BESCHWERDEKAMMERN DES EUROPÄISCHEN PATENTAMTS

BOARDS OF APPEAL OF THE EUROPEAN PATENT OFFICE

CHAMBRES DE RECOURS DE L'OFFICE EUROPEEN DES BREVETS

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File Number: T 514/90 - 3.2.2

Application No.: 85 300 510.6

Publication No.: 0 151 000

Title of invention: A liquid-phase epitaxial growth method of a IIIb-Vb Group compound

Classification: C30B 19/04, C30B 19/10, C30B 29/40

D E C I S I O N
of 24 November 1992

Proprietor of the patent: MITSUBISHI MONSANTO CHEMICAL CO. LTD. et al.

Opponent: TEMIC TELEFUNKEN microelectronic GmbH

Headword:

EPC Article 56

Keyword: "Inventive step (denied)"

Europäisches Patentamt | European Patent Office | Office européen des brevets

Beschwerdekammern | Boards of Appeal | Chambres de recours

Case Number : T 514/90 - 3.2.2

D E C I S I O N
of the Technical Board of Appeal 3.2.2
of 24 November 1992

Appellant : (Opponent)
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Decision under appeal :
Decision of the Opposition Division of the European Patent Office dated 27 April 1990 rejecting the opposition filed against European patent No. 0 151 000 pursuant to Article 102(2) EPC.

Composition of the Board :

Chairman : G. Szabo
Members : P. Dropmann
J. Van Moer

Summary of Facts and Submissions

I. European patent No. 0 151 000 was granted on 4 November 1987 on the basis of European patent application No. 85 300 510.6 filed on 25 January 1985.

II. An opposition was filed against this patent on the grounds of lack of novelty and inventive step (Article 100(a) EPC).

III. By its decision dated 27 April 1990 the Opposition Division rejected the opposition.

IV. The Appellant (Opponent) filed a Notice of Appeal against this decision on 26 June 1990 and paid the appeal fee on the same date. The Statement of Grounds was received on 2 July 1990.

The following documents were considered particularly relevant, documents (7) and (8) being cited for the first time in the appeal proceedings:

(3) DE-C-2 616 700,

(7) IBM Technical Disclosure Bulletin, Vol. 18, No. 8, January 1976, page 2713, G. Limestahl et al. "Dissolution Doping Technique", and

(8) Japanese Journal of Applied Physics, Vol. 16, No. 9, September 1977, pages 1605 to 1615, K. Ohta et al. "Liquid Phase Epitaxial Growth of $Ga_xIn_{1-x}Sb$ by Vertical Dipping Method".

V. Oral proceedings were held on 24 November 1992. At these proceedings the Respondents (Proprietors of the patent) submitted five sets of claims, one as a main request and four as auxiliary requests.

Claim 1 according to the main request is worded as follows:

"A method for epitaxially growing a single crystalline film formed of at least one Te-doped III-V Group inorganic compound consisting of a Group IIIb element and a Group Vb element of the Periodic Table on a single crystalline substrate by means of liquid-phase epitaxial growth, wherein a Te source for doping said III-V Group compound or compounds of the single crystalline film consists of a single crystalline or polycrystalline III-V Group compound which is the or one of the said III-V Group compounds of said single crystalline film, characterised in that:

said Te source contains Te at a concentration of at least 1 x $10^{17}cm^{-3}$ of Te and either;

said Te source consists of polycrystalline GaAs and said III-V Group inorganic compound of the film is at least one of GaAs, $GaAs_{1-x}P_x$ (1>x>0) and $Ga_{1-x}Al_xAs$ (1>x>0); or

said Te source consists of polycrystalline GaP and said III-V Group inorganic compound of the film is at least one of GaP and $GaAs_{1-x}P_x$ (1>x>0)."

The first claims according to the auxiliary requests differ from Claim 1 of the main request in the following respects:

- Claim 1 of the first auxiliary request is restricted to the first alternative specified in Claim 1 of the main request, i.e. to a Te source consisting of GaAs and the compound of the film comprising As.

- In Claim 1 of the second auxiliary request the upper limit of 1 x $10^{19}cm^{-3}$ of the Te concentration of the Te source is also indicated.

- Claim 1 of the third auxiliary request is directed to a method of making a light emitting diode or semiconductor laser comprising the method according to Claim 1 of the main request.

- Claim 1 of the fourth auxiliary request relates to a method of making a light emitting diode comprising the method according to Claim 1 of the main request.

