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**Datasheet for the decision  
of 3 March 2011**

**Case Number:** T 2201/08 - 3.2.08

**Application Number:** 00970218.4

**Publication Number:** 1152074

**IPC:** C30B 15/04

**Language of the proceedings:** EN

**Title of invention:**

Silicon single crystal wafer and production method therefor

**Applicant:**

Shin-Etsu Handotai Co., Ltd.

**Headword:**

-

**Relevant legal provisions:**

EPC Art. 54, 56, 94(3), 111(1), 113(1), 123(1)

**Relevant legal provisions (EPC 1973):**

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**Keyword:**

"Inventive step - main request (no)"

"Novelty - auxiliary request (yes)"

"Substantial procedural violation (no)"

"Reimbursement of the appeal fee (no)"

"Remittal"

**Decisions cited:**

-

**Catchword:**

-



Case Number: T 2201/08 - 3.2.08

**D E C I S I O N**  
of the Technical Board of Appeal 3.2.08  
of 3 March 2011

**Appellant:** Shin-Etsu Handotai Co., Ltd.  
**Applicant:** 6-2, Ohtemachi 2-chome  
Chiyoda-ku  
Tokyo (JP)

**Representative:** Grünecker, Kinkeldey, Stockmair  
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**Decision under appeal:** Decision of the Examining Division of the  
European Patent Office posted 1 July 2008  
refusing European patent application  
No. 00970218.4 pursuant to Article 97(2) EPC.

**Composition of the Board:**

**Chairman:** T. Kriner  
**Members:** R. Ries  
E. Dufrasne

## Summary of Facts and Submissions

I. By its decision dated 1 July 2008, the examining division refused European patent application 00970218.4.

During substantive examination, the following documents had been considered:

D1: JP-A-11 157995 (abstract) and computer translation into English;

D1a: US-A-6 113 687 (published 5 September 2000; corresponding to document D1,);

D2: US-A-5 954 873;

D3: JP-A-11199385 and computer translation into English;

D4; JP-A-11195565 and computer translation into English;

D4a US-B1-6 468 881 (published 22 October 2002, corresponding to document D4);

D5: Abe, T., et al: "Dynamic behaviour of intrinsic point defects in FZ and CZ silicon crystals", Materials Research Soc. Symposium Proc., volume 262, 1992, pages 3 to 13 (XP002936340)

In a first official communication, the examining division raised objections under Article 54 EPC since the subject matter of independent claims 1 and 4 as originally filed was found to lack novelty over the

technical disclosure of documents D1 or D3, respectively.

In the revised set of claims enclosed with the appellant's response to the communication, claim 1 was amended whereas claims 2 to 6 were upheld unchanged. Given that no oral proceedings had been requested, the examining division refused the application without issuing a further communication.

- II. On 14 August 2008, the applicant lodged an appeal against the decision of the examining division and paid the appeal fee on the same date.

The statement setting out the grounds of appeal was received on 6 November 2008. Enclosed therewith, the appellant submitted revised set of claims 1 to 6 as a main request and a further set of claims 1 to 4 as an auxiliary request, thereby replacing the former request underlying the impugned decision. In the appellant's view, the refusal of the application after only one official communication represented a procedural violation which justified the reimbursement of the appeal fee.

- III. In a communication annexed to the summons for oral proceedings, the Board gave its provisional assessment of the case. In particular, the subject matter of independent claim 4 of the main request was found to lack novelty over the technical disclosure of any of documents D2, D4a or D5. The subject matter of independent claim 3 of the auxiliary request was found to lack inventive step having regard to the same prior art.

In addition to the cited prior art considered by the examining division, reference was made to document:

D6: F. Gonzales, R.P.S.Thakur, I. Bondarenko, Q. Zhong and G.A. Rozgonyi: "Effect of Oxidation Induced Stacking Fault (OSF) Ring on Generation and Motion of Slip Dislocation"; Electrochemical Society Proceedings, Volume 97-12; Symposium on Diagnostic Techniques for Semiconductor Materials and Devices; Montreal PQ, 6 to 8 May 1997, volume 3322, pages 223 to 234; Publisher: Society of Photo-Optical Instrumentation Engineers, Bellingham, WA, USA (XP009136890).

In the Board's provisional view, a procedural violation under Article 113(1) EPC as alleged by the appellant in its statement of the grounds of appeal could not be identified.

