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D E C I S I O N
of 5 April 1995

Case Number: T 0916/92 - 3.3.2

Application Number: 86307428.2

Publication Number: 0219254

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Language of the proceedings: EN

Title of invention:
Joined ceramic-metal composite

Applicant:
KABUSHIKI KAISHA TOSHIBA

Opponent:
-

Headword:
Ceramic-metal composite/TOSHIBA

Relevant legal provisions:
EPC Art. 56

Keyword:
"Inventive step - (yes) - unexpected improvement"

Decisions cited:
-

Catchword:
-



Case Number: T 0916/92 - 3.3.2

D E C I S I O N
of the Technical Board of Appeal 3.3.2
of 5 April 1995

Appellant: KABUSHIKI KAISHA TOSHIBA
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Decision under appeal: Decision of the Examining Division of the European Patent Office dated 29 May 1992 refusing European patent application No. 86 307 428.2 pursuant to Article 97(1) EPC.

Composition of the Board:

Chairman: P. A. M. Lançon
Members: G. J. Wassenaar
J. A. Stephens-Ofner

Summary of Facts and Submissions

- I. European patent application No. 86 307 428.2 was refused by a decision of the Examining Division. The decision was taken on the basis of an amended set of claims, containing two method claims (Claims 1 and 2) and 4 product claims (Claims 3 to 6).
- II. In the contested decision the following documents were cited:
- (1) US-A-4 409 278
 - (2) US-A-4 413 766

In its decision the Examining Division took the view that the claimed process did not involve an inventive step over (1) for the following reasons:

The problem underlying the claimed invention was considered to be providing an improved joined metal-ceramic-composite whereby the production of blisters is prevented. It was considered that a skilled person would realize that flat surfaces exhibiting a low warp were a prerequisite to solving the problem, and that the means required by Claim 1, i.e. specular polishing and/or wet honing the substrate to ensure a maximum warp of 20 μm /50 mm, were standard technical measures to obtain extremely flat surfaces. The process of Claim 1 was thus no more than the obvious solution of the problem to be addressed and hence did not involve an inventive step.

- III. The Appellant lodged an appeal against this decision. With the Statement of Grounds of Appeal, the Appellant filed two sets of claims as main- and auxiliary request. Apart from a clarifying correction, the content of the

claims of the main request was identical to that of the claims on which the decision under appeal was based. The auxiliary request differed therefrom in that Claim 1 contained the additional requirement that "the grooves (3) are formed by pressing edges of the blades against the copper sheet (2)". With respect to the main request it was argued that (1) did not suggest that the substrate surface should be polished and honed to have a maximum warp of 20 μm per 50 mm of surface line. The reference to "sanding or filling" in (1) would imply a surface flatness which is orders of magnitude cruder than the maximum warp indicated in present Claim 1 and that flat surfaces are not essential for reliable bonding). With respect to the auxiliary request it was further argued that by forming the grooves by plastic deformation as defined in auxiliary Claim 1, the grooves disappear after bonding. This would have the advantage that no etchant could penetrate the bonded structure. With respect to the auxiliary request, document (2) was regarded to represent the closest prior art. Although (2) mentioned "embossing" to form grooves in the metallic sheet, there was considerable doubt as to the interpretation of this expression; anyhow there was no intention to recover the grooves at elevated temperatures. The skilled reader would not be led to forming grooves by the pressing of edges of blades or any other plastic deformation process. The Statement of Grounds was accompanied by an Affidavit of Mr Matsumura, one of the co-inventors, with experimental evidence to show the effect of plastic deformation.

