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Datasheet for the decision of 13 March 2014

Case Number: T 2381/09 - 3.4.03

Application Number: 03745948.4

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IPC: H01L21/205, C30B23/02, C30B25/14, C30B29/38, C30B29/40, C23C16/34

Language of the proceedings: EN

Title of invention:

VAPOR PHASE GROWTH METHOD FOR Al-CONTAINING III-V GROUP COMPOUND SEMICONDUCTOR, AND METHOD AND DEVICE FOR PRODUCING Al-CONTAINING III-V GROUP COMPOUND SEMICONDUCTOR

Applicant:

Tokyo University of Agriculture and Technology Tlo Co., Ltd.

Headword:

Relevant legal provisions:

EPC Art. 123(2)
EPC 1973 Art. 54(2), 56

Keyword:

Novelty - main request (no) - auxiliary request (no)
Inventive step - auxiliary request (no)
Amendments - extension beyond the content of the application as filed (yes)

Decisions cited:
T 0279/89

Catchword:

Europäisches Patentamt
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Case Number: T 2381/09 - 3.4.03

D E C I S I O N
of Technical Board of Appeal 3.4.03
of 13 March 2014

Appellant: (Applicant)	Tokyo University of Agriculture and Technology Tlo Co., Ltd. 24-16 Naka-cho 2-chome Koganei-shi, Tokyo 184-8588 (JP)
Representative:	TBK Bavariaring 4-6 80336 München (DE)
Decision under appeal:	**Decision of the Examining Division of the European Patent Office posted on 17 July 2009 refusing European patent application No. 03745948.4 pursuant to Article 97(2) EPC.**

Composition of the Board:

Chairman: G. Eliasson
Members: S. Ward
T. Bokor

Summary of Facts and Submissions

I. The appeal is against the decision of the Examining Division refusing European patent application No. 03 745 948 on the grounds that the claimed subject-matter did not "meet the requirements of Art. 123(2), 52, 54, and 56 EPC".

II. The following documents cited by the Examining Division are referred to in this decision:

D1: US 6 218 269 B1;
D3: US 4 888 303 A;
D5: US 3 471 324 A.

III. The appellant requested that the decision under appeal be set aside and that a patent be granted on the basis of a main request filed with the statement of grounds of appeal, or alternatively on the basis of one of first to seventh auxiliary requests. The first, second, fourth and fifth auxiliary requests were filed with the statement of grounds of appeal and the third, sixth and seventh auxiliary requests were filed with a letter dated 27 November 2009. Oral proceedings were also requested.

IV. The Board issued a summons to oral proceedings and a communication under Article 15(1) of the Rules of Procedure of the Boards of Appeal (RPBA) setting out its provisional views.

V. In a letter dated 11 February 2014 the appellant withdrew the request for oral proceedings and requested "a decision on the file as it stands."

VI. Oral proceedings were held on the appointed date. The appellant was not represented.

VII. Claim 1 according to the main request, which is identical to claim 1 upon which the contested decision was based, reads as follows:

"1. A method for growing a crystal of an Al-containing III-V group compound semiconductor containing Al as a group III element by vapor phase epitaxy, comprising the steps of
reacting a solid Al with a halogenated hydrogen at a temperature in the range of 300 °C to 660.4 °C to produce a halogenated product of Al; and
reacting the halogenated product of Al with a gas containing a group V element at a temperature of 700 °C or above."

VIII. Claim 1 according to the first auxiliary request differs from claim 1 of the main request in that the temperature range of "300 °C to 660.4 °C" has been amended to "300 °C to 650 °C".

Claim 1 according to the second auxiliary request differs from claim 1 of the main request in that the temperature range of "300 °C to 660.4 °C" has been amended to "300 °C to 600 °C".

Claim 1 according to the third auxiliary request reads as follows:

"1. A method for growing a crystal of an Al-containing III-V group compound semiconductor containing Al as a group III element by vapor phase epitaxy in a quartz reactor, comprising the steps of

reacting a solid Al with a halogenated hydrogen at a temperature in the range of 300 °C to 700 °C to produce a halogenated product of Al; and
reacting the halogenated product of Al with a gas containing a group V element at a temperature of 700 °C or above, wherein the carrier gas for the halogenated hydrogen is hydrogen or a mixture of hydrogen and an inert gas."

