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Datasheet for the decision of 26 January 2009

Case Number: T 0396/06 - 3.2.07

Application Number: 96922326.2

Publication Number: 0835336

IPC: C30B 29/36

Language of the proceedings: EN

Title of invention:
A device and a method for epitaxially growing objects by CVD

Patent Proprietor:
Norstel AB

Opponent:
L P E S.p.a.

Headword:
-

Relevant legal provisions:
EPC Art. 54, 56, 83, 84, 100(b), 100(c), 123(2) and (3)
RPBA Art. 12, 13

Keyword:
"Subject-matter extends beyond content of application as originally filed (main and auxiliary request I - yes; auxiliary requests II to VII - no)"
"Sufficiency of disclosure (auxiliary request II - no)"
"Novelty (auxiliary request III - no; auxiliary request VII - yes)"
"Clarity (auxiliary requests IV to VI - no)"
"Inventive step (auxiliary request VII - yes)"
"Amendment to the appellant's case" (not allowed)

Decisions cited:
T 0215/84, T 0016/87, T 0523/89

Catchword:
-

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Case Number: T 0396/06 **-** 3.2.07

D E C I S I O N
of the Technical Board of Appeal 3.2.07
of 26 January 2009

Appellant: (Opponent)
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Decision under appeal:
Decision of the Opposition Division of the European Patent Office posted 20 January 2006 rejecting the opposition filed against European patent No. 0835336 pursuant to Article 102(2) EPC.

Composition of the Board:

Chairman: H. Meinders
Members: H. Hahn
E. Dufrasne

Summary of Facts and Submissions

I. The opponent (appellant) lodged an appeal against the decision of the Opposition Division to reject the opposition against European patent No. 0 835 336 and requested that the decision be set aside and the patent be revoked.

II. For this decision the following documents of the opposition proceedings are of relevance:

D1 = EP-A-0 554 047

D4 = "Growth and characterisation of silicon carbide power device material", O. Kordina, Dissertation Linköping University No. 352, presented 01.12.1994, pages 1-140

D7 = "CVD-growth of low-doped 6H SiC epitaxial films", O. Kordina et al., Materials Research Society, Symp. Proc. Vol. 339, 1994, pages 405-410

D8 = "SiC- A semiconductor for high-power, high-temperature and high-frequency devices"; E. Janzen et al., Physica Scripta, vol. T54, 1994, pages 283-290

D9 = EP-A-0 599 468

D10 = US-A-5 037 502

D11 = "A novel hot-wall CVD reactor for SiC epitaxy", O. Kordina et al., Institute of Physics Conference Series Number 137, Silicon Carbide and Related Materials, Proceedings of the Fifth International Conference Washington D.C. 1993, published 1994

D20 = "Bulk GaN single-crystals growth", G. Kamler et al., Journal of Crystal Growth, vol. 212, (2000), pages 39-48

D23 = US-A-4 866 005

D24 = WO-A-97 01658 (published form of the application in suit as originally filed)
D28 = "AlN single crystals", G.A. Slack and T.F. McNelly, Journal of Crystal Growth, vol. 42 (1977), pages 560-563
D29 = "Dry etching of thin-film InN, AlN and GaN", S.J. Pearton et al., Semiconductor Science and Technology, Vol. 8 (1993), pages 310-312

Of the present appeal proceedings the following document:

D34 = US-A-3 382 113

is relevant.

III. An opposition had been filed against the patent in its entirety under Article 100(a) EPC, for lack of novelty and inventive step and that certain aspects lack industrial applicability, under Article 100(b) EPC, that the patent does not disclose the invention in a manner sufficiently clear and complete for it to be carried out by the person skilled in the art, and under Article 100(c) EPC, that the patent as granted extends beyond the content of the application as originally filed.

The Opposition Division held that no objection of a lack of industrial applicability can be upheld against the contested patent. Furthermore, apparatus claims 1 and 4 as granted and the acknowledgement of D1 in the description were considered to meet the requirements of Articles 123(2) EPC. It further held that the arguments presented in respect of Articles 100(b) and 83 EPC were

not convincing. The Opposition Division further considered that the subject-matter of claim 1 was novel, particularly with respect to D1, D4, D8 and D9 while the subject-matter of independent method claim 9 was considered to be novel, particularly with respect to D1, D4 and D8 to D10. Furthermore, the subject-matter of claim 1 was considered to involve an inventive step, particularly in view of D1 taken alone or in combination with either of D23, D4 or D8. The subject-matter of claim 9 was likewise considered to involve an inventive step in view of D1 and D4.

IV. Claims 1, 4 and 9 as granted read as follows:

"1. A device for epitaxially growing objects of SiC, a Group III-nitride or alloys thereof by Chemical Vapour Deposition on a substrate (13) comprising a susceptor (7) having circumferential walls (8) with a substantially uniform thickness surrounding a room (18) for receiving the substrate and means (11) for heating said circumferential susceptor walls and by that the substrate and a gas mixture decomposed by this heating and fed to the substrate for the growth by feeding means, said heating means being arranged to heat the susceptor (7) and by that the substrate (13) above a temperature level from which sublimation of the material grown starts to increase considerably, thus combining both decomposition of gases of the gas mixture and sublimation in the same room (18), said feeding means being arranged to feed a gas mixture including precursor gases to be decomposed into elements for deposition on said substrate for epitaxial growth thereon and at least one etching gas with such a composition and at such a rate into the susceptor that

a positive growth takes place, i.e. the deposition rate of elements forming the material grown on the substrate is higher than the rate of material leaving the layers on the substrate due to sublimation and etching, said circumferential walls extending substantially vertically, said susceptor having a lower inlet (15) for said gas mixture and an upper gas outlet (14) for a gas flow in the susceptor from the lower inlet to the substrate (13) and then out through the upper outlet (14)."

"4. A device according to any of claims 1-3, **characterized in that** it is adapted for growing boules (19) and said substrate (13') is a seed crystal."

"9. A method for epitaxially growing objects of SiC, a Group III-nitride or alloys thereof by Chemical Vapour Deposition on a substrate (13, 13') arranged to be received by a susceptor (7, 7'), said substrate and a gas mixture fed to the substrate for said growth being heated through heating of the susceptor, **characterized in that** the etching action of said gas mixture upon the susceptor and substrate is varied by varying the content of at least one etching gas in said gas mixture, that the substrate is heated by heating the susceptor (7, 7') above a temperature level from which sublimation of the material grown starts to increase considerably, and that the content of said at least one etching gas in the gas mixture and the supply rate of precursor gases to be decomposed into elements for deposition on the substrate for epitaxial growth thereon included in the gas mixture are regulated so that a positive growth takes place, i.e. the deposition rate of elements forming the material grown on the

substrate is higher than the rate of material leaving the layers on the substrate due to sublimation and etching."

