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Aktenzeichen / Case Number / N° du recours : T 166/87 - 3.3.1

Anmeldenummer / Filing No / N° de la demande : 83 304 750.9

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Bezeichnung der Erfindung: Process for growing crystalline material

Title of invention:

Titre de l'invention :

Klassifikation / Classification / Classement : C30B 11/00

ENTSCHEIDUNG / DECISION

vom / of / du 16 May 1989

Anmelder / Applicant / Demandeur : Western Electric Company, Incorporated

Patentinhaber / Proprietor of the patent /

Titulaire du brevet :

Einsprechender / Opponent / Opposant :

Stichwort / Headword / Référence :

EPU / EPC / CBE Article 56

Schlagwort / Keyword / Mot clé : "Inventive step - affirmed after amendment of the claims"

Leitsatz / Headnote / Sommaire

Europäisches
Patentamt

Beschwerdekammern

European Patent
Office

Boards of Appeal

Office européen
des brevets

Chambres de recours



Case Number : T 166/87 - 3.3.1

I N T E R L O C U T O R Y D E C I S I O N
of the Technical Board of Appeal 3.3.1
of 16 May 1989

Appellant : Western Electric Company, Incorporated
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Representative : Watts, Christopher Malcolm Kelway, Dr.
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Decision under appeal : Decision of Examining Division 018
of the European Patent Office
dated 28 January 1987 refusing
European patent application
No. 83 304 750.9 pursuant to
Article 97(1) EPC

Composition of the Board :

Chairman : K.J.A. Jahn
Members : R. Spangenberg
G.D. Paterson

Summary of Facts and Submissions

- I. European patent application No. 83 304 750.9, filed on 17 August 1983 containing ten claims and claiming priority of 23 August 1982 from an earlier application in the United States of America, was published as EP-A-104 741.

By a decision dated 28 January 1987 the Examining Division refused the application on the basis of nine claims. The only independent claim read as follows:

"A process for growing a single crystal of a group III-V or group II-VI semiconductor compound by cooling melt in a container until the melt solidifies to form the crystal in the container, characterised in that the compound is kept from contacting the container both in the molten and crystallised state by a layer of an interposed substance which is liquid during the solidification process and in that the crystal is removed from the container before the said substance becomes hard".

- II. The stated ground for refusal was that the subject-matter of these claims did not involve an inventive step in the light of the disclosure in

- (1) EP-A-10307
- (2) DE-A-1 959 392

The Examining Division considered that in the method of growing a single crystal of a semiconductor of the III-V or II-VI group by cooling melt in a container until the melt solidifies in the container, which is known from e.g. (2), the problem existed to avoid contamination of the melt by the container material. According to the application in suit this problem was solved by interposing a substance

between the melt and the container which is liquid during the solidification process. A solution to a similar problem arising in the growing of single crystals of silicon was already known, since (1) describes the growing of silicon crystals, a group IV semiconductor, in carbon containers, wherein silicon is kept from contacting the container both in the molten and crystalline state by a layer of alkaline earth fluorides, optionally in admixture with up to 90% of alkaline earth silicates. This interposing layer is liquid during the crystallisation process, see the paragraph bridging pages 6 and 7. Therefore, the application of this general principle to the preparation of group III-V or group II-VI semiconductors was considered obvious.

- III. An appeal was lodged against this decision on 24 March 1987 and a statement of grounds of appeal was received on 30 May 1987. However, the appropriate fee was not paid in due time.

On 24 June 1987 the Appellant filed an application for re-establishment of rights under Article 122 EPC and paid the appropriate fees.

By an interlocutory decision dated 16 May 1988 the Board of Appeal re-established the Appellant in his rights. The appeal fee is therefore to be regarded as being filed in due time.

- IV. Together with the statement of grounds of appeal the Appellant filed a new set of four claims which, following a communication pursuant to Article 110(2), were further amended. The independent claim now reads as follows:

1. A process for growing a single crystal of gallium arsenide or indium phosphide by a crystal growth technique involving solidifying a melt in a container (12, 22, 52)

into a crystalline material, characterised in that an inert material (15, 25, 60) comprising boron oxide is interposed, prior to said solidifying step, between the container and the melt.

The Appellant substantially argued as follows:

The claimed process relates to an improvement over the prior art disclosed in (2) because the claimed process provides a rapid procedure for growing high quality, high purity crystals of the said semiconductor materials, which has been demonstrated by two affidavits filed 3 January 1989. In (2) boron oxide is proposed to prevent contamination of the melt of GaAs contained, e.g. in a boron nitride crucible, via the gas phase. In the claimed process, however, the function of the boron oxide is quite different, since it forms an interposing liquid layer between the crucible and the growing crystal, thereby improving the quality of the crystals. This effect of boron oxide could not be expected. It certainly could not be rendered obvious by (1) which relates to a quite different solution of a different problem.

