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Datasheet for the decision of 24 July 2014

Case Number: T 0425/12 - 3.2.08

Application Number: 06251968.1

Publication Number: 1712661

IPC: C30B29/04, C30B25/20

Language of the proceedings: EN

Title of invention:
Single crystalline diamond and producing method thereof

Patent Proprietor:
Sumitomo Electric Industries, Ltd.

Opponent:
Element Six Limited

Headword:

Relevant legal provisions:
EPC Art. 56

Keyword:

Decisions cited:

Catchword:

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European Patent Office
D-80298 MUNICH
GERMANY
Tel. +49 (0) 89 2399-0
Fax +49 (0) 89 2399-4465

Case Number: T 0425/12 - 3.2.08

D E C I S I O N
of Technical Board of Appeal 3.2.08
of 24 July 2014

Appellant: (Patent Proprietor)	Sumitomo Electric Industries, Ltd. 5-33, Kitahama 4-chome, Chuo-ku Osaka-shi, Osaka (JP)
Representative:	Boult Wade Tennant Verulam Gardens 70 Gray's Inn Road London WC1X 8BT (GB)
Appellant: (Opponent)	Element Six Limited Kings Ride Park Ascot SL5 8BP (GB)
Representative:	Atkinson, Ian Anthony Slingsby Partners LLP 5 Chancery Lane GB-London EC4A 1BL (GB)
Decision under appeal:	**Interlocutory decision of the Opposition Division of the European Patent Office posted on 21 December 2011 concerning maintenance of the European Patent No. 1712661 in amended form.**

Composition of the Board:

Chairman	T. Kriner
Members:	M. Alvazzi Delfrate
	D. T. Keeling

Summary of Facts and Submissions

I. By its decision posted on 21 December 2011 the opposition division found that European patent No. 1712661, in amended form according to auxiliary request 6 then on file, and the invention to which it related met the requirements of the EPC.

II. Both appellant 1 (patent proprietor) and appellant 2 (opponent) lodged an appeal against that decision in the prescribed form and within the prescribed time limit.

III. Oral proceedings before the Board of appeal were held on 24 July 2014.

IV. At the end of the oral proceedings the requests of the parties were as follows:

Appellant 1 requested that the decision under appeal be set aside and the patent be maintained on the basis of auxiliary request 8 submitted with letter of 23 June 2014.

Appellant 2 requested that the decision under appeal be set aside and that the patent be revoked.

V. Claim 1 of auxiliary request 8 submitted with letter of 23 June 2014 (now the main request) reads as follows:

"A method for producing a single crystalline diamond, wherein, when a linear polarized light which is composed of two linear polarized lights perpendicular to each other is introduced into one main face of the single crystalline diamond, a maximum value of a retardation measured by the method of de Senarmont

between the two linear polarized lights perpendicular to each other which come out from an opposite main face is not more than 50 nm per a crystal thickness of 100 µm across an entire of the single crystalline diamond, and wherein a concentration of nitrogen as an impurity is 0.1 to 5 ppm measured by SIMS, the method comprising the steps of:
mechanically polishing a main face and a side face of a single crystalline diamond substrate as a seed, wherein an inclination of the side face of the single crystalline diamond substrate after the mechanically polishing is within a range of not less than 82 degrees and not more than 98 degrees with respect to the main face, and the surface roughness of the main face and side face is not more than 0.1 µm in terms of Rmax and not more than 10 nm in terms of Ra;
etching a layer from the main face and the side face by reactive ion etching;
newly growing a single crystalline diamond layer thereon by chemical vapor deposition; and
separating the single crystalline diamond layer newly grown by chemical vapor deposition from the single crystalline diamond substrate as a seed by slicing by means of a laser beam with a wavelength of not more than 360 nm."

VI. The following documents played a role for the present decision:

D1: EP -A- 1 555 337;
E1: W0 -A- 2004/046427; and
E12: EP -A- 0 567 129.

VII. The arguments submitted by appellant 2 in respect of the sole request (former auxiliary request 8 filed with letter of 23 June 2014) can be summarised as follows:

Like the patent in suit, D1 related to the production of high quality diamonds of large size. Since it also disclosed a method similar to the method of claim 1, this document represented the most relevant prior art.

The method disclosed in D1 comprised mechanical polishing a main face and, at least in the embodiments disclosed in paragraphs [0044] and [0067], a side face of a single crystalline diamond substrate as a seed, wherein an inclination of the side face of the single crystalline diamond substrate after the mechanical polishing was within a range of not less than 82 degrees and not more than 98 degrees with respect to the main face. According to paragraph [0053] the surface roughness of the main face measured as Rmax was 0.1 µm. It was obvious to choose the same Rmax for the main and the side face to obtain the same quality of the diamond growth. Paragraph [0044] further disclosed etching a layer from the main face and the side face by reactive ion etching. After newly growing a single crystalline diamond layer thereon by chemical vapor deposition this diamond layer was separated from the single crystalline diamond substrate as a seed by slicing by means of a laser beam.