IV. Oral proceedings took place before the Board on 3 March 2011. The appellant requested that the decision under appeal be set aside and the patent be granted on the basis of claims 1 to 3 according to the main request filed with letter of 3 February 2011 or, in the alternative, on the basis of the single claim according to the auxiliary request submitted during the oral proceedings.

In addition, the appellant requested the reimbursement of the appeal fee.

Claim 1 of the main request reads as follows:

"A manufacturing process for a silicon single crystal wafer comprising steps of growing a silicon single crystal rod by means of a Czochralski method, wherein an OSF ring region is formed in an annular region with a width of 10 mm or less from a periphery of the silicon single crystal rod by adjusting the pulling conditions, respectively, and wherein the silicon single crystal rod is pulled while doping the silicon single crystal rod with nitrogen at a concentration in the range of  $1 \times 10^{10}$  to  $5 \times 10^{15} / \text{cm}^3$ , and slicing the grown silicon crystal rod into silicon single crystal wafers each having the OSF ring region in a peripheral region with a width of 10 mm or less from the periphery of the silicon single crystal wafer."

The dependent claims 2 and 3 relate to preferred embodiments of the method set out in claim 1.

The single claim according to the auxiliary request reads as follows:

"1. "A manufacturing process for a silicon single crystal wafer comprising steps of growing a silicon single crystal rod by means of a Czochralski method, wherein a polycrystalline silicon as a starting material is used to pull a p-type silicon single crystal rod with a <100> orientation and a diameter of 6 inches, pulling the crystal rod by controlling an F/G value in the central portion of the crystal in the range of 0.25 and 0.33  $\text{mm}^2 / ^\circ\text{C} \cdot \text{min}$  to form an annular OSF ring region with a width of about 10 mm from a periphery of the silicon single crystal rod, and doping

the single crystal rod with nitrogen at a concentration in the range of  $5 \times 10^{13}$  to  $1 \times 10^{14}$  atoms/cm<sup>3</sup>, wherein F denotes the pulling rate and G denotes the average temperature gradient of the crystal rod in the pulling direction in a length between points corresponding to a silicon melting point and 1400°C, slicing the grown silicon single crystal rod into silicon single crystal wafers each having the annular OSF ring region with a width of about 10 mm from the periphery of the silicon single crystal wafer, preparing mirror polished wafers by applying an ordinary wafer process, inserting the mirror polished wafers into a vertical furnace or a horizontal furnace, placing the wafer on a transportation quartz boat for heat treatment, wherein at least a portion of the wafer in contact with the quartz boat is formed of said OSF ring region, performing a heat treatment on the wafers in an argon atmosphere at 1150°C for one hour in conditions of a load/unload temperature of 850°C for the vertical furnace or 950°C for the horizontal furnace, a quartz boat speed of 15cm/min, a temperature rise rate of 10°C/min for the vertical furnace and 6°C/min for the horizontal furnace and a temperature fall rate of 5°C/min for the vertical furnace and 3°C/min for the horizontal furnace, conducting a further heat treatment at 800°C for 4 hours in a nitrogen atmosphere and at 1000°C for 16 hours in a dry oxygen atmosphere, and taking out the wafers from the furnace."

V. The appellant's arguments can be summarized as follows:

Novelty and inventive step:

Document 4a, representing the most relevant state of the art, disclosed a method of producing silicon wafers comprising the steps of pulling a silicon rod with a pulling rate not higher than 0.7 times the maximum pulling rate (see D4a, column 3, line 62 to column 4, line 56). This rather low pulling rate resulted in a OSF ring located at about the half region in the direction of the crystal radius. At 0.6 times the maximum pulling rate, the OSF ring region disappeared even at the centre of the silicon rod (see D4a, column 4, lines 7 to 10) rather than that it was generated at the outermost periphery as required in claim 1 of the present application.

Hence, document D4a did not disclose a process comprising the steps of forming an OSF ring in an annular region with a width of 10 mm or less from the periphery of the silicon single crystal rod in combination with nitrogen doping the crystal in the specific concentration during pulling, and neither did any of the other prior art documents. The subject matter of claim 1 of the main request was therefore novel.