IX. Claim 1 according to the fourth auxiliary request reads as follows:

"1. A method for growing a crystal of an Al-containing III-V group compound semiconductor containing Al as a group III element by vapor phase epitaxy, comprising the steps of
reacting a solid Al with a HCl at a temperature in the range of 300 °C to 700 °C to produce $AlCl_3$ *and*
reacting the $AlCl_3$ *with a gas containing a group V element at a temperature of 700 °C or above, wherein the HCl has an input partial pressure of* $1*10^{-4}$ *to* $5*10^{-2}$ *atm."*

X. Claim 1 according to the fifth auxiliary request reads as follows:

"1. A method for growing a crystal of an Al-containing III-V group compound semiconductor containing Al as a group III element by vapor phase epitaxy, comprising the steps of
reacting a solid Al with a HCl at a temperature in the range of 300 °C to 700 °C to produce $AlCl_3$ *and*
reacting the $AlCl_3$ *with a* NH_3 *gas at a temperature of 700 °C or above, wherein*

the HC1 has an input partial pressure of $1*10^{-4}$ to $5*10^{-2}$ atm and the NH_3 gas has an input partial pressure of 0.1 to 0.5 atm."

Claim 1 according to the sixth auxiliary request is in substance the same as claim 1 of the fourth auxiliary request except that the temperature range of "300 °C to 700 °C" has been amended to "300 °C to 650 °C".

Claim 1 according to the seventh auxiliary request is in substance the same as claim 1 of the fifth auxiliary request except that the temperature range of "300 °C to 700 °C" has been amended to "300 °C to 650 °C", and the temperature range of "700 °C or above" has been modified to "900 to 1100 °C".

XI. The appellant's arguments may be briefly summarised as follows:

The subject-matter of claim 1 of the main request was novel over document D1 as it satisfied the three criteria for novelty of a selection invention. Firstly, this subject-matter did not represent an arbitrary choice, but resulted in a technical effect in that "using Al in the solid state enables a high speed reaction between Al and HCl." Moreover, the document Dl "discloses the reaction of Ga (or Ga and Al) with HCl at temperatures between 350°C and 800°C." With respect to this, the claimed range was narrow and sufficiently far removed from the end points. All criteria for the novelty of a selection invention were therefore fulfilled.

This subject-matter also involved an inventive step. The technical problem solved by the method according to claim 1 of the main request was avoiding a

contamination of the compound semiconductor with Si from the quartz vessel, as explained in the description (page 5, lines 7–19 and page 6, line 21 – page 7, line 1). Document D1 "does not consider the problem of the reaction of monohalogenated Al with quartz or suggests or proposes an upper temperature limit of 660.4°C for the first reaction step."

Furthermore, the present invention derived from particular theoretical and mathematical research. "Such a theoretical approach has never been done by anybody in the world before, and nobody got the conclusion with respect to the corrosion of the quartz tube before." This theoretical approach had been confirmed by experimental data.

The independent claims of the auxiliary requests incorporated further features which distinguished the claimed subject-matter over the prior art.

Reasons for the Decision

1. The appeal is admissible.

2. As announced in advance, the duly summoned appellant did not attend the oral proceedings. According to Rule 71(2) EPC 1973, the proceedings could however continue without the appellant. In accordance with Article 15(3) RPBA, the Board relied for its decision only on the appellant's written submissions. The Board was in a position to decide at the conclusion of the oral proceedings, since the case was ready for decision (Article 15(5) and (6) RPBA), and the voluntary absence

of the appellant was not a reason for delaying a decision (Article 15(3) RPBA).

3. *Main Request*

3.1 The document D1 discloses (see for example: column 6, lines 38 to 67; column 7, line 51 to column 8, line 16; and embodiment 2) a method for growing a crystal of an Al-containing III-V group compound semiconductor containing Al as a group III element by vapor phase epitaxy, comprising the steps of reacting Al with a halogenated hydrogen to produce a halogenated product of Al, and reacting the halogenated product of Al with a gas containing a group V element at a temperature of 700°C or above ("800 to 1200° C": see D1, column 8, lines 11-14).

Aluminium is a solid up to a temperature of 660.4°C, and hence over most of the temperature range disclosed in document D1 ("350 to 800° C" – see column 6, line 60 and column 8, line 1) in which aluminium is reacted with with halogenated hydrogen (HCl), the aluminium metal would be in the form of a solid.

This accounts for all features of claim 1 other than the temperature range of 300°C to 660.4°C in which the first step is carried out. As mentioned above, the corresponding temperature range disclosed document D1 is 350°C to 800°C. The question is therefore whether defining the claimed range in this manner is sufficient to render the subject-matter of claim 1 novel over the disclosure of document D1.