It was true that D1 did not disclose a value of Ra. However, a value in accordance with claim 1 was disclosed in E1, which described it as advantageous for reducing the defects in the diamond. Therefore, no inventive step could be based on this feature.

Nor could the presence of an inventive step be acknowledged on the basis of the selection of a wavelength of not more than 360 nm for the laser

slicing, since this wavelength was common for this purpose, as evidenced by E12.

Therefore, the subject-matter of claim 1 did not involve an inventive step.

VIII. The arguments submitted in response by appellant 1 can be summarised as follows:

Starting from the most relevant prior art D1 it was not obvious to arrive at the method of claim 1.

Not only did D1 not mention Ra, but was also completely silent on the roughness to be achieved by mechanical polishing of the side face. In the claimed method, by controlling Ra and Rmax of the main and the side face the retardation could be kept in the range stipulated by claim 1 also in the horizontally grown regions, i.e. over the whole surface of the diamond in a cost-effective way. Costs were also reduced by the step of slicing the diamond from the substrate with a laser cut of the wavelength specified in claim 1.

Therefore, in the claimed method the selection of the polishing parameters and the wavelength of the slicing laser both contributed to the object of providing a low-cost method of production of high quality diamonds for semiconductor applications.

E12 could not render it obvious to use a wavelength in accordance with claim 1 because it did not relate to slicing CVD diamonds from their seed substrate.

In respect of the roughness of the polished surfaces, D1 did not attach any importance to this parameter but rather linked the high quality of the diamond crystals

with the performance of etching. As to E1, it was silent on the value of Rmax of the main face and, most importantly, did not address at all the issue of the roughness of the side face.

Therefore, the prior art did not lead in an obvious way towards the method of claim 1. Accordingly, the subject-matter of this claim involved an inventive step.

Reasons for the Decision

1. The appeals are admissible.

2. Inventive step

2.1 D1, which relates to the same technical field as the patent in suit, namely the production of high-quality single crystalline diamonds of large size, and discloses a method similar to the method of claim 1, is undisputedly the most relevant prior art.

The method disclosed in D1 comprises the steps of mechanical polishing a main face and a side face of a single crystalline diamond substrate as a seed (see paragraphs [0044] and [0067]), wherein an inclination of the side face of the single crystalline diamond substrate after the mechanical polishing is within a range of not less than 82 degrees and not more than 98 degrees with respect to the main face (see Figures 1 and 2), etching a layer from the main face and the side face by reactive ion etching (see paragraph [0044]), newly growing a single crystalline diamond layer thereon by chemical vapor deposition (see claim 1); and

separating the single crystalline diamond layer newly grown by chemical vapor deposition from the single crystalline diamond substrate as a seed by slicing by means of a laser beam (see paragraph [0071]).

D1 further discloses an N content measured by SIMS of the obtained diamond crystal of 3.1 ppm (paragraph [0073]). No measurement of the retardation is disclosed.

2.2 Starting from this prior art the object achieved by the claimed invention is to provide a low-cost method for the production of diamond single crystals with large areas and little distortion to be used for semiconductor devices (paragraph [0006] of the patent in suit).

This object is achieved in accordance with claim 1 by keeping the surface roughness of the main and the side face no more than 0.1 µm in terms of Rmax and no more than 10 nm in terms of Ra. These conditions prevent anomalous growth of the single crystal and reduce the distortion. The reduction of distortion correspondingly reduces the retardation. By controlling also the roughness of the side face, this effect is achieved also in the horizontal growth region providing a retardation as stipulated by claim 1 (paragraphs [0017] and [0039]).

2.3 The prior art does not render it obvious to achieve this object in accordance with claim 1.

It is true that D1 itself discloses an embodiment where the main face is polished to an Rmax of 0.1 µm (see paragraph [0053]). However, no information is provided on the value of Ra and this embodiment does not involve

polishing the side face, which is not associated to crystal growth in the same way as the main face. Moreover and most importantly D1 does not disclose any link between the values of Ra and Rmax and the quality of the crystal. Accordingly, it does not teach that the given object should be achieved by controlling Ra and Rmax of the side face in the range stipulated by claim 1.

Nor is such a teaching to be found in E1. It is true that this document discloses that the substrate surface must be carefully prepared by polishing to an Ra within the range stipulated by claim 1 to reduce the defect level (see last paragraph on page 17). However, this teaching, which does not mention a specific level of Rmax, relates solely to the main surface. Since nothing is said on the side face, E1 does not teach that the given object should be achieved by controlling Ra and Rmax of this latter face in the range stipulated by claim 1 either.

Accordingly, the subject-matter 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 Opposition Division with instructions to maintain the patent on the basis of the following documents:

- Claims 1 and 2 of auxiliary request 8 filed with letter of 23 June 2014;

- Description, pages 2 to 7, filed at the oral proceedings before the Opposition Division.

The Registrar: The Chairman:

A. Wolinski T. Kriner

Decision electronically authenticated