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D E C I S I O N
of 16 April 2002

Case Number: T 0233/97 - 3.4.3

Application Number: 92310487.1

Publication Number: 0544437

IPC: H01L 21/205

Language of the proceedings: EN

Title of invention:

Method for selectively growing aluminum-containing layers

Applicant:

AT&T Corp.

Opponent:

-

Headword:

-

Relevant legal provisions:

EPC Art. 56

Keyword:

"Inventive step (yes - after amendments)"

Decisions cited:

-

Catchword:

-



Case Number: T 0233/97 - 3.4.3

D E C I S I O N
of the Technical Board of Appeal 3.4.3
of 16 April 2002

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 16 October 1996
refusing European patent application
No. 92 310 487.1 pursuant to Article 97(1) EPC.

Composition of the Board:

Chairman: R. K. Shukla
Members: V. L. P. Frank
E. Lachacinski

Summary of Facts and Submissions

I. The appeal lies against the decision of the examining division to refuse the European patent application No. 92 310 487.1 dated 16 October 1996. The decision refers to the following documents:

D1: Journal of Crystal Growth, vol. 107, 1991, pp. 1021-1029,

D2: Journal of Crystal Growth, vol. 55, 1981, pp. 229-234, and

D3: Journal of Crystal Growth, vol. 93, 1988, pp. 7-14

The grounds for the refusal were that the claims as a whole were not concise (Article 84 EPC) because of the various definitions of the invention given in independent claims 1 and 5 and that the subject-matters of claims 1 and 3 were not new having regard to the disclosure of document D1 (Articles 54(1) and (2) EPC). The examining division further observed that the subject-matter of claims 2 and 4 to 7 did not involve an inventive step with respect to the disclosure of document D1 and the general knowledge of the skilled person (Article 56 EPC).

II. The appellant (applicant) lodged an appeal which was received on 29 November 1996, and paid the appeal fee on 26 November 1996. The statement of the grounds of appeal and new claims 1 to 3 corresponding to claims 5 to 7 referred to in the decision under appeal were received on 12 December 1997.

III. In response to a communication from the board informing the appellant of the board's provisional view that the new claims did not involve an inventive step, the

appellant filed with his letter dated 25 September 2001 amended claims 1 to 3, and requested the grant of a patent on the basis of these claims. In the event that the board was considering dismissal of the appeal, the appellant requested oral proceedings.

The independent claim of this request has the following wording (emphasis added by the board):

"1. A method for growing a layer of aluminum gallium arsenide on a workpiece comprising the steps of:

providing a workpiece including a surface layer of III-V semiconductor material of the gallium arsenide family and further comprising a silicon nitride mask covering a portion of said surface layer while exposing selected portions;

heating said workpiece in a reduced pressure chamber to a temperature in the range 500°C to 550°C;

exposing said workpiece to a gaseous aluminum precursor, a gaseous gallium precursor and PhAs so as to selectively grow a layer of aluminum gallium arsenide on said selected portions of said surface area."

IV. Oral proceedings were held before the board on 16 April 2002. The appellant, although duly summoned, did not appear and did not previously inform the board that he was not going to attend the oral proceedings.

Reasons for the Decision

1. The appeal is admissible.

2. *Amendments*

The claims of the request under consideration differ from the corresponding originally filed claims 5 to 7 only by the expressions which are emphasized in point III above.

2.1 The use of a silicon nitride mask and the preferred process temperature range of 500°C to 550°C are disclosed in the published application on page 2, line 41, page 3, lines 2 to 3 and 24, and on page 3, lines 10 to 11, respectively.

2.2 Although the application equates phenylarsine with PhAs (cf. page 2, lines 37 to 38 of the published application), they are not the same compound. In fact, the chemical formula of phenylarsine is PhAsH₂ and PhAs is a cracking product obtained by its decomposition (cf. document D1, page 1022, right-hand column, last paragraph). However, in the present method, a workpiece exposed to phenylarsine is also exposed to PhAs, since this product arises from the decomposition of the former during the growth process.

2.3 The board is, for these reasons, satisfied that the amendments made to claim 1 comply with Article 123(2) EPC.

3. *Novelty*

None of the cited prior art documents disclose a method for growing aluminium gallium arsenide layers in which a silicon nitride mask is used.

Moreover, the subject-matters of claims 1 and 3 on which the decision of the examining division was based, and which were objected as not involving novel subject-matter, are no longer claimed.

Consequently, the subject-matter of the claims under consideration is new.

4. *Inventive step*

4.1 The application in suit relates to a method for selectively growing aluminum-gallium-arsenide (AlGaAs) layers on the unmasked portions of a workpiece. Prior art methods employing arsine and a silicon dioxide mask achieved selective growth of AlGaAs only at temperatures above 800°C (cf. D2, page 232, Fig. 5). At lower temperatures ($\leq 600^\circ\text{C}$) the growth process using arsine is non selective, leading to growth not only on the unmasked substrate but also upon the mask. For fabrication of electronic devices, such high temperatures are, however, undesirable and there is a need for an alternative method requiring lower temperatures.

