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**Datasheet for the decision
of 9 October 2019**

Case Number: T 1876/16 - 3.3.05

Application Number: 10154952.5

Publication Number: 2182100

IPC: C30B29/36, C30B23/00,
C30B33/00, H01L21/324

Language of the proceedings: EN

Title of invention:

High purity semi-insulating single crystal silicon carbide wafer

Applicant:

Cree, Inc.

Headword:

Silicon carbide wafer/Cree

Relevant legal provisions:

EPC Art. 83, 123(2)
EPC R. 103

Keyword:

Sufficiency of disclosure - (no) (main request, first group of auxiliary requests)

Amendments - allowable (no) (second group of auxiliary requests)

Reimbursement of appeal fee - (no)

Decisions cited:

Catchword:



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Case Number: T 1876/16 - 3.3.05

D E C I S I O N
of Technical Board of Appeal 3.3.05
of 9 October 2019

Appellant:
(Applicant)

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Representative:

Isarpatent
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Decision under appeal:

**Decision of the Examining Division of the
European Patent Office posted on 8 April 2016
refusing European patent application No.
10154952.5 pursuant to Article 97(2) EPC.**

Composition of the Board:

Chairman E. Bendl
Members: S. Besselmann
P. Guntz

Summary of Facts and Submissions

I. The present appeal lies from the decision of the examining division to refuse European patent application No. 10154952.5. The patent application concerns a "high purity semi-insulating single crystal silicon carbide wafer".

II. The examining division found that the present application did not enable the skilled person to produce a silicon carbide wafer having the claimed properties, expressed in terms of the parameter values of resistivity, micropipe density and the combined concentration of shallow level dopants.

The then pending main request, relating to a silicon carbide wafer, and the then pending three auxiliary requests, relating to production methods, were found to lack sufficient disclosure (Article 83 EPC). The examining division additionally found that essential features were missing from claim 1 of the then pending auxiliary requests (Article 84 EPC). It refused the application.

III. The patent applicant (now appellant) appealed this decision. In support of its arguments that the invention was sufficiently disclosed, the appellant filed supplementary evidence in the form of a declaration and copies of experimental results.

With its grounds of appeal, the appellant re-submitted the former three auxiliary requests as a main request and first and second auxiliary requests, and filed additional auxiliary requests 3 to 5.

In reply to the preliminary opinion of the board, the appellant filed additional auxiliary requests 1, 1-1, 1-2, to be discussed after the main request.

The appellant also made a request for the reimbursement of the appeal fee.

- IV. All requests relate to production methods. The main request and a first group of auxiliary requests (namely auxiliary request 1 of 7 October 2019 and the five auxiliary requests filed with the statement of grounds of appeal) retain the definition of the silicon carbide single crystal by referring to the parameters.

In a second group of auxiliary requests (auxiliary requests 1-1 and 1-2 of 7 October 2019), this definition has been omitted.

- V. The appellant's arguments regarding the main request and the first group of auxiliary requests (see point IV.), as far as relevant to the present decision, may be summarised as follows.

According to a first line of reasoning, the properties of the silicon carbide single crystal are not needed to further define the claimed method, but have only been retained in the claim for formal reasons, in order to preclude an objection on the basis of added matter.

The claimed method steps provide the advantageous single polytype silicon carbide single crystals by avoiding thermal stress on the seed crystal, and by rapidly cooling the heated bulk single crystal. Specifically, thermal stress is reduced by using a flat seed holder. The rapid cooling to room temperature in

less than 70 minutes prevents point defects disappearing or being re-annealed.

According to a second line of reasoning, the skilled person would have understood from the original application as a whole that at least the combination of all method steps disclosed therein would lead to the desired parameter values for resistivity, micropipe density and the combined concentration of shallow level dopants. Where this required a specific method step to be selected, it would have been easy to make a selection from several disclosed alternatives, based on common general knowledge alone and without undue burden.

The invention is therefore sufficiently disclosed.

- VI. The appellant's arguments regarding the second group of auxiliary requests (see point IV.), as far as relevant to the present decision, may be summarised as follows.

The properties of the silicon carbide single crystal are the inevitable result of the claimed process steps and therefore need not be cited in the claim.

Several parallel applications, derived from the same parent application, have been granted. This supports the conclusion that the claimed combinations of method steps, without mentioning the desired parameters, are directly and unambiguously derivable from the original application.

- VII. The appellant requests that the decision under appeal be set aside and a patent be granted on the basis of the main request as filed with the statement of grounds of appeal or, alternatively, based on one of auxiliary

requests 1, 1-1 or 1-2 as filed with the letter dated 7 October 2019 or former auxiliary request 1 or auxiliary requests 2 to 5, all as filed with the statement of grounds of appeal. The appellant further requested the reimbursement of the appeal fee.

Reasons for the Decision

Main request

1. Sufficiency of disclosure (Article 83 EPC)
 - 1.1 The board shares the examining division's view that the desired single polytype silicon carbide single crystal, characterised, *inter alia*, by the specific parameter values of resistivity, micropipe density and the combined concentration of shallow level dopants, represents the result to be achieved. Obtaining these desired properties of the silicon carbide single crystal is an integral feature of the method claim.
 - 1.2 There is no evidence that this result is inevitably obtained when carrying out the claimed method steps, involving a flat seed holder and heating followed by rapid cooling (see also points 1.7 and 3.4 below). The desired parameter values consequently need to be treated as an additional limiting feature of the claimed method.
 - 1.3 A silicon carbide single crystal exhibiting the claimed parameter values was initially presented as the invention (see original claim 1 and paragraph [0039] of the application). There is no evidence of common general knowledge on how to routinely control the synthesis of silicon carbide single crystals in order

to obtain the combination of properties defined in the claim.

1.4 In the absence of such common general knowledge, the invention may only be carried out if the application as filed provides the skilled person with the necessary instructions.

1.5 However, the original application provides neither a single example, nor a full description of a production method. The application merely describes numerous independent aspects and method steps, but does not teach how these are to be combined into an actual production method. It is only stated vaguely that "several of the disclosed method steps can be used concurrently or sequentially to achieve the desired result" (paragraph [0212]).

1.6 Even if the skilled person attempted to combine all method steps disclosed in the original application into a single method, the skilled person would need to select alternatives, and would have to choose the specific practical implementation of the generally mentioned method steps.

For instance, the claimed feature according to which the surface of the seed holder deviates from flat by no more than 10 μm has the purpose of fostering the macroscopic direct contact of the seed and the seed holder, see paragraphs [0155]-[0157], and thus represents a mutually exclusive alternative to the separation of the seed and seed holder, maintaining a sufficient gap, see paragraphs [0207]-[0208].

Choices would also have to be made when interpreting the vague instruction "to minimize a concentration of

dopants that contribute to conductive characteristics" (claim 1 and paragraph [0075]) into specific practical measures.

- 1.7 At the same time, there is no evidence that the method steps taught in the present application, or a specific combination thereof, actually result in silicon carbide single crystals with the claimed properties.

As indicated, the application does not contain any working examples.

The supplementary evidence provided with the grounds of appeal does not set out which method steps were performed, and not all of the required parameters (see point 1.1) have been measured.

This supplementary evidence merely contains the general indication that the first wafer "was produced without being heated to a temperature that thermodynamically increases the concentration of point defects", and the second wafer "was heated to a temperature that thermodynamically increases the concentration of point defects and then cooled at a sufficiently rapid rate to maintain the increased concentration of point defects" (point 3 of the grounds of appeal). These vague indications do not constitute a reproducible description of a method. It is not known which specific installation has been used, or which seed crystal (properties, origin), or which conditions have been applied (temperatures, gas atmosphere, cooling rate, etc.).

As regards the required parameters, the declaration indicates neither the resistivity nor the combined concentration of shallow level dopants.

- 1.8 For these reasons, the skilled person, wishing to carry out the claimed method such that the claimed properties of the silicon carbide single crystal result, would thus need to carry out a research programme in order to identify the necessary practical measures, while still being doubtful whether the desired properties of the silicon carbide single crystal can actually be obtained.
- 1.9 As correctly decided by the examining division, the invention has therefore not been sufficiently disclosed (Article 83 EPC).

First group of auxiliary requests (see point IV.)

2. Sufficiency of disclosure

- 2.1 The claimed method is defined with reference to the resulting single polytype silicon carbide single crystal. As indicated, the definition of this silicon carbide single crystal is the same as in the main request. Hence, the same considerations apply, and the disclosure is insufficient for the same reason (Article 83 EPC).

Second group of auxiliary requests (see point IV.)

3. Amendments

- 3.1 The original application relates to the silicon carbide single crystal as such, characterised by the indicated parameters as essential features (see original claim 1, paragraph [0039], and paragraph [0050]).

In this context, and in view of the indication that "[a] number of techniques enhance the production of wafers according to the present invention" (paragraph [0073]), the subsequent parts of the original application, describing method aspects, are understood to be linked to obtaining the indicated parameters.

- 3.2 A similar understanding is reflected in the appellant's own argument regarding sufficiency of disclosure. According to the appellant, the skilled person would derive from the original application that at least a combination of all of the disclosed method steps produces the desired parameters (see point V.).
- 3.3 However, in claim 1, the parameters relating to resistivity, micropipe density and shallow level dopants have been omitted.
- 3.4 There is no reason to conclude that these parameters would be the inherent result of the claimed method, so that it would be unnecessary to explicitly cite these parameters. On the contrary, the feature "while minimizing a concentration of dopants that contribute to conductive characteristics" is so vague that the claimed method cannot be associated with a specific resistivity or concentration of dopants in the resulting single carbide single crystal.
- 3.5 The appellant has not indicated the basis for omitting the parameters concerned, and has not established that the presently claimed method, possibly yielding other values of these parameters than originally claimed, is directly and unambiguously derivable from the application as filed.

Whether similar method claims were granted in parallel applications is irrelevant here.

3.6 Hence, the requirements of Article 123(2) EPC are not fulfilled.

4. Request for reimbursement of the appeal fee

4.1 This request was made in the notice of appeal, but has not been substantiated in the statement of grounds of appeal, and no circumstances are apparent from the file which would justify the requested reimbursement of the appeal fee pursuant to Rule 103 EPC.

4.2 The request for the reimbursement of the appeal fee is therefore refused.

Order

For these reasons it is decided that:

The appeal is dismissed.

The Registrar:

The Chairman:



C. Vodz

E. Bendl

Decision electronically authenticated