3.2 The appellant argues that the subject-matter of claim 1 is new as "the three criteria for novelty of a selection invention" are met, clearly referring to the

principles set out, for example, in section I.C.5.2.1 of "Case Law of the Boards of Appeal of the EPO, 7th Edition 2013". However, these principles were developed to deal with the case of "a selection of a sub-range of numerical values from a broader range" (see e.g. T 279/89, Reasons, point 4.1), in other words a case in which the claimed range lies *entirely within* the range disclosed in the prior art.

Claim 1 of the main request, however, defines an upper limit (660.4°C) which is *inside* the range disclosed in document D1 (350°C to 800°C) and a lower limit (300°C) which is *outside* the prior art range. The claimed range is not, therefore, a sub-range of the range disclosed in document D1, and hence the principles cited by the appellant are not relevant to the present case.

3.3 In fact, the ranges defined by claim 1 and document D1 *overlap*, and the boards have developed a different set of principles to deal with this eventuality (see section I.C.5.2.2 of "Case Law of the Boards of Appeal of the EPO, 7th Edition 2013"). The Board considers it appropriate to apply these principles to the present case.

According to this approach, the decisive question is whether the person skilled in the art would, in the light of the technical facts, seriously contemplate applying the technical teaching of the prior art document in the range of overlap. If it can be fairly assumed that he would do so, it must be concluded that the claimed range is disclosed in the prior art.

In the present case the disclosed range is 350°C to 800°C and the range of overlap is 350°C to 660.4°C, corresponding to almost 70% of the disclosed range. No

reason is apparent to the Board why a skilled person would seriously contemplate carrying out the method of document D1 only in the highest (approximately) 30% of the disclosed range.

As 660.4°C is the melting point of aluminium, the range of overlap corresponds to that part of the disclosed range in which aluminium is solid, whereas in the remaining upper part of the range aluminium would be liquid. However, no reason can be identified in document D1 (which simply refers to "Al metal" – column 6, line 65) why a skilled person would not seriously contemplate using aluminium in solid form as a source material, and the idea that there exists in document D1 an implicit intention to exclude the use of solid aluminium as a source material can hardly be reconciled with the choice of a lower limit for the temperature range in the source zone of 350°C, which is more than 300°C below the melting point of aluminium.

Even if the appellant's point that the use of solid aluminium "enables a high speed reaction between Al and HCl" is an accurate observation, this does not constitute an argument that the skilled person would not seriously consider operating in the range of overlap.

In summary, the Board can see no reason why a skilled person would not contemplate carrying out the method of document D1 over the entire disclosed range, including the region of overlap with the claimed range, which is therefore disclosed in document D1. Hence, the subject-matter of claim 1 of the main request is not new within the meaning of Article 54(2) EPC 1973.

4. *First and second Auxiliary Requests*

4.1 Claim 1 of the first auxiliary request and claim 1 of the second auxiliary request both differ from claim 1 of the main request only in the upper limit of the temperature range of the first step, which is 650°C for the first auxiliary request and 600°C for the second auxiliary request.

Both of these amendments still result in ranges of overlap of more than 50% with the temperature range disclosed in document D1, and the arguments given above that claim 1 of the main request is not new applies equally to claim 1 of the first auxiliary request and claim 1 of the second auxiliary request, *mutatis mutandis*. The subject-matter of both of these claims is not therefore new within the meaning of Article 54(2) EPC 1973.

5. Third Auxiliary Request

5.1 In claim 1 of the 3rd auxiliary request the upper limit of the temperature range is amended to 700°C. For the same reasons as those set out above in connection with the main request, *mutatis mutandis*, this amendment does not achieve novelty over of the range disclosed in document D1.

Furthermore, quartz reaction tubes or channels are disclosed in document D1 (column 7, lines 51 to 63).

Claim 1 of the 3rd auxiliary request therefore differs from document D1 in that the carrier gas is hydrogen or a mixture of hydrogen and an inert gas. In document D1 the carrier gas is the inert gas argon.

In the application it is suggested that the carrier gas "may be hydrogen, an inert gas, or a mixture of hydrogen and an inert gas ... Hydrogen is advantageously used because it brings little, if any, impurities into the resulting crystal." (See page 17, lines 12–16.)

5.2 The use of hydrogen as a carrier gas, however, has long been known in the art (e.g. document D3, column 3, lines 57 to 60 and document D5, column 3, lines 16 to 19). Given that document D5 was published in 1969, it must be presumed that the technical consequences of using hydrogen as a carrier gas are well-established.

In particular, even if it is a valid observation that using hydrogen as the carrier gas has a beneficial effect on the level of impurities, it is implausible that this effect would not have been noticed previously, nor does the appellant argue that this is the case. Hence, the selection of hydrogen as the carrier gas would merely correspond to the selection of a substance long known to be suitable for the required purpose, to benefit thereby from its known advantages.

5.3 Consequently, the Board judges that the subject-matter of claim 1 of the 3rd auxiliary request does not involve an inventive step within the meaning of Article 56 EPC 1973.

6. Fourth Auxiliary Request

Claim 1 of the 4th auxiliary request comprises the feature that the HCl has an input partial pressure of 1×10^{-4} to 5×10^{-2} atm. The basis for this feature is said to be page 22, lines 1 to 9. This passage reports a "growth experiment" conducted using HCl input partial

pressures within this range in order to determine suitable parameter values for growing an AlN layer having high crystal quality. As a result of the experiments, an apparently optimal figure of 5×10^{-3} atm was arrived at.

This range is not, therefore, disclosed as a working range of the method, but merely as a suitable range over which to carry out experiments in order to determine appropriate input partial pressures at which the method may be implemented.

Indeed, the very fact that such experiments were conducted implies a doubt about the feasibility of carrying out the method over this broad range of input partial pressures, the experiments being necessary to determine workable values.

The optimal figure was found to be of 5×10^{-3} atm, and it may fairly be assumed that input partial pressures similar to this could also be successfully used. There is, however, no disclosure in the application as filed that the method could be carried out at or near the end points of the range (1×10^{-4} and 5×10^{-2} atm), which are far removed from the optimal value.

In short, the application as filed does not disclose a method for growing a crystal in which the HCl has an input partial pressure in the range 1×10^{-4} and 5×10^{-2} atm. For this reason, the subject-matter of claim 1 of the fourth auxiliary request does not satisfy the requirements of Article 123(2) EPC.

For completeness, even if this range were considered to be a disclosed working range, it is only disclosed in combination with other parameters such as the input

partial pressure of the NH_3, the temperature of the Al material and the temperature of the growth area.

The claimed range is not disclosed *per se* in the application as originally filed, i.e. in a context in which these other parameters are not specified. For this reason also, the subject-matter of claim 1 of the fourth auxiliary request does not satisfy the requirements of Article 123(2) EPC.

7. *Fifth Auxiliary Request*

Claim 1 of the fifth auxiliary request adds to the features of claim 1 of the fourth auxiliary request the feature that the NH_3 gas has an input partial pressure of 0.1 to 0.5 atm.

The subject-matter of claim 1 of the fifth auxiliary request comprises the range of HCl input partial pressures which has been found, in the analysis of claim 1 of the fourth auxiliary request, not to be disclosed in the application as filed. For this reason alone, the subject-matter of claim 1 of the fifth auxiliary request does not satisfy the requirements of Article 123(2) EPC.

For completeness, it is also mentioned that the partial pressures of the NH_3 gas disclosed in the application as originally filed (i.e. "0.1, 0.2, 0.4 and 0.5 atm" – page 22, lines 3 to 4) represent a set of partial pressures at which the "growth experiment" was carried out. On the basis of similar reasoning to that presented in relation to claim 1 of the fourth auxiliary request, *mutatis mutandis*, this does not constitute a disclosure of a method for growing a crystal in which the NH_3 gas has an input partial

pressure of 0.1 to 0.5 atm. Hence, for this reason also, the subject-matter of claim 1 of the fifth auxiliary request does not satisfy the requirements of Article 123(2) EPC.

8. *Sixth and Seventh Auxiliary Requests*

Claim 1 according to the sixth auxiliary request comprises as a feature the same range of HCl input partial pressures which was found, in the discussion of claim 1 of the fourth auxiliary request, to extend beyond the content of the application as filed.

Claim 1 according to the seventh auxiliary request also comprises this feature, and additionally comprises as a feature the range of NH_3 input partial pressures which was found, in the discussion of claim 1 of the fifth auxiliary request, to extend beyond the content of the application as filed.

Consequently, claim 1 according to the sixth auxiliary request and claim 1 according to the seventh auxiliary request do not meet the requirements of Article 123(2) EPC.

9. As the Board judges that none of the appellant's requests meets the requirements of the EPC, the appeal cannot be allowed.

Order

For these reasons it is decided that:

The appeal is dismissed.

The Registrar: The Chairman:

S. Sánchez Chiquero G. Eliasson

Decision electronically authenticated