VI. The arguments presented by the Appellant against the newly submitted claims can be summarised as follows:

Document (3), in particular column 9, lines 48 to 62, represented the closest state of the art and already disclosed a method for growing, by liquid-phase epitaxial growth, a single crystalline n-type GaAs film on a single crystalline substrate. As an n-type dopant, tellurium (Te) incorporated in crystalline GaAs could be added to the Ga melt. The person skilled in the art and knowing from document (7) about the problem of doping a melt with minute amounts of Te, would consider the teaching of document (8). This document (cf. page 1606, final paragraph) disclosed that Te was introduced as an n-type dopant into the solution in a form of heavily Te doped InSb or GaSb polycrystal, i.e. a Te source consisting of a IIIb-Vb Group inorganic compound. The skilled person would thus arrive at the claimed method in an obvious manner.

VII. In contesting these arguments, the Respondents submitted that the present invention was concerned with the problems arising when elemental Te was introduced into the melt. The problem solved by the patent in suit was to obtain

good reproducibility of the doped layers and uniform distribution of Te in the layer. None of the documents referred to in the proceedings was concerned with this problem. Therefore, the expert would not have considered these references. Furthermore, the state of the art neither disclosed nor directly led to add to the epitaxial growth solution, Te in the form of a Te doped GaAs polycrystal as the Te source rather than in elemental form. In particular, document (8) being a research type document and being concerned with lower temperatures than those applied in the claimed epitaxial growth method, did not suggest the minimum doping level of Te in the Te source, let alone the composition of the Te source itself used in the patent in suit. Thus the claimed method was novel and involved an inventive step.

VIII. The Appellant requests that the decision under appeal be set aside and the patent be revoked.

The Respondents request that the appeal be dismissed and the patent be maintained on the basis of one of the sets of claims according to the main and auxiliary requests submitted at the oral proceedings.

Reasons for the Decision

1. The appeal is admissible.

2. Amendments

The amended Claims 1 meet the requirement of Article 123(2) EPC, since the features now incorporated into these claims are disclosed in the application as originally filed. As to Claims 1 of the main and first auxiliary requests, reference is made to Claims 1 and 2 as

well as to page 3, lines 2 to 4, 11 and 12 of the original application. The upper limit of the Te concentration of the Te source specified in Claim 1 of the second auxiliary request is supported by the original statement on page 5, lines 11 to 13. The features concerning the light emitting diode or semiconductor laser in Claims 1 according to the third and fourth auxiliary requests find their basis on page 1, lines 14 and 15 and page 6, lines 13 to 26.

Furthermore, the features introduced into the amended Claims 1 represent a limitation of the scope of protection in comparison with the granted Claim 1. In particular, this applies to Claims 1 of the third and fourth auxiliary requests, since it is clear from the example described in the patent specification that the method for epitaxially growing a single crystalline film in accordance with Claim 1 as granted is intended to be used especially for the production of light emitting diodes. The amended Claims 1, therefore, do not contravene Article 123(3) EPC either.

3. Novelty

The claimed method is novel with regard to any document mentioned during the proceedings. Indeed, none of these documents teaches, in combination, the use of a Te source consisting of GaAs and Te in a minimum concentration of $1 \times 10^{17} cm^{-3}$ of Te.

4. Closest state of the art

Document (3) represents the state of the art which is closest to the subject-matter of Claims 1 although they have been delineated over document (8).

From document (3), in particular column 3, lines 57 to 63 and column 9, lines 48 to 62, a method for growing, by liquid-phase epitaxial growth, a single crystalline n-type GaAs film on a single crystalline substrate is known which method is intended to be used also in the production of light emitting diodes or semiconductor lasers. As a possible n-type dopant Te is mentioned which can be added to the Ga melt either in elemental form or in the form of a Te doped crystalline GaAs, which is then to be considered as a Te source (cf. column 9, lines 49 to 60). The document, however, is silent as to the Te concentration of the Te source.

The Board shares the Appellant's view that the sentence contained in column 9, lines 61 and 62 of document (3) can only be interpreted as referring to the substrate crystal 20 instead of the crystalline GaAs 30, since the dopants Cr, Mn etc. mentioned in this sentence are common for the substrate 20 (cf. column 9, lines 66 to 68). This sentence, therefore, does not introduce any obscurity into the two sentences preceding that sentence.

5. Problem and solution

Document (3) leaves it open which one of the two disclosed possibilities of introducing Te into the liquid phase epitaxial growth solution is better, either that one of adding Te in elemental form or that one of incorporating Te in the form of Te doped crystalline GaAs.

The skilled person is well aware of the difficulty of doping a Ga-rich melt with minute amounts of Te as such and the necessity to increase the accuracy of such doping which should also automatically lead to improved reproducibility of Te doping (cf. document (7) and column 1, lines 29 to 42 of the patent specification).

Thus, in correspondence with the Respondents' statements in the patent specification and during the oral proceedings, the objective technical problem underlying the patent in suit can be seen as being to improve reproducibility of Te doping, in particular to obtain good reproducibility of the doped layers and uniform distribution of Te in the layer.

This problem is solved, in accordance with Claim 1 of the first auxiliary request and the first alternative mentioned in Claims 1 of the main request and the third and fourth auxiliary requests, by introducing Te into the melt in the form of Te doped crystalline GaAs having a minimum Te concentration of $1 \times 10^{17} cm^{-3}$. According to Claim 1 of the second auxiliary request the Te concentration of the Te source is limited to the range of 1×10^{17} to 1×10^{19} atoms in cm^3.

The claimed method is illustrated by the example mentioned in the patent specification, which example shows an improved reproducibility and uniform distribution of the dopant in the layer in comparison with the results of the comparative example (the figure 2.3×10^{17} stated in column 5, line 17 of the patent specification is apparently a typing error as indicated by the Respondents at the oral proceedings). It is therefore credible that the above technical problem is solved.

6. Inventive step

6.1 Main and first auxiliary requests

As pointed out in point 4 above, reference (3) teaches the use of either elemental Te or a Te source consisting of Te doped GaAs for doping the melt for epitaxially growing a Te doped n-type GaAs film on a substrate. Since the

skilled person is familiar with the problem and difficulties of adding microscopic amounts of elemental Te to Ga rich melts (cf. document (7)), he would certainly avoid this way of doping the melt and make use of the clearly more attractive alternative way indicated in reference (3), i.e. adding Te in the form of Te doped crystalline GaAs as the Te source. This is also in line with general practice in chemistry where minute amounts of solids are preferably introduced in a diluted form e.g. in an easily measurable volume of a solution. It is for this reason already that no inventive step can be seen in the choice of this alternative doping technique when epitaxially growing a Te doped GaAs film.

Moreover, such a way of doping an epitaxial growth melt by adding a Te source is also known from document (8), page 1606, final paragraph. According to this document, dopant Te is introduced into the melt for liquid phase epitaxial growth of $Ga_xIn_{1-x}Sb$ in the form of heavily Te doped InSb or GaSb polycrystal, which belongs to the IIIb-Vb Group compounds specified in the preamble of Claim 1.

Furthermore, since the Te source is in this case necessarily added to the melt in an amount larger than that when elemental Te is used, the expert using such a Te source instead of elemental Te for doping would expect that the problem of accuracy arising from the use of minute amounts of elemental Te as described in document (7) would be avoided and, hence, reproducibility would be improved. This is a further reason why the skilled person faced with the problem underlying the patent would choose the second alternative disclosed in document (3), i.e. the use of a Te source which in fact is a Te prealloy. Since in a prealloy the minor components are already present in dispersed form, which means better distribution of such components in the melt, the observed effect that Te is

distributed in the epitaxially grown film more uniformly than after use of elemental Te, cannot be considered as surprising and contributing to an inventive step.

Therefore, the choice of the second alternative indicated in reference (3) has to be regarded as obvious.

As to the minimum concentration of Te in the Te source, the following considerations apply. The minimum concentration is necessarily governed by the result, i.e. the requisite Te concentration in the epitaxial film. In order to obtain a certain Te concentration in the film, a concentration higher than this must be present in the Te source. This means that a Te concentration of e.g. about 10^{17} atoms cm^{-3} normally expected in the film, requires a Te concentration of the source of at least this figure, as specified in the claim.

Therefore, the feature of Claim 1 concerning the minimum level of Te in the source cannot be the basis for an inventive step either.

Hence, the method according to Claim 1 of the first auxiliary request lacks an inventive step.

The same objection applies to Claim 1 of the main request, which also covers, as one embodiment, the method according to Claim 1 of the first auxiliary request. There is, therefore, no need to consider any other embodiment.

6.2 Second auxiliary request

The incorporation of the upper limit of $1 \times 10^{19} cm^{-3}$ of the concentration of Te atoms into Claim 1, as done in the second auxiliary request, cannot lead to an allowable claim since this claim still embraces the embodiment

comprising the minimum concentration of 1 x $10^{17}cm^{-3}$ specified in Claims 1 of the main and first auxiliary requests. These claims, however, are not allowable as reasoned in point 6.1 above. Moreover, the Respondents have not shown a surprising effect which could justify the presence of an inventive selection. Claim 1 of the second auxiliary request thus shares the same fate as Claims 1 of the preceding requests.

6.3 Third and fourth auxiliary requests

As already mentioned in point 4, the method described in document (3) also comprises the making of light emitting diodes or semiconductor lasers. Adding these features to the claim, therefore, does not render the methods according to Claims 1 of the third and fourth auxiliary requests inventive.

6.4 Hence, none of Claims 1 according to the present requests meets the requirements of Articles 52(1) and 56 EPC.

Order

For these reasons, it is decided that:

1. The decision under appeal is set aside.

2. The patent is revoked.

The Registrar: The Chairman:

S. Fabiani G. Szabo

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