- V. The Appellant requested that the appeal be allowed on the basis of Claims 1 to 6 filed on 3 January 1989.

Reasons for the Decision

1. Taking into account the interlocutory decision of 16 May 1988 the appeal complies with Articles 106 to 108 EPC and Rule 64. It is, therefore, admissible.

2. No objection under Article 123(2) EPC arises against the current version of the claims since they are duly supported by the application as filed. Claim 1 is based upon original Claims 1, 5 and the description, page 5, lines 26 to 28. Claim 2 is based upon the disclosure in the description, page 5, lines 8 to 26, Claim 3 corresponds to original Claim 5, Claim 4 to the description, page 5, lines 26 to 28, Claim 5 to original Claim 6, and Claim 6 to original Claim 7.
3. The claimed subject-matter is not described in any of the cited prior art documents. The Board therefore agrees with the Examining Division that the claimed subject-matter is novel.
4. It is therefore now to be investigated whether this subject-matter also involves an inventive step.
 - 4.1 The closest prior art with respect to the process now claimed is (2) describing inter alia a process for growing a single crystal of gallium arsenide or indium phosphide by a crystal growth technique involving solidifying a melt in a container into a crystalline material. In respect of this prior art the technical problem underlying the claimed process may be seen in improving the yield and reducing the number of crystal defects in the single crystal.

In order to solve this problem it is proposed in the application in suit to interpose an inert material comprising boron oxide between the container and the melt. It is shown by the test results contained in the two affidavits submitted by the Appellant on 3 January 1989, that indeed gallium arsenide crystals which have a greater crystal size and lower defect density than single crystals obtained according to the prior art are obtained by the

claimed method in improved yields if a boat consisting of boron nitride is used as a container.

According to the explanation given in the application in suit and in the Appellant's letter of 3 January 1989 the effect of the boron oxide is to form a liquid layer between the boat material and thereby to improve the growth of the crystal within the boat. This reasonable and at present irrefutable explanation is also applicable for indium phosphide and for boats or crucibles consisting of other materials than boron nitride, e.g. quartz. Therefore, the Board is satisfied that the existing problem is credibly solved by the claimed process.

- 4.2 This problem is neither addressed in (1) nor in (2). Document (1) relates to the production of silicon single crystals in a carbon container and the interposing layer of alkaline earth fluorides in this case only protects the container material from chemical reaction with the molten silicon and facilitates removal of the silicon crystal from the container without destruction of the latter. The growth of a single crystal, however, is not envisaged or considered in this document.

The problem underlying (2) is to prevent contamination of gallium arsenide or indium phosphide single crystals grown in a quartz apparatus by silicon. This problem was solved by coating the inner walls of this quartz apparatus with an inert material such as - among others - boron oxide (see Claims 1 and 3).

In a broad sense the quartz containers addressed in (2) also comprise the boats or crucibles in which the crystals are growing. However it becomes clear from the context of this document that a coating of this part of the apparatus for growing gallium arsenide or indium phosphide single

crystals is neither disclosed nor suggested therein, since it is acknowledged that it was already known to reduce this contamination by using boats or crucibles of boron nitride, aluminium nitride or aluminium oxide (see the paragraph bridging pages 1 and 2). This measure was considered insufficient since contaminating silicon was also provided by the wall of the quartz ampoule in which the said boats or crucibles are heated. This ampoule could not be made from the inert materials used for the boats or crucibles because these materials do not possess sufficient mechanical stability. Therefore it was proposed, in order to remove this further source of contamination, to coat the inner walls of this quartz ampoule by inter alia boron oxide. Thus in the Board's judgment the expression "quartz containers" used in (2) does not relate to the boats or crucibles containing the melt, and consequently this document, in contrast to the application in suit, does not teach or foreshadow the use of boron oxide in direct contact with the molten gallium arsenide or indium phosphide. Moreover, this document is completely silent with respect to the problem of improving the yield and the defect density of gallium arsenide or indium phosphide single crystals.

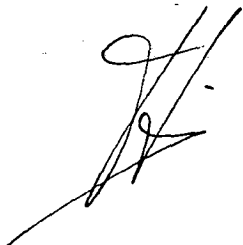
- 4.3 In the Board's judgment, therefore, the process according to Claim 1 involves an inventive step.
5. Claims 2 to 6 relate to specific embodiments of the process of Claim 1 and derive their patentability from this claim.
6. In the Board's view the final adaptation of the description to the pending claims should be done by the competent Examining Division.

Order

For the reasons set out above, it is decided that:

1. The decision of the Examining Division is set aside.
2. The case is remitted to the Examining Division with the order to grant a patent on the basis of Claims 1 to 6 submitted on 3 January 1989 and a description yet to be adapted thereto.

The Registrar:



The Chairman:

