqueous solution. From the discussion in this document of the results obtained by varying the relative proportion of the etchant components, it follows that in case of GaAs,

(i) the etching rate increases with increasing HCl proportion at a constant rate of $K_2Cr_2O_7$ and H_2SO_4,

(ii) the HCl free etchant has a slow etching rate of 0.03 µm/min whereas the HCl containing etchant has an etching rate of more than 12 µm/min, and

(iii) the quality of the etched surface decreases with decrease of the proportion of $K_2Cr_2O_7$ (cf. page 2450, left-hand column, second full paragraph, and Table I).

Moreover, the etch-profiles obtained in GaAs wafers with the HCl containing etchant show well defined vertical walls whereas no such profiles were observed with the HCl free system. Based on these observations the authors suggest that the three component etching solution can be used for forming vertical etched mirror lasers in the GaAs/GaAlAs system (cf. page 2453 and Figure 5). However, since in GaAs/GaAlAs lasers, the vertical mirrors are formed only on the GaAs active layer, it follows that the above disclosure does not imply an etching of the GaAlAs compound using the three components etchant. Thus, the etching of an aluminium

containing III-V compound has not been disclosed in this document.

2.2 The etchant employed in the process of claim 1 of the application in suit differs from the one disclosed in this document in that

(i) the etching solution is a two-component system and consists only of dichromate ion and phosphoric acid,

(ii) the III-V semiconductor compound to be etched contains aluminum, and in that

(iii) the concentrations of dichromate ion and phosphoric acid are as specified in the claim.

2.3 The objective problem solved by the application, having regard to these differences, is therefore the provision of an etching solution for etching an Al containing III-V semiconductor compound.

The Board is satisfied that this problem is solved by the claimed etchant, as the application discloses that on GaAlAs etch rates as high as 0.1 µm/min were achieved (cf. Table I).

2.4 The Board agrees with the finding in the decision under appeal that a skilled person, following the suggestion in document D1 to use the three component etchant for etching GaAs/GaAlAs, would be led to investigate whether or not the etchant would also etch GaAlAs. However, the Board does not agree with the contention in the decision under appeal that, since in this document an investigation of the effect of the

variation of the HCl proportion on the etching of GaAs is reported, it was obvious to conduct such an investigation using the HCl-free two component etchant of this document in the case of GaAlAs. In this connection, the data in document D1 indicate that the HCl-free system etches GaAs at a very slow rate, which is about three orders of magnitude smaller than the rate of the full three component etchant solution so that for all practical purposes, it cannot be regarded as a useful etchant. Moreover, this document clearly suggests to use the three component solution for etching vertical mirrors, since no vertical etched surfaces were achieved by using the HCl-free etchant. Indeed, the data shown for the HCl-free etchant are a comparative example which further emphasizes the effectiveness of the HCl containing etchant.

Thus, the skilled person would not have expected the HCl-free etchant to etch GaAlAs at an acceptable etching rate. In consequence, there was no motivation in this document which would have induced the skilled person to try the HCl-free etchant on GaAlAs.

2.5 Furthermore, as the appellant has pointed out, the amount of dichromate ion used in the present application is about an order of magnitude lower than the amount used in document D1. In the Board's view, therefore, a skilled person would not have been induced to try out etchant solutions with a lower concentration of dichromate ion, since document D1 clearly states that the etched surface's quality degrades with lower concentrations of dichromate ion.

2.6 In summary, in the Board's view, a skilled person would not have considered the use of the etchant disclosed in

document D1 to be suitable for etching an Al containing III-V compound. Moreover, he would not have been induced by this disclosure to further modify the etchant so as to have a composition as claimed in claim 1.

3. For the foregoing reasons, in the Board's judgement, the method of claim 1 was not obvious to a person skilled in the art, so that it involves an inventive step in the sense of Article 56 EPC. Dependent claims 2 to 7 concern preferred embodiments of the invention and also 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 V above.

The Registrar: The Chairman:

L. Martinuzzi R. K. Shukla