V. On appeal the appellant maintained its objection under Article 100(c) EPC with respect to claim 1 and its objections with respect to method claim 9 for lack of novelty and inventive step as well as sufficiency of disclosure.

VI. With the summons dated 10 November 2008 the Board arranged for oral proceedings and presented its preliminary opinion with communication dated 13 November 2008 based on claims 1-19 of the patent as granted and claims 1-19 of the auxiliary request as filed by the respondent with letter of 6 December 2006.

Claims 1 and 4 as granted appeared to contravene Article 123(2) EPC. The same conclusion appeared to be valid with respect to the auxiliary request containing an identical claim 4. Therefore both requests appeared not to be admissible.

With respect to the issue of sufficiency of disclosure the Board stated that it seemed that the skilled person was confronted with an undue burden occasioned by the high number of experiments necessary for carrying out the process claimed in method claim 9 with respect to the class of materials other than SiC ("group III-nitrides or alloys thereof") so that this subject-matter did not fulfil the requirements of Article 83 EPC. The respondent's arguments concerning the sufficiency of disclosure for the SiC growth, however, appeared to be acceptable.

With respect to the discussion of novelty of the subject-matter of method claim 9 of both requests, insofar as SiC was concerned, the Board remarked that claim 9 could be feasibly interpreted such that the processes according to D1, D4, D7, D8, D11 and D34 were novelty destroying for its subject-matter.

VII. With fax dated 21 December 2008 the appellant submitted further documents and additional arguments. For the first time in the appeal proceedings it cited document D23 in the context of the issue of whether the "mount base 37" according to D1 could be considered a susceptor as claimed in claims 1 and 9.

VIII. With fax dated 23 December 2008 the respondent submitted auxiliary requests I to X in combination with arguments concerning the allowability of the amendments made therein and the patentability thereof taking account of the Board's communication.

IX. Oral proceedings before the Board were held on 26 January 2009.

(a) The appellant requested that the decision under appeal be set aside and that the patent be revoked.

(b) The respondent requested that the appeal be dismissed and that the patent be maintained as granted or, in the alternative, that the decision under appeal be set aside and that the patent be maintained on the basis of one of the auxiliary requests:

- I to VI, filed with letter dated 23 December

2008;
- VII, filed during the oral proceedings; or
- VIII to X, filed with letter dated 23 December 2008.

(c) At the end of the oral proceedings the Board announced its decision.

X. Claim 1 of auxiliary request I differs from claim 1 as granted in that the feature "**in the direction of the gas feed into the susceptor**" (all emphasis added by the Board) has been introduced between the terms "said circumferential walls extending substantially vertically" and ", said susceptor having a lower inlet (15) …".

Claims 2 to 18 of auxiliary request I correspond to claims 2-3 and 5-19 as granted, respectively.

XI. Claim 1 of auxiliary request II differs from claim 1 of auxiliary request I in that the feature "… for growing objects of SiC" has been replaced by the feature "… for growing **layers** of SiC".

The remaining claims 2 to 18 of auxiliary request II correspond to claims 2, 3 and 5 to 19 as granted, respectively.

XII. Claims 1 and 8 of auxiliary request III are besides the deletion of the feature "**a Group III-nitride or alloys thereof**" identical with claims 1 and 8 of auxiliary request II.

The dependent claims 2 to 7 and 9 to 18 of auxiliary request III correspond to claims 2, 3, 5 to 8 and 10 to 19 as granted, respectively.

XIII. Claim 8 of auxiliary request IV differs from claim 8 of auxiliary request III in that the feature "**wherein comparatively extensive etching and sublimation is provided during growth, such that formation of crystal defects and incorporation of unwanted impurities into the object grown are counteracted**" has been added after the feature "… due to sublimation and etching".

The remaining claims 1 to 7 and 9 to 18 of auxiliary request IV correspond to those of auxiliary request III.

Claim 8 of auxiliary request V differs from claim 8 of auxiliary request IV in that the feature "**whereby the substrate is heated at a temperature above 1900°C**" has been inserted between the features "… starts to increase considerably," and "and that the content of said at least one etching gas …".

Claims 1 to 7 and 9 to 17 of auxiliary request V correspond to claims 1 to 7, 9 to 13 and 15 to 18 of auxiliary request III, respectively.

Claim 8 of auxiliary request VI differs from claim 8 of auxiliary request IV in that the feature "**whereby the substrate is heated at a temperature between 2000 and 2500°C**" has been inserted between the features "… starts to increase considerably," and "and that the content of said at least one etching gas …".

The remaining claims 1 to 7 and 9 to 16 of auxiliary request VI correspond to claims 1 to 7, 9 to 13 and 16 to 18 of auxiliary request III, respectively.

XIV. Claim 7 of auxiliary request VII differs from claim 8 of auxiliary request III in that the feature "**having circumferential walls with a substantially uniform thickness surrounding a room**" has been inserted between the features "… to be received by a susceptor (7, 7')" and ", said substrate and a gas mixture …" and that the feature "**walls**" has been inserted between the terms "… through heating of the susceptor" and ", characterized in that the etching action …".

Dependent claim 4 has been amended by replacing the feature "for growing objects of SiC" by "for growing **layers** of SiC".

Claim 1 of auxiliary request VII is identical with claim 1 of auxiliary request III.
The remaining claims 2, 3, 5, 6 and 8 to 17 of auxiliary request VII correspond to claims 2, 3, 6 to 8 and 10 to 19 as granted, respectively.

XV. The wording of auxiliary requests VIII to X is of no relevance to the present decision, considering the outcome.

XVI. The appellant argued essentially as follows:

Claim 1 as granted specifies a lower inlet for the gas supply and an upper gas outlet which corresponds to the embodiment of Figure 2 of the application as originally filed, i.e. a specific embodiment adapted only for

growing **layers** of SiC (see D24, page 7, lines 13 to 16) while the second specific embodiment of the invention, which is the one according to Figure 3 is only adapted for growing **boules** (see page 7, lines 18 to 20). Consequently, since claim 4 as granted depends on claim 1 it is evident that claims 1 and 4 of the main request and claim 1 of auxiliary request I contravene Article 123(2) EPC. The respondent argues that it is obvious to the skilled person that one can also grow boules with the device shown in Figure 2 and claimed in claim 1, but what is required is that the features are directly and unambiguously derivable from the original application, i.e. the novelty criteria have to be applied. Furthermore, taking account of the embodiment of Figure 5 of D23, which provides the same gas flow as the embodiment of Figure 3 of the patent in suit, the person skilled in the art would all the more assume that only said embodiment of Figure 3 is suitable for growing boules. Therefore claim 1 of the main request and claim 1 of auxiliary request I contravene Article 123(2) EPC.

Although the patent in suit provides a rather acceptable disclosure for a method for growing objects of SiC it does not contain an acceptable disclosure for the other class of materials, i.e. the "group III-nitrides and alloys thereof". This class contains materials being totally different from SiC in structure and behaviour and there exists only a short statement in the patent in suit which simply asserts that the process of (now) independent claim 8 of auxiliary request II is applicable to this class of materials (see paragraph [0025]). There is no disclosure at all in the patent in suit concerning the required

temperature, the pressure, the precursor gases, the etching gases, etc. for any of these group III-nitrides or their alloys. Such disclosure, however, should have been comprised in the patent in suit to provide sufficiency of disclosure. Hence it represents an extreme case of insufficient disclosure which places an undue burden onto the person skilled in the art to establish appropriate values for the above parameters. Metal organic compounds as disclosed in e.g. D4 or D29 are usually used at much lower temperatures than that described for SiC in the patent in suit, i.e. above 1900°C. Therefore the patent, for the method of claim 8 of auxiliary request II, does not comply with Article 83 EPC.

The subject-matter of method claim 8 of auxiliary request III lacks novelty over the process according to D34 which discloses a CVD process for the growth of SiC in the temperature range of from 1400-2000°C (see column 1, lines 61 to 70). According to D34 the SiC is grown in a reaction chamber 10 on a SiC seed 14 being supported on a susceptor 12 of graphite or tantalum which is inductively heated by the induction coils 15 (see column 2, lines 4 to 13). The input gas mixture containing silane and methane as precursor gases decomposes in the vicinity of said susceptor at the specified temperatures and generates SiC and hydrogen which latter acts as an etchant (see column 2, lines 13 to 22). Since the SiC can be N or P doped by introducing a gaseous mixture consisting of PH_3 or N_2 and B_2H_6, respectively, or $Al(BH_4)_3$ into the reaction chamber via tube 18 the content of the hydrogen in said atmosphere changes as result of such doping (see column 2, lines 23 to 28). Such a variation is as

claimed, as it represents one kind of variation of the etchant according to the patent in suit (see patent, paragraph [0028]). Since said temperature range of 1400-2000°C according to D34 overlaps with the preferred range of above 1900°C to 2500°C of the patent in suit it has to be concluded that the sublimation of the grown SiC has considerably increased so that the subject-matter of claim 8 of auxiliary request III is anticipated by the process of D34.

The method of claim 8 likewise lacks novelty over the process described in the context of Figure 5 of D23. According to this embodiment silane and ethylene are used as precursor gases (without mentioning any carrier gas) to form SiC at approximately 2400°C whereby hydrogen is generated in a graphite susceptor comprising wall 36 and a lid 34 (see column 11, lines 1 to 19 and line 55 to column 12, line 30; and Figure 5). Although D23 has not been addressed in the grounds of appeal it has been mentioned in the submission of 21 December 2008 with respect to the definition of what constitutes a susceptor.

The feature commonly added to the claims 8 of auxiliary requests IV to VI attempts to define a result to be achieved where it is possible to define the invention by other concrete technical features and thus contravenes Article 84 EPC.

Auxiliary request VII is not objected to under Articles 123(2) and (3) EPC. The subject-matter of method claim 7 of auxiliary request VII, however, lacks an inventive step over a combination of the teachings of either D34 and D23, or of D1 and D23. Novelty of the

method of claim 7 over D34 is established through the claimed shape of the graphite susceptor, which is different from the one in D34 (see column 2, line 6 and the Figure). The result of this feature is even and uniform heating of the substrate. To solve the problem of uniform heating the person skilled in the art would search in the prior art for information concerning the shape of the susceptor. The embodiment according to Figure 5 of D23 concerns a CVD process including a susceptor comprising elements 34 and 36 within a cylindrical heater and its susceptor walls have a substantially uniform thickness. Claim 7 does not exclude any temperature gradient and the gradient according to D23 is relatively small when taking account of the values 2300°C at the sublimation source and 2200°C at the growing SiC crystal (see column 11, lines 13 to 19). Furthermore, the subject-matter of claim 7 likewise does not exclude any further element of the susceptor such as the graphite barrier 37 according to D23.

Starting from D1 it was argued that the mount base 37 and heater 35 form a susceptor since said base can be rotated and moved up and down. Therefore it can be provided with the shape of the susceptor according to Figure 5 of D23 discussed above. The objective problem starting from D1 would be how to realize the susceptor. In view of the fact that claim 7 does not exclude the use of a graphite susceptor the respondent's argument that D1 teaches not to use a graphite crucible and thus to avoid a graphite susceptor cannot be accepted. The shape of the susceptor walls having substantially uniform thickness is available to the person skilled art as common general knowledge. Applying the teaching

of D23 to the device of D1 the person skilled in the art will arrive at the subject-matter of claim 7 of auxiliary request VII without any inventive skill.

The amendments made to the description are not objected to.

XVII. The respondent argued essentially as follows:

The feature of claim 1 as granted defining that the walls extend substantially vertically is supported by claim 10 as originally filed but also by the specification in its totality (see D24, e.g. page 9, lines 9 to 11). The gas flow in the claimed susceptor is implicit. A limitation of device claim 1 to growing "layers" instead of "objects" has no effect, as the reference only relates to the intended use of the device. This is also in analogy with how intended use features are considered in view of patentability, following established jurisprudence (see e.g. T 0215/84 and T 0523/89, both not published in OJ EPO). Furthermore, the definition "objects" generally includes any type of crystals such as layers of different thicknesses as well as thick boules (see D24, page 1, lines 10 and 11; page 11, lines 11 to 13). Thus the specific embodiments discussed in the patent are generally to be seen as apt for growing objects, even though the embodiment discussed in relation to Figure 2 is preferred for use in growing layers while that according to Figure 3 is preferred for growing boules. This is also emphasized by the discussion that it is primarily the controlled etching action that renders it possible to use the inventive device for growing both layers and boules by CVD techniques (see D24, page 2,

lines 5 and 14 to 18; page 4, lines 18 to 20; page 5, line 35 to page 6, line 6; page 9, lines 32 to 37; page 10, lines 24 to 26). It is obvious to the person skilled in the art that he can use the embodiment of figure 2 also for growing boules. It is rather a question of time than a different type of device. Therefore claim 1 as granted meets the requirements of Article 123(2) EPC. The same arguments apply to claim 1 of auxiliary request I.

Claim 1 of auxiliary request II has been restricted to the specific embodiment of Figure 2 so that the requirements of Article 123(2) EPC should be met.

As admitted by the appellant the disclosure of the patent in suit concerning growing SiC is sufficient and the person skilled in the art therefore knows how to carry out the invention with this material. Although it bears the burden of proof the appellant has not submitted any evidence that the invention cannot be carried out (see T 0016/87, OJ EPO 1992, 212). According to established case law normally one example is sufficient if it can be easily adapted for the rest of the ambit of the claims. The person skilled in the art knows how said other materials are grown by CVD processes see e.g. D4 (see page 18), D28 (AlN) or D29 (InN, GaN, AlN). Taking account of D20 (see page 41), in which is disclosed that the term "sublimation" represents a broader definition for a transport in the gas phase the person skilled in the art knows how to carry out the invention with the "group III-nitrides and alloys thereof". Therefore the patent with the method of claim 8 of auxiliary request II meets the requirements of Article 83 EPC.

With respect to novelty of claim 8 of auxiliary request III it is remarked that D23 has not been introduced into the appeal proceedings, let alone for being novelty destroying, and should thus not be considered at all. Furthermore, D23 is irrelevant as it concerns the sublimation of solid material and not of gaseous precursors. D34 concerns a different teaching, namely to avoid or prevent the etching of the device and substrate by the formed hydrogen through the addition of argon as inert gas (see column 1, lines 24 to 44; column 2, lines 29 to 34; claim 4).

The feature "wherein comparatively extensive etching and sublimation is provided during growth, such that formation of crystal defects and incorporation of unwanted impurities into the object grown are counteracted" incorporated into claims 8 of auxiliary requests IV to VI has a basis at page 6, lines 30 to 33 of D24 so that Article 123(2) EPC should have been complied with.

The features incorporated into claim 7 of auxiliary request VII have a basis at page 8, lines 5 to 17 of D24 so that the requirements of Articles 123(2) and (3) EPC are met.

Neither D1, nor D34, but D4 is considered to represent the closest state of the art for high temperature hot wall CVD growth of SiC. The objective problem is therefore the provision of a process which allows to obtain a higher growth rate and a higher quality of the SiC. D34 concerns a cold-wall CVD growth of SiC in a quartz chamber and suggests that not too much etching

should take place (see column 2, line 6 and lines 29 to 34). D23 on the other hand relates to sublimation techniques of solid SiC material and requires the presence of a temperature gradient for the growth of the SiC crystal (see column 8, line 60 to column 9, line 7). Furthermore, the susceptor according to the embodiment of Figure 5 of D23 does not necessarily have a substantial uniform thickness of the walls and the described technique additionally uses a membrane 37 in order to arrange the formed SiC at a certain point in the chamber (see column 12, lines 23 to 29). Thus the person skilled in the art has no reason at all to choose the susceptor of D23. Also the process of D1 requires a temperature gradient (see Table 1). Furthermore, the heater 35 and base 37 according to D1 do not form a susceptor wherein the gas mixture is decomposed (see Figure 1). D1 aims to avoid using a graphite crucible to prevent any problems on production of products having their origin in such a crucible (see page 3, lines 1 to 3; and page 4, lines 46 to 50). Therefore the person skilled in the art would also not combine the process and device of D1 with the susceptor of Figure 5 of D23. D1, D34 and D23 are incompatible since they concern totally different concepts and technologies. According to the patent in suit the SiC growth is done without any gradient (see patent, column 4, lines 2 to 9). Consequently, the subject-matter of claim 7 of auxiliary request VII involves an inventive step.

Reasons for the Decision

1. *Admissibility of amendments (Articles 123(2) and (3) EPC)*

Main request

1.1 Claim 1 as granted (main request) is directed to "a device for epitaxially growing objects of SiC, …" and includes the feature "… said susceptor having a lower inlet (15) for said gas mixture and an upper gas outlet (14) for a gas flow in the susceptor from the lower inlet to the substrate (13) and then out through the upper outlet (14)" (see point IV above).

Claim 1 had been amended during the examination proceedings wherein it had been argued (see letter of the applicant dated 15 March 2001) that it was based on claims 1, 2 and 10 in combination with information derivable from page 8, line 33 to page 9, line 29; and page 8, lines 20 to 28 of the application as originally filed (= corresponding to the published document D24).

1.1.1 Claim 10 as originally filed, however, defined "that the susceptor (7,7') is adapted to be positioned with the circumferential walls (8) extending substantially vertically **in the direction of the gas feed into the susceptor**" (emphasis added by the Board). The bold typed feature of claim 10 as originally filed, however, has **not** been incorporated into claim 1 as granted.

This feature of claim 10 as originally filed as well as the feature "**said susceptor having a lower inlet (15) for said gas mixture and an upper gas outlet (14) for a**

gas flow in the susceptor from the lower inlet to the substrate (13) and then out through the upper outlet (14)" are derived from the specific embodiment of Figures 1 to 2 which are stated to show a device "according to a first preferred embodiment adapted for growing **layers**" (see D24, page 7, lines 10 to 16; page 8, lines 23 to 28; and page 9, lines 9 to 11).

By omitting said features concerning the direction of the gas feed into the susceptor the subject-matter of claim 1 as granted extends beyond the content of the application as originally filed. This is due to the fact that according to claim 1 as granted the gas feed could be introduced e.g. from the circumferential side of the susceptor. Such an embodiment, however, was never disclosed in D24.

1.1.2 Furthermore, since claim 1 as granted defines that the device is "for epitaxially growing objects of SiC …" while the features incorporated by said amendment into the subject-matter of claim 1 were taken from the specific embodiment adapted for growing **layers** it is likewise evident that - taking account of the statement at page 11, lines 11 to 13 of D24 that "the definition "object" in the claims is made for including the epitaxial growth of all types of crystals such as layers of different thicknesses as well as thick boules" (emphasis added by the Board) - claim 1 as granted also for this reason extends beyond the content of the application as originally filed.

The respondent's arguments concerning the scope of protection of claim 1 and any restriction by the intended use of the device of claim 1 are not

considered to be relevant with respect to the question whether or not there exists a basis for this amendment in the application as originally filed.

It is not apparent from D24 that both specific embodiments are **generally** to be seen apt for growing "objects", even though the embodiment of Figure 2 would be preferred for growing layers while that according to Figure 3 would be preferred for growing boules, because the description of D24 is simply silent with respect to such a "generalised" intended use.

1.1.3 Consequently, claim 1 as granted contravenes Article 123(2) EPC.

1.1.4 Furthermore, D24 discloses two distinct embodiments of susceptors, the first one according to Figures 1 and 2 having its gas outlet holes 14 at the top, the second one according to Figure 3 having its gas outlet holes 14' at the bottom.

D24 states at page 7 that (emphasis added by the Board) "**Fig 2** is a perspective view **of the susceptor used in the device of Fig 1** according to a first preferred embodiment adapted for epitaxially growing **layers**, parts of the susceptor wall being broken away so as to illustrate the interior of the susceptor, and **Fig 3** is a view similar to Fig 2 of a susceptor according to a second embodiment adapted for growing **boules** by Chemical Vapour Deposition" (see page 7, lines 10 to 20; page 9, lines 6 to 19 and line 31 to page 10, line 9; and page 10, lines 12 to 22). Taking account that in the paragraph on page 10 following the description of Figure 3 it is stated that "SiC **boules** ... may in this

way be epitaxially grown by CVD at a sufficiently high grow rate thanks to the high temperature used" and that "the control of etching is carried out in the way described above for the growth of **layers**" (see page 10, lines 24 to 36) it is evident that for growing boules a different susceptor is needed, i.e. the one being adapted according to the second embodiment of Figure 3.

Furthermore, the description of the first embodiment of a susceptor being adapted for growing **layers** in D24 does not contain any hint that it could be used for growing **boules**, let alone that it can be adapted for this purpose. Consequently, the respondent's arguments to the contrary, particularly that it would be obvious to the person skilled in the art that the first embodiment could also be used for growing boules, cannot be accepted since it is directly and unambiguously derivable from the specification of D24 that the susceptor has to be specifically adapted for each of the two alternatives.

Consequently, claim 4 as granted - which is based on claim 5 as originally filed which referred to a broader claim 1 defining "a device for epitaxially growing objects of SiC …" **not** specifying the position of the outlet and inlet holes 14 and 15 at all - when referring to claim 1 as granted extends beyond the content of the application as originally filed, contrary to Article 123(2) EPC, as it allows for boules to be grown in a device not identical with the device of the second embodiment of Figure 3.

1.2 Therefore the main request is not allowable.

Auxiliary request I

1.3 The subject-matter of claim 1 of auxiliary request I differs from that of claim 1 of the main request in that only the feature concerning the direction of the gas feed has been incorporated, so that it still defines "a device for epitaxially growing objects of SiC …" (see point X above).

Consequently, the conclusion of point 1.1.2 above applies *mutatis mutandis* to claim 1 of auxiliary request I which thus also contravenes Article 123(2) EPC. Therefore auxiliary request I is not allowable.

Auxiliary request II

1.4 The subject-matter of claim 1 of auxiliary request II differs from that of claim 1 of auxiliary request I in that the remaining objection of points 1.1.2 and 1.3 above has been overcome by specifying "a device for epitaxially growing **layers** of SiC …" (see point XI above).

1.4.1 Claim 1 of auxiliary request II is thus based on claim 1 as granted with claims 2 and 10 in combination with page 8, line 33 to page 9, line 29; and page 8, lines 20 to 28, all of the application as originally filed. Since claim 1 has also been restricted by these amendments it meets the requirements of Articles 123(2) and (3) EPC.

1.4.2 The Board notes that dependent claim 4 as granted - which had been objected to under Article 123(2) EPC (see point VI above) - has been deleted from auxiliary

request II and that the subject-matter of its independent method claim 8 - being identical with independent method claim 9 as granted (see points X and XI above) - does not contravene Article 123(2) EPC.

1.4.3 Auxiliary request II is thus admissible in this respect.

2. *Sufficiency of disclosure (Articles 100(b) and 83 EPC)*

2.1 The patent in suit discloses in general preferred temperature ranges of "above 1900°C" or "between 2000 and 2500°C" for the epitaxial CVD deposition of **SiC** (see patent, claims 15 and 16). It further discloses that silane with propane or methane represent the preferred precursor gases to be reacted at e.g. about 2200°C and that the etching gas is preferably hydrogen which may preferably be diluted with a non-etching gas such as argon (see patent, paragraph [0020]; claims 13 and 14).

Furthermore, the arguments of the respondent concerning the determination of the sublimation rate of **SiC** as well as a determination of the etching rate thereof by the skilled person employing its common general knowledge are convincing to the Board: accordingly, the sublimation rate can be determined by heating a SiC film having a known thickness to a desired temperature without flow of etching gas and then measuring the thickness change due to the sublimation, while the etching rate determination can be made at the desired temperature with etching gas but without flow of precursors by etching a SiC film having a known thickness and measuring the thickness change and considering the loss through sublimation.

At the oral proceedings the appellant agreed that the disclosure of the patent in suit with respect to the growth of **SiC** was sufficient for the person skilled in the art.

2.2 With respect to a "**Group III- nitride or alloys thereof**" the patent, however, only discloses that "as already mentioned the invention is also applicable to the growth of a group III-nitride, an alloy of group III-nitrides or an alloy of SiC and one or more group III-nitrides, for which the corresponding positive results **may be expected**" (emphasis added by the Board; see patent, paragraph [0025]).

2.2.1 However, the group III-nitrides being either Group IIIa: BN, AlN, GaN, InN and Tl_3N (TlN does not exist according to Wikipedia) or Group IIIb: ScN, YN, LaN, AcN, have physical properties which differ considerably from each other and it is not established that all of them undergo a sublimation at certain pressure/temperature conditions. InN for example decomposes into In and nitrogen. But even if one were to assume that the skilled person would consider any gas phase transport of a solid compound to fall under the definition "sublimation" of claim 8 the Board considers that it is still confronted with an undue burden occasioned by the high number of experiments necessary for:

a) selecting suitable precursors for synthesizing each of the Group III-nitrides via a CVD process,
b) determining the appropriate high temperature in the CVD process for each of them where "sublimation of the

material grown starts to increase considerably" (this temperature is also pressure dependent),
c) selecting an etchant for each of the Group III-nitrides which not necessarily may be the same for all of them, particularly when considering that also alloys of these Group III-nitrides and/or with SiC should be produced, and finally
d) determining the ratio between these components and how to regulate the supply rates of the etchant and the precursors so that a positive growth takes place.

2.2.2 The respondent's arguments in this context are not convincing, particularly as the cited documents D4, D20, D28 and D29 only show that compounds such as e.g. TMG (trimethylgallium), TMA (trimethylaluminium), trimethylindium, triethylgallium or trimethylamine alane are used for Metal organic CVD (MOCVD) Growth of GaN and AlN or InN (see D4, page 18, first paragraph; D20, page 39; D29, page 310, left-hand column, first paragraph) and/or disclose a temperature range of 1200-1250°C for the sublimation of GaN (see D20, page 42) or a temperature of about 2250°C for AlN (see D28, page 560, abstract). An MOCVD process, however, is normally carried out at relatively low temperatures, according to D29 the nitride layers were deposited at about 500°C, particularly since such an MOCVD process is commonly plasma-assisted (e.g. by an ECR-plasma; see D29, page 310, left-hand column, second paragraph) so that the parameters disclosed by such a process cannot be simply transferred by the person skilled in the art to a high temperature CVD process.

2.3 Therefore the Board considers that the subject-matter of method claim 8 of auxiliary request II insofar as

relating to the Group III-nitrides and alloys thereof does not fulfil the requirements of Article 83 EPC (compare Case Law of the Boards of Appeal of the EPO, 5th edition, 2006, II.A.3 and II.A.4).

Consequently, auxiliary request II is not allowable.

Auxiliary request III

3. *Admissibility of amendments (Articles 123(2) and (3) EPC)*

3.1 The subject-matter of claims 1 and 8 of auxiliary request III differs from claims 1 and 8 of auxiliary request II in that they have been restricted to SiC (see point XII above).

3.2 The Board considers that deletion of the alternative "**a Group III-nitride or alloys thereof**" from claims 1 and 8 of auxiliary request III is neither objectionable under Article 123(2) EPC nor under Article 123(3) EPC.

Claims 1 and 8 of auxiliary request III are therefore admissible.

4. *Novelty (Article 54 EPC) - method claim 8*

4.1 Of the method of claim 8, D34 discloses a CVD method using a cold-wall reactor for epitaxially growing SiC crystals of high quality for the microelectronic industry. The CVD process uses a gas mixture comprising silane (SiH_4) and methane (CH_4) which is pyrolytically decomposed into 4 H_2 and SiC, the latter being precipitated on a monocrystalline SiC seed at a

temperature of 1400°C to 2000°C (see column 1, lines 61 to 70; claims 1 and 4 to 6). The reaction chamber 10 comprises a graphite or tantalum support block 12, which is mounted on a stem 13, supports a SiC seed 14 upon which the layer of SiC is to be epitaxially grown and the seed is heated by heating the block 12 by means of induction coils 15 wound on reaction container 11 (e.g. made from quartz) which are energized by a power source connected to terminals 16. An input gas mixture is directed into tube 17 and therefrom via a tube 18 into chamber 10. The input gas mixture is heated in the vicinity of the SiC seed so that it decomposes into SiC and output gases including hydrogen, causing epitaxial growth of SiC on the seed 14. The output gas exits from chamber 11 via a tube 20 as a result of the pressure differential in chamber 11 between tube 18 and tube 20 (see column 2, lines 4 to 22; Figure 1). If desired the SiC can be doped by introducing a doping gas via tube 19 into tube 18 (see column 2, lines 23 to 28). D34 states, however, that an inert carrier gas such as argon is added only if required (see column 1, lines 66 to 70).

4.1.1 Silane and methane as disclosed in D34 are amongst the preferred precursor gases according to the patent in suit (see column 5, line 58 to column 6, line 3) while the generated hydrogen represents an etching gas according to the patent in suit (see also claim 13 of this request). The maximum temperature of 2000°C according to D34 overlaps with the preferred temperature range of "above 1900°C" of the patent in suit (see claim 14 of this request) which thus represents a temperature level as required by claim 8

of auxiliary request III "from which sublimation of the material grown starts to increase considerably".

4.1.2 Furthermore, taking account of paragraph [0028] of the patent in suit, where it is stated that the feature "varying the content" is intended to include a constant supply of the etching gas in question with a variation of other components of the gas mixture indirectly leading to a variation of the proportion of said gas in the gas mixture, D34 has to be considered novelty destroying for the subject-matter of claim 8 of this request since the process of D34 uses a gas mixture which forms in the vicinity of the susceptor hydrogen which represents an etchant. By introducing a dopant into this gas mixture as suggested the content of hydrogen in the gas mixture is varied whereby also the etching action onto the grown SiC is varied. At the temperature of 2000°C the sublimation of the material grown on the SiC seed has started to increase considerably and since an epitaxial layer grows under these conditions, a positive growth must have taken place so that the deposition rate of the material grown is higher than the rate of material leaving the layer on the substrate due to sublimation and etching.

4.1.3 The respondent's arguments cannot be accepted for the following reasons.

The Board considers that due to the disclosed precursors of D34 no hydrogen chloride can be generated at all and the statement "neither the apparatus nor the grown SiC layer is attacked" since "no HCl and **only small quantities of hydrogen** are produced" will be true only in the case that argon is used as a carrier gas in

large amounts as is suggested according to the preferred embodiments of D34 (see claims 4 to 6). In this context it needs also to be considered that D34 utilizes a cold-wall reactor, preferably having a quartz reaction chamber which will not be attacked by hydrogen at all. Furthermore, D34 is not restricted to the use of argon since the broadest disclosure according to D34 is the simple use of an input gas stream comprising silanes and hydrocarbons (methane) which are pyrolytically decomposed to epitaxially grow the SiC layer (see column 1, lines 58 to 60; claim 1) since the argon is added only if required. Furthermore, since the hydrogen is generated upstream of the susceptor any reaction products formed by a possible reaction between said hydrogen and the susceptor material will be transported downstream to the gas exit tube 20 so that the grown SiC is expected not to contain a large amount of impurities therefrom (see Figure).

4.1.4 The Board therefore concludes that the subject-matter of claim 8 of this request lacks novelty over the process of D34 (Article 54 EPC).

5. *Admissibility of amendments (Articles 84 and 123(2) and (3) EPC)*

Auxiliary requests IV to VI

5.1 Claims 8 of auxiliary requests IV to VI contain the feature "**wherein comparatively extensive etching and sublimation is provided during growth, such that formation of crystal defects and incorporation of unwanted impurities into the object grown are**

counteracted" (see point XIII above) which has a basis at page 6, lines 30 to 33 of the application as originally filed. The temperature ranges incorporated into claims 8 of auxiliary requests V and VI (see point XIII above) have a basis in claims 20 and 21 as originally filed, respectively.

Therefore claim 8 of auxiliary requests IV to VI complies with Article 123(2) and (3) EPC.

5.2 However, said added feature "**wherein** comparatively extensive etching and sublimation **is provided during growth, such that** formation of crystal defects and incorporation of **unwanted impurities** into the object grown **are counteracted**" is considered to define the method by a result to be achieved, where positive method features are feasible. Furthermore, the definition "**unwanted impurities**" renders claim 8 unclear since it is not known which elements and amounts are falling under this definition and which not, particularly as some elements may be added as dopants during the growth of SiC (see patent, paragraph [0027]). The type and amount of the impurities which may be incorporated into the grown SiC object particularly depend on the temperature and also on the materials of the device used, i.e. specifically the susceptor material such as graphite.

The Board therefore considers that claim 8 of each of the auxiliary requests IV to VI contravenes Article 84 EPC.

The auxiliary requests IV to VI are therefore not allowable.

Auxiliary request VII

5.3 The features added to claim 7 of auxiliary request VII to further define the susceptor as "**having circumferential walls with a substantially uniform thickness surrounding a room**" and that the substrate and gas mixture are heated through the susceptor "**walls**" (see point XIV above) have a basis at page 8, lines 5 to 17 and can be derived from Figures 1 to 3 of the application as originally filed.

Claim 7 with this amendment therefore complies with Articles 123(2) and (3) EPC.

5.3.1 Claim 1 of auxiliary request VII is identical with claim 1 of auxiliary request II so that the conclusion of point 1.4.1 above with respect to Article 123(2) and (3) EPC applies *mutatis mutandis* to claim 1 of auxiliary request VII.

5.3.2 Dependent claim 4 of auxiliary request VII has been restricted to "layers of SiC" which is derivable from a combination of claims 5 and 6 as granted. The other maintained dependent claims were only renumbered (see point XIV above) and are thus also not objectionable under Articles 123(2) and (3) EPC.

5.3.3 The Board also considers that the amendments made to the claims of auxiliary request VII do not render them unclear, which thus meet the requirements of Article 84 EPC.

Consequently, auxiliary request VII is considered to be formally admissible.

6. *Novelty (Article 54 EPC)*

6.1 Document D23 had not been mentioned by the appellant in its grounds of appeal. It was only in the letter dated 21 December 2008 that the appellant mentioned D23 for the first time in the appeal proceedings (see point VII above). In this letter D23 was cited as another piece of evidence as to what the person skilled in the art would understand by the term "mount base" disclosed in D1. Therefore it was not apparent from said letter that the appellant intended to consider D23 to be novelty-destroying for the method claim as granted.

The Board further notes that during the entire opposition proceedings the appellant had never argued that the disclosure of D23 would be novelty destroying for the subject-matter of any claim as granted.

6.2 Therefore the Board, likewise the respondent, were surprised when the appellant during the oral proceedings wished to discuss novelty of the subject-matter of method claim 7 of auxiliary request VII in the light of D23 and particularly with respect to the process described in the context of its Figure 5.

The respondent requested that D23 should not be considered for formal reasons and because it is irrelevant, as it concerns the sublimation of solid material.

6.3 According to the embodiment of Figure 5 of D23 silane and ethylene are used as precursor gases to form SiC at approximately 2400°C in the lower part of a graphite susceptor which comprises walls 36, a lid 34 and a porous graphite barrier 37 which separates the upper part of the susceptor wherein the SiC which has passed through said barrier 37 sublimates and condenses on the face of the growing crystal 33 (see column 11, lines 1 to 19 and line 59 to column 12, line 30; Figure 5). D23 is silent with respect to any carrier gas. The specified reaction of SiH_4 and C_2H_4 generates hydrogen. The sublimation reaction, however, is carried out in vacuum (see column 10, lines 40 to 50 and lines 58 to 64; examples 1 and 2). Thus it has to be concluded that said hydrogen will be removed from the system by the vacuum pumps so that it will be prevented from entering the separate chamber containing the growing SiC crystal and consequently, no etching of the SiC crystal can take place. Hence D23 is *prima facie* not novelty destroying.

6.4 Taking account of the considerations above and of the provisions of Articles 12(2) and 13(1) of the Rules of Procedure of the Boards of Appeal with respect to an amendment of the appellant's case, the Board decided not to allow the appellant to present arguments for lack of novelty of the subject-matter of claim 7 of auxiliary request VII on the basis of D23 but only to present arguments for lack of inventive step on D23.

6.5 The appellant did not present any further arguments concerning lack of novelty of the subject-matter of method claim 7. The appellant did also not object to the patentability of claim 1 as granted (see letter

dated 15 February 2007, page 1, seventh paragraph). The Board is thus satisfied that none of the submitted documents, particularly D34 which does not disclose a CVD process for epitaxially growing objects of SiC using a susceptor having circumferential walls with a substantially uniform thickness surrounding a room containing the substrate, discloses the subject-matter of device claim 1 or of method claim 7 of auxiliary request VII.

Therefore the subject-matter of the independent claims 1 and 7 of auxiliary request VII is novel (Article 54 EPC). The same conclusion applies to the dependent claims 2 to 6 and 8 to 17 of auxiliary request VII, which define preferred embodiments of the device of claim 1 or the method according to claim 7, respectively.

7. *Inventive step (Article 56 EPC)*

7.1 The appellant's arguments that a combination of either D1 and D23 or D34 and D23 would render the subject-matter of claim 7 of auxiliary request VII obvious cannot be accepted for the following reasons.

7.2 D1 discloses a process for single crystal growth of SiC using an arrangement comprising a chamber divided into a reaction zone 20 and a sublimation zone 30 (see Figure 1, and page 2, lines 44 to 58). The flow of the process gases silane, hydrocarbon gas, doping gas and carrier gas to provide a gaseous mixture into the reactor is controlled by a plurality of valves 22a-22f and pressure regulating valve 23 (see page 3, lines 13 to 18). Said reaction zone 20 comprises a reaction tube

24 which is heated by heater 27 from the outside and has a projecting part 24a inserted into the sublimation zone 30. An exhaust pipe 31a is opened to the interior of said projecting part 24a, while another exhaust pipe 31b is opened to the lower part of the sublimation zone 30. A supply conduit 34 equipped with a flow regulating valve 33 is opened to the interior of the sublimation zone 30, to introduce an inert gas such as Ar into the sublimation zone (see page 3, lines 19 to 30). After said chamber is evacuated the gaseous mixture having a predetermined composition is supplied into the chamber while controlling the valves 32a and 32b, and 33, etc. unreacted gaseous components, e.g. hydrogen and hydrocarbon among the gaseous mixture supplied to chamber 10 are discharged through the exhaust pipes 31a and 31b to the outside.

The sublimation chamber has a heater 35 for heating the interior with a predetermined temperature gradient. The formed solid-phase SiC flows from the reactor tube 24 into the sublimation zone and is therein evaporated due to being heated by said heater 35; this part of zone 30 serves as sublimator part 36. The lower part of zone 30 comprises the crystal growth zone 40 comprising a mount base 37 for mounting a single crystal thereon. Said mount base 37 is supported with a rotary shaft 38 coupled with an elevator rod 39 so that it can be rotated in said zone 40 and withdrawn from the chamber 10.

The evaporated SiC gas is condensed on the seed crystal attached to said mount base 37 under the condition that the environmental temperature is maintained with a predetermined temperature gradient at a constant

pressure whereby the SiC single crystal grows (see page 3, line 31 to page 4, line 6).

According to an example the gaseous mixture comprised silane, propane, hydrogen and nitrogen while Ar gas was supplied via conduit 34 into the sublimation zone, which was maintained at a lower pressure than the reaction zone (see page 4, lines 10 to 22). The reaction zone was heated to 1200-1400°C while the sublimation zone was heated to a temperature in the range of 2000-2400°C and the temperature gradient was 15°C/**cm** (see Table 1; gradient unit in bold corrected by the Board).

Taking account of said separation of the reaction and sublimation chamber D1 is not considered to represent the closest prior art for a CVD process wherein a susceptor is used which combines both functions in one chamber as required by claim 7 of auxiliary request VII. There is no suggestion in D1 to combine these two functions in one chamber. Furthermore, it belongs to the teaching of D1 to prevent the use of graphite crucibles in order to avoid the migration of impurities from said crucible to the single crystal (see page 3, lines 1 to 5; and page 4, lines 46 to 51).

As a consequence of this teaching of D1 the person skilled in the art would refrain from applying the teaching of D23, i.e. using the graphite susceptor according to Figure 5 of D23. Thus the appellant's argument to the contrary, i.e. that this teaching cannot be considered since claim 7 does not exclude the use of graphite, cannot hold.

In any case, such an incorporation of the susceptor according to D23 would require a complete redesign of the apparatus of D1 requiring inventive skills. If the heater 35 and the mount base 37 - the latter can also be considered to form a susceptor - of D1 would be replaced by the graphite susceptor of D23 then another heater for heating said susceptor would be necessary. Furthermore, in a modified apparatus according to such a combination there would still be two separate chambers for the decomposition reaction and the sublimation of the SiC. Additionally the impurity problems caused by the graphite would emerge again. There is also no suggestion in D23, let alone according to the disclosure according to Figure 5, to combine the CVD reaction chamber with the sublimation chamber since these two functions are separated by the barrier element 37. Thus from the Board's point of view the person skilled in the art has no reason at all to consider the susceptor of D23 and even if he were to do so he would not arrive at the subject-matter of claim 7 of auxiliary request VII.

7.3 The same conclusion as concerns the combination of the teachings of D1 and D23 is valid with respect to the appellant's argument that the shape of the susceptor walls having substantially uniform thickness is also obvious to the person skilled in the art when applying common general knowledge. In this case the apparatus of D1 would be modified by replacing the mount base 37 and heater 35 by such a susceptor, however the resulting apparatus would still have the separate reaction chamber for forming the SiC particles and the susceptor chamber for the sublimation reaction.

7.4 Starting from D34 it is noted that it concerns high temperature cold-wall CVD growth of SiC on a support block made of graphite or tantalum in a quartz chamber at temperatures of 1400-2000°C using preferably a gas mixture consisting of silane and methane as precursor gases in combination with argon (see column 2, lines 5 to 22).

D34 - being published on 7 May 1968 - relates to a much older and different CVD technology than the - with respect to the patent in suit - more recent document D4 which was made available to the public on 1 December 1994. Therefore the person skilled in the art would not consider the teaching of D34 relating to a cold-wall CVD apparatus as a starting point for the **hot-wall** CVD growth of SiC, let alone for combining it with a susceptor having two separate chambers, one for the CVD reaction to form SiC and another one for the sublimation thereof. If he nevertheless were to do so he still would not arrive at the subject-matter claimed which requires one chamber for both functions.

7.5 D4 is considered to represent the closest state of the art for the claimed high temperature **hot-wall** CVD growth of SiC. The CVD process according to D4 uses an RF heated SiC coated graphite susceptor having an elliptical shape with a rectangular shaped reaction chamber wherein the substrates are placed and through which the reaction gases pass (see page 56, Figure 1). The high purity SiC coating on said susceptor is foreseen to prevent etching and sublimation of the graphite which, at high temperatures will add to the C/Si ratio of the gas stream; it also prevents outdiffusion of mainly aluminium and boron impurities

from the graphite which will produce unwanted acceptor levels in the grown layers (see page 48, last paragraph to page 49, first paragraph; page 69, third paragraph). D4 uses either silane and propane as precursors diluted in hydrogen or silane and methane diluted in hydrogen (see page 47, abstract; page 48, first paragraph to page 49, first paragraph). The SiC is grown on Si-substrates which are first etched with hydrogen at approximately 1100°C. Then propane is introduced at room temperature and then the temperature is increased to the growth temperature at which after typically 30-60 seconds silane is introduced and a SiC layer formed (see page 49, third paragraph to page 50, first paragraph). The growth on SiC substrates is described at temperatures in the range of **1200-1700°C** (see page 51, second and third paragraph; page 52, first and second paragraph).

7.6 The subject-matter of claim 7 of auxiliary request VII differs from the process according to D4 in that
i) the susceptor has circumferential walls with a substantially uniform thickness, and
ii) the substrate is heated above a temperature level from which sublimation of the material grown starts to increase considerably.
The latter feature is interpreted by the Board as implying a temperature above 1900°C (compare claim 13 of this request).

7.6.1 Feature i) provides a uniform temperature over the entire susceptor wall and avoids hot spots (see patent, paragraph [0012]).

7.6.2 Feature ii) is responsible that the growth rate increases considerably compared to conventional CVD while at the same time the crystalline quality of the SiC grown is improved due to the increased etching action of an etchant, e.g. hydrogen, at this temperature level (see patent, paragraphs [0008] and [0009]).

The objective problem is therefore the provision of a CVD method which allows to obtain higher growth rate and higher quality of the epitaxially grown SiC.

7.7 This problem is solved by the method as defined in claim 7 of auxiliary request VII. It is credible that the claimed measures provide an effective solution to said technical problem.

7.8 The Board considers that the subject-matter of claim 7 is not obvious for the person skilled in the art when starting from D4:

7.8.1 Although it may be admitted that the person skilled in the art, in order to provide a more even temperature distribution in the susceptor, might have foreseen substantially circumferential walls the Board considers that the disclosure of D4 would have prevented him from using temperatures above 1700°C.

7.8.2 This conclusion takes account of the fact that the impurities contained in high-purity graphite cause problems even at temperatures below 1700°C. This fact is described in D4 which, in order to better deal with these problems, discloses that the graphite susceptor is coated with a high-purity SiC coating (see pages 48

and 49, page bridging paragraph) but further describes that parts of this SiC coating of the susceptor are eventually etched away after several runs so that significant amounts of aluminium and boron contaminants can be introduced into the grown SiC layer (see page 68, third paragraph; and page 69, third paragraph). D4 further states in the context of a temperature raise from 1450°C to 1550°C that "higher temperatures provide even better morphology, however, at higher temperatures fast susceptor degradation followed by impurity leaching effects become problematic" (see page 69, fourth paragraph). The highest growth temperatures for SiC according to D4 were 1650°C and 1700°C (see page 66, second paragraph; page 51, third paragraph).

7.8.3 Consequently, the subject-matter of claim 7 of auxiliary request VII involves an inventive step.

The same conclusion applies to the dependent claims 8 to 17 which define preferred embodiments of the method of claim 7.

7.9 With respect to the device claim 1 and its dependent claims 2 to 6 the Board has no reason to deviate from the Opposition Division's conclusion concerning inventive step since the appellant did not bring forward any objection in that respect (see point 6.7 above).

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 first instance, with the order to maintain the patent on the basis of:

   - claims 1 to 17 filed as auxiliary request VII during the oral proceedings;
   - description pages 2 to 5 filed during the oral proceedings; and
   - Figures 1 to 3 of the patent as granted.

The Registrar: The Chairman:

G. Nachtigall H. Meinders