As a solution to the above problem, the method according to claim 1 specifies the use of phenylarsine as arsenic source, silicon nitride as the mask's material and a process temperature in the range of 500-550°C. Under these conditions selective growth of AlGaAs layers in the unmasked portions of a workpiece is achieved (cf. published application, page 2, lines 37 to 41).

4.2 Document D1, which represents the closest prior art, is a research article reviewing alternative source materials for use in metalorganic molecular beam epitaxy (MOMBE) for III-V semiconductor compounds and,

in particular, for aluminum gallium arsenide (AlGaAs) (cf. page 1021, right-hand column; page 1028, penultimate paragraph).

According to this document, phenylarsine (PhAsH_2) appears to be better adapted as an As source for the MOMBE process than arsine (AsH_3) itself, since in contrast to arsine it decomposes on a GaAs substrate at low temperatures and can, therefore, be used without a high temperature precracking cell. It is also mentioned in this document that the PhAsH_2 decomposition is less efficient when the GaAs surface is oxidized. It is conjectured from this observation that the phenylarsine decomposition reaction is not a simple pyrolysis but a surface catalysed process (cf. page 1022, last paragraph). Document D1, however, does not specify what is to be understood by "low temperatures", since it does not provide any process temperature values.

Several compounds are also mentioned in this document as gaseous precursors for aluminum and gallium (cf. page 1023, "3. Group III sources").

- 4.3 The method of claim 1 thus differs from that of document D1 in that a silicon nitride mask is used to cover a portion of the surface and in that the workpiece is processed at a temperature in the range of 500-550°C.
- 4.4 The technical problem addressed by the application having regard to the closest prior art is, therefore, the achievement of selective growth of AlGaAs layers at lower temperatures than in the prior art, ie. the problem stated in the application in suit.
- 4.5 From the disclosure in document D1 that the phenylarsine decomposition reaction is a surface catalysed process (cf. the paragraph bridging

pages 1022 and 1023), the skilled person learns that with this compound selective growth is possible. However, there is no suggestion in document D1 as to the specific mask materials which would achieve selective growth. In particular, it is stated in this document that "the important role of surface catalytic effects, like those showing up in selective growth, should be kept in mind. Thus, a test of the reactivity is only possible under real growth conditions, i.e. together with the coreactants on a clean III-V surface." (cf. page 1027, middle of first paragraph, emphasis added by the Board). If the process parameters and materials are suitable or not has, consequently, to be tested under real working conditions and cannot be established beforehand.

Document D3, which concerns metalorganic chemical vapour deposition (MOCVD) of GaAs, discloses that good quality GaAs films were grown using phenylarsine at temperatures between 500 to 600°C (cf. page 12, "3.4 Growth using PhAsH₂"). No selective growth is, however, reported. The teaching of this document, therefore, leads the skilled person to employ this temperature range when using phenylarsine, but does not guide him in the choice of a mask material for selective growth.

The use of a silicon nitride mask for selective growth of AlGaAs is, for these reasons, not rendered obvious by the prior art documents available.

- 4.6 In the board's judgement, therefore, the subject-matter of claim 1 involves an inventive step in the sense of Article 56 EPC.
- 4.7 The description, however, needs to be adapted for consistency with the claims.

5. *Non appearance of a party at the oral proceedings*

As stated under point IV above, although the appellant was duly summoned to the oral proceedings requested by him, he did not appear at the oral proceedings without any prior notification that he intended to do so.

Article 116(1) EPC states that "Oral proceedings shall take place ... at the request of any party to the proceedings", and Rule 71(1) EPC states that "The parties shall be summoned to oral proceedings provided for in Article 116 EPC ...". A summons is thus an authoritative call to attend the oral proceedings. By issuing such a summons, a board of appeal commits itself to holding oral proceedings at the specified time and place, as part of the related appeal proceedings. As a party to the appeal proceedings, a party which receives such a summons has an obligation either to appear at the oral proceedings or to notify the board as soon as it knows that it is not going to appear. In the absence of any such prior notification, the board loses control over the proceedings leading to an undue delay in concluding the proceedings, since usually the summons to attend oral proceedings are sent several months before the date of the oral proceedings. In an ex-parte case, the party should notify the board as soon as possible that it does not maintain its request for oral proceedings when it no longer considers them to be necessary.

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 with the following claims and figures, and a description to be adapted:

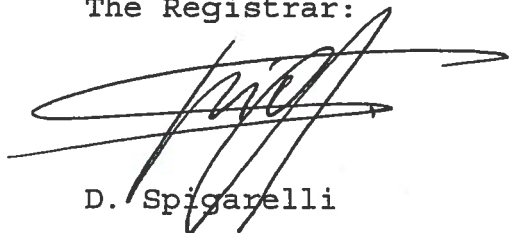
Claims:

No. 1 to 3 filed with the letter of 25 September 2001.

Figures:


No. 1 to 5 as originally filed.

The Registrar:



D. Spigarelli

The Chairman:



R. K. Shukla