IV. In response to several objections raised by the Board, a new set of claims, containing only method claims, and amended pages 2, 2a, 3 and 4 were presented as only request. The only independent Claim 1 reads as follows:

"1. A method of forming a joined ceramic-metal composite which comprises a ceramic substrate (1) and a copper sheet (2) joined to one or each of the major surfaces of said ceramic substrate (1), said method comprising:

forming a plurality of grooves (3) in at least one major surface of said copper sheet for contacting one of the major surfaces of said ceramic substrate (1),

superposing the grooved major surface of said copper sheet (2) on one of the major surfaces of said ceramic substrate (1);

heating the superposed layers so as to directly join said ceramic substrate (1) to said copper sheet (2) by enabling any gas emanating from said ceramic substrate (1) or said copper sheet (2) to be vented by said grooves; and

cooling the hot composite consequently formed;

characterized by the steps, prior to the said superposition of the copper sheet on the substrate, of forming the grooves (3) by pressing edges of blades against said copper sheet (2); and specular polishing and then whet honing said ceramic substrate (1) to ensure said ceramic substrate (1) has a warp of no more than $20\mu/50\text{mm}$;

and in that the heating is at a temperature in the range of 1065° to 1083°C ."

- V. The Appellant requested that the decision under appeal be set aside and that a patent be granted on the basis of the claims filed on 20 December 1994 with the letter dated 19 December 1994 and the amendment in Claim 4 filed on 16 January 1995, with the letter of 12 January 1995.

Reasons for the Decision

1. *Admissibility*

The appeal is admissible.

2. *Allowability of amendments (Article 123(2) EPC)*

The description as originally filed discloses a method of forming a joint ceramic-metal composite with all the features of present Claim 1. With respect to the characterizing feature that the grooves (3) are formed by pressing edges of blades against the cooper sheet, see page 5, first paragraph. With respect to the further characterizing feature that the ceramic substrate is given a specular polishing and then a whet honing to ensure said ceramic substrate has a warp of no more than 20 $\mu\text{m}/50 \text{ mm}$, see page 3, first paragraph. With respect to the final characterizing feature that the heating is in a temperature of 1065° to 1083°C, see page 4, first paragraph.

The additional features mentioned in the dependent Claims 2 to 6 are also disclosed in the description as originally filed. The new definition of the depth of the grooves in Claim 4, is supported by original Claim 3 together with the only example showing a depth of 0.1 mm.

Thus Claims 1 to 6 satisfy the requirements of Article 123(2)EPC.

3. *Novelty*

Novelty was not disputed in the contested decision. The present main claim is narrower in scope than the method claim on which the contested decision was based. The Board also finds that there is no document disclosing all the features of the only independent Claim 1, so that the novelty requirement of Article 54 EPC is satisfied.

4. *Inventive step*

4.1 With respect to present Claim 1, the closest prior art is, in agreement with the Appellant, considered to be document (2). This document discloses a process for forming a joined ceramic-metal composite from which a conductor pattern on a ceramic substrate can be made, which comprises a ceramic substrate and a copper sheet. The process comprises the forming of a plurality of grooves in the copper sheet, superposing the grooved surface on the ceramic substrate using a eutectic composition and heating the superposed layers to form the joined composite (column 3, lines 3-63). This bonding technique implies a bonding temperature between the eutectic temperature and the melting point of copper. According to document (1), this implies a temperature between 1065 and 1083°C (column 7, Table II). The grooves are formed to enable gas, emanating from the ceramic substrate or copper sheet during heating, to escape so that no blisters are formed in the bonded structure (column 1, lines 22-32 and 65-68). Formation of grooves by etching and bonding of the etched copper sheet is described in detail in column 3, lines 18 to 63, with reference to Figures 1 to 8.

4.2 According to Appellant's submissions in his Statement of Grounds, one disadvantage of the forming of grooves by etching as disclosed in (2) is that the grooves remain after bonding so that etchants of subsequent treatments of the joined composite can penetrate the bonded structure, causing undesirable etching of the metal sheet. This was not recognized, or at any rate not discussed in the prior art, and was related to the drawback of poor adhesion and inferior thermal conductivity as mentioned in the original description. The problem underlying the invention therefore consisted in improving the bonding between a copper sheet and a ceramic substrate in a method to bond a copper sheet to a ceramic substrate by eutectic bonding. This problem was solved by the method of Claim 