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D E C I S I O N
of 18 February 2003

Case Number: T 0231/00 - 3.2.2

Application Number: 97306517.0

Publication Number: 0826797

IPC: C30B 15/30

Language of the proceedings: EN

Title of invention:

Methods for holding and pulling single crystal

Applicant:

SHIN-ETSU HANDOTAI COMPANY LIMITED

Opponent:

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Headword:

-

Relevant legal provisions:

EPC Art. 52(1), 56

Keyword:

"Inventive step (yes, after amendment)"

Decisions cited:

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Catchword:

-



Case Number: T 0231/00 - 3.2.2.

D E C I S I O N
of the Technical Board of Appeal 3.2.2
of 18 February 2003

Appellant: SHIN-ETSU HANDOTAI COMPANY LIMITED
4-2, Marunouchi 1-Chome
Chiyoda-ku
Tokyo (JP)

Representative: Cooper, John
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Decision under appeal: Decision of the Examining Division of the
European Patent Office posted 6 September 1999
refusing European patent application
No. 97 306 517.0 pursuant to Article 97(1) EPC.

Composition of the Board:

Chairman: S. S. Chowdhury
Members: R. Ries
U. J. Tronser

Summary of Facts and Submissions

I. This appeal is against the decision of the examining division dated 6 September 1999 to refuse European patent application No. 97 306 517.0.

The ground of refusal was that the claims did not meet the inventive step requirement of Article 52(1) EPC, having regard to the following documents:

D1: EP-A-0 466 457

D2: EP-A-0 449 260

II. On 28 October 1999 the appellant (applicant) lodged an appeal against the decision and paid the prescribed fee on the same date. On 22 December 1999 a statement of grounds of appeal was filed.

III. The appellant requests that the decision under appeal be set aside and that a patent be granted on the basis of the following documents:

- Claim 1 filed at the oral proceedings on 18 February 2003
- Description pages 1 to 14 and insert page 5A filed at the oral proceedings on 18 February 2003
- Figures 1, 2(A) and 2(B) as originally filed.

IV. Independent claim 1 reads as follows:

"1. A method for pulling a single crystal in a Czochralski method, wherein a seed crystal (8, 52) is

pulled while rotating after the seed crystal (8, 52) is contacted with a raw material melt (2, 54), part of the growing single crystal is mechanically held during pulling and the single crystal of heavy weight can be pulled regardless of a mechanical strength of the seed crystal (8, 52) or a neck portion (9, 55) thereof; characterised in that: a magnetic field is applied to the raw material melt (2, 54) when the growing crystal is mechanically held, said magnetic field being applied temporarily (i) only during the time when an action is made to mechanically hold the growing crystal or (ii) just after oscillation of the crystal actually occurs during pulling of the growing crystal in order to suppress such oscillation; and in that: a strength of the magnetic field is 500 gauss or more in the vicinity of the crystal growing boundary."

V. The appellant presented the following arguments

The prior art was concerned exclusively with vibrations within the melt itself and with the application of continuous magnetic fields to the mass of the melt. In contrast the application was concerned with the behaviour of the crystal and with the selective application of a temporary magnetic field in the vicinity of the crystal growing boundary.

D1 referred to a magnetic field having an intensity in the range 2000 to 5000 gauss being applied to the melt as a whole. This would not necessarily result in a magnetic field strength of 500 gauss in the vicinity of the crystal growing boundary, particularly when cusp type magnetic fields were used, in which case the field in the vicinity of the crystal growing boundary would be zero.

Reasons for the Decision

1. The appeal is admissible.

2. *Amendments*

The solitary claim combines the subject-matter of original claims 3 to 6, and additionally stresses that the magnetic field is applied temporarily either at the time the crystal is mechanically held or when oscillation of the crystal occurs for some other reason.

This latter feature is supported by page 3, lines 46 to 48 and 52 to 54 of the A1 publication, so that the claim is satisfactory as regards Article 123(2) EPC.

3. *Novelty*

This was not questioned by the examining division and the Board is satisfied that the claimed subject-matter is novel, as will become apparent from the subsequent argument.

4. *Inventive step*

4.1 Closest prior art

The claim relates to a method for pulling a single crystal by a Czochralski method. Such a crystal may become heavy so that there is a danger that an initial necked portion of the crystal may break off and cause a serious accident. In order to prevent this a larger diameter portion is formed in the necked portion for

engagement by a lifting jig which supports the weight of the crystal during growth so that the necked portion does not support the entire weight of the crystal and therefore does not break off quite so easily.

The document D2 discloses such a method and apparatus for carrying out the method and discloses the features of the preamble of the claim, and is the closest prior art document, accordingly. This document is silent about oscillations of the crystal and it does not disclose applying a temporary magnetic field, or the application of a magnetic field having a strength of 500 gauss or more in the vicinity of the crystal growing boundary.

4.2 Technical problem

The lifting jig of the prior art apparatus may not be perfectly aligned with the axis of rotation of the crucible, so engagement of the crystal is not perfectly symmetrical and lateral forces are applied to the crystal which induce oscillations thereof, leading to crystal defects. It is therefore necessary to suppress oscillations of the crystal occurring during engagement of the jig with the crystal, or oscillations of the crystal occurring during pulling of the growing crystal for any other reason.

4.3 Solution

A magnetic field is applied temporarily, either only during the time when an action is made to mechanically hold the growing crystal, or when oscillation occurs during pulling of the growing crystal, the strength of the magnetic field being 500 gauss or more in the

vicinity of a crystal growing boundary.

4.4 Document D1

The document D1 relates to a Czochralski method for pulling a single crystal, in which the rotation rate of the crucible and the intensity of the magnetic field are controlled during crystal pulling in order to obtain a crystal with perfectly circular cross-section and with a minimum occurrence of growth striations. The occurrence of forced flow and vibration of the molten mass is abated by applying a magnetic field of 2000 to 5000 gauss to increase the effective viscosity of the molten mass, as set out in column 3, lines 21 to 27 and column 4, line 56 to column 5, line 10.

In this document the crucible is rotated continuously and the crystal is pulled continuously, so that heat convection, forced flow generation, and vibrations will also occur continuously. Therefore, the magnetic field would also be applied continuously, and the application of a temporary magnetic field would not make technical sense in this context.

Moreover, since the heat convection, forced flow generation, and vibrations occur within the molten mass contained in the crucible, the magnetic field is applied within this mass so as to increase its effective viscosity. There is no suggestion of applying a magnetic field strength of 500 gauss or more in the vicinity of a crystal growing boundary.

4.5 Inventive step

Whereas document D1 aims at abating vibrations in the

mass of the melt, the application seeks to suppress oscillations of a growing crystal. These different aims also give rise to different solutions for the respective problems. In D1 the problem of vibrations is a continuous one and the magnetic field field is applied continuously, accordingly, and in the application the occurrence of oscillations is transient and temporary magnetic fields are applied. Again, in D1 the magnetic field is applied to the bulk of the melt to increase its viscosity, and in the application the magnetic field is applied in the vicinity of a crystal growing boundary.

In short, the present application seeks to suppress oscillations from a source external to the melt, and does so by the application of a magnetic field that is limited both temporally and spatially as compared with the prior art. This is a different teaching to that given in D1. Nor does any other prior art document give this teaching.

Nor would the application of a magnetic field having an intensity of 2000 to 5000 gauss to the molten mass necessary result in a magnetic field of 500 gauss in the vicinity of the crystal growing boundary, such that the method described in document D1 would incidently also solve the present problem.

4.6 For these reasons the method of claim 1 involves an inventive step.

Order

For these reasons it is decided that:

1. The decision under appeal is set aside.
2. The case is remitted to the first instance with the order to grant a patent on the basis of the following documents:

Claim: 1 filed at the oral proceedings on
18 February 2003

Description: pages 1 to 14 and insert page 5A filed
at the oral proceedings on 18 February
2003

Figures: 1, 2(A) and 2(B) as originally filed.

The Registrar:

The Chairman:

V. Commare

S. S. Chowdhury