Having regard to the low pulling rates in combination with doping the crystal during pulling used in the process of D4a, the skilled person was not prompted to provide a method using a high pulling rate in order to form the OSF ring in a region within a width of 10 mm or less from the periphery of the rod while doping the



crystal with nitrogen. The subject matter of claim 1 of the main request therefore involved an inventive step.

The same statement was true for the method set out in claim 1 of the auxiliary request. None of the cited prior art documents taken individually or in combination disclosed the claimed method or made it obvious to select the technical features and parameters defining the claimed process.

Reimbursement of the appeal fee:

The applicant's view, put forward in its response to the first communication of the examining division, was submitted in good faith. The applicant expected that it should be given a further chance to overcome the objections raised by the examining division, should its arguments not be convincing. For the sake of fairness, the examining division was obliged to issue a further communication in order to caution the applicant about the refusal of the application if the maintained objections were not overcome by amendment. However, the applicant was not given the chance to submit amended claims or to request oral proceedings in order to avoid the refusal.

Hence, the decision of the examining division to refuse the application immediately after the first communication represented a violation of the applicant's right to be heard pursuant to Article 113(1) EPC, which justified the reimbursement of the appeal fee.

## Reasons for the Decision

1. The appeal is admissible.
  
2. Substantial procedural violation; reimbursement of the appeal fee:
  - 2.1 In the first and only communication, the examination division informed the applicant that the subject matter of product claim 1 and method claim 4 then on file lacked novelty over the technical disclosure of document D1 or document D3, respectively (point 2 of the official communication of 2 August 2007). Enclosed with its response, the applicant submitted a revised set of claims wherein product claim 1 was amended. However, method claim 4 was upheld unchanged. Given this situation, the examining division decided to refuse the application since claim 4 still lacked novelty over document D3 for the reasons already referred to in the first communication.

The reasons for refusing the application on the ground that independent claim 4 lacked novelty in view of the contents of document D3 had been duly communicated by the examining division to the applicant. Since the applicant did not in substance modify the scope of independent claim 4 in its reply and no oral proceedings had been requested, the refusal in respect of these reasons fulfils the requirement of Article 113(1) EPC that decisions may only be based on grounds or evidence on which the parties concerned have had the opportunity to present their comments.

2.2 The appellant argued that it was not given a warning that the refusal of the application must be expected if the maintained objections were not overcome by amendment. It further argued that it was not provided with a chance to request at least oral proceedings.

2.3 According to Article 94(3) EPC, if the examination reveals that the application does not meet the requirements of the EPC, the examining division shall invite the applicant, as often as necessary, to file his observations and, subject to Article 123(1) EPC, to amend the application. According to the established case law of the Boards of Appeal, it is left to the examining division's discretion to decide whether to issue a further invitation. The words "*as often as necessary*" indicate that the examining division may use its discretion to act according to the circumstances. Under Article 113(1) EPC it is not necessary to give the applicant repeated opportunities to comment on the examining division's submission if the main objections to the grant of the European patent remain the same (Case Law of the Boards of Appeal, Sixth Edition 2010, chapter VII.B.2.1).

Having regard to the transitional provisions on the applicability of the EPC 2000, Articles 94 and 123 EPC shall apply to European patent applications pending at the date of entry into force of the EPC 2000 (Article 1, No. 1 of the Decision of the Administrative Council of 28 June 2001 on the transitional provisions, in conjunction with Article 7(1), second sentence, of the Act revising the EPC of 29 November 2000). Since the filing date of the present application is the

31 October 2000, Articles 94 and 123 EPC are to be applied.

The Board also notes that the right of a party to have oral proceedings is dependent on a request for such proceedings. In the absence of such a request, a party has no right to oral proceedings, and the EPO can issue a decision, whether adverse or not, without appointing oral proceedings. Thus, if the appellant had in mind to request oral proceedings before the examining division, it should have filed such a request at the latest with its observations in reply to the first communication of the examining division in order to avoid the risk of an adverse decision being issued without the appointment of oral proceedings.

2.4 Given this situation, no substantial procedural violation with respect to Article 113(1) EPC is discernible. Consequently, the appellant's request for reimbursement of the appeal fee is dismissed.

3. Main request; claim 1:

3.1 Like the application, document D4a, which is not challenged by the appellant as being the counterpart of document D4, discloses a process of producing silicon wafers manufactured from a rod produced by the Czochralski (CZ) method. Due to thermal oxidation on the surface, the wafers exhibit oxidation induced stacking faults which are usually formed in a ring-shaped area generally referred to as an OSF ring (D4a, column 1, lines 20 to 26). In most cases, Si single crystals are produced at a high pulling rate, which results in an OSF ring located in the outermost

peripheral region of the crystal. However, in the process of D4a, the pulling rate is controlled so that the OSF ring is located between the outer peripheral region and the centre, or disappears at the centre (see D4a, column 4, lines 46 to 49).

Furthermore, nitrogen doping to the silicon melt is known to suppress the generation of the vacancy clusters and, in consequence thereof, the generation of dislocation clusters at the inner portion of the OSF ring (D4a, column 1, lines 38 to 45; column 2, lines 1 to 5 and lines 45 to 57). Reference is also made in this context to page 10, line 23 to page 11, line 4 of the translation of the international application, in the following called "the application as filed"). As disclosed in document D4a, column 2, lines 34 to 39, the nitrogen concentration in the crystal is not less than  $1 \times 10^{13}$  or preferably not less than  $1 \times 10^{14}$  atoms/cm<sup>3</sup>. These values fall within the range for nitrogen specified in claim 1 of the main request.

3.2 Consequently, the claimed process differs from that disclosed in document D4a only in that the OSF ring region is located in a peripheral region with a width of 10 mm or less from the periphery of the single crystal wafer. Given that this feature is not disclosed in the remaining prior art, the subject matter of claim 1 is novel.

3.3 However, the application does not comprise any technical information or reason as to why the claimed restriction to a width of  $\leq 10$  mm from the periphery of the wafer is critical and therefore should be adhered to. Furthermore, it remains unclear what technical

problem actually is meant to be solved by this feature. This lack of information leads to the conclusion that a special technical effect unknown in the prior art cannot be attributed to the selected width of  $\leq 10$  mm and, in consequence thereof, that the selection has been made arbitrarily rather than intentionally.

Furthermore, the statement given in document D4a, column 1, lines 41 to 45 reflects the general knowledge that the outermost peripheral region comprising the OSF ring is not useful for forming semiconductor devices. This background knowledge complies with the statement given on page 6, lines 5 to 10 of the application as filed. It is, therefore, obvious for the person skilled in the art to restrict the ring-shaped area comprising the OSF ring to a minimum.

The appellant's argument that the process of document D4a uses a "low" pulling rate of 0.7 times the maximum rate and the OSF ring is formed at about the half region in the direction of the crystal radius, is not disputed. It has, however, no bearing on the matter since the distinguishing feature of  $\leq 10$  mm has been arbitrarily chosen and not been proven to solve a particular technical problem. Bearing in mind that most single crystals are pulled at high pulling speeds and, as in the claimed process, an OSF ring is formed at the outermost periphery of the crystal (or wafer, respectively), the selected width of 10 mm or less amounts to nothing more than what is generally achieved by the processes of the prior art.

- 3.4 The subject matter of claim 1 of the main request therefore lacks an inventive step.

4. Auxiliary request

4.1 Amendments; Article 123(2) EPC:

The single claim of the auxiliary request is based on the technical details featuring in examples 1, 3 and 4 in combination with the technical information given on page 6, lines 10 to 18 of the application as filed. Hence there are no formal objections to claim 1 under Article 123(2) EPC.

4.2 Novelty; Article 54 EPC:

The process set out in claim 1 of the auxiliary request comprises numerous technical features and parameters which in their entirety are not anticipated by D4a or any of the other cited documents. The novelty of the subject matter of claim 1 therefore cannot be disputed.

Given that the ground of lack of novelty set out in the decision of the examining division for refusing the application no longer applies, the Board cannot support the decision under appeal and it is, therefore, set aside.

Compared with the process set out in claim 1 of the main request, which was distinguished by only one technical feature from the disclosure of document D4a, claim 1 of the auxiliary request has been amended to include numerous distinguishing technical features which have not yet been taken into account by the first instance during substantive examination. It is therefore considered appropriate in accordance with

Article 111(1) EPC to remit the case to the first instance for further prosecution.

## **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 for further prosecution on the basis of the auxiliary request filed during the oral proceedings.

The Registrar:

The Chairman:

V. Commare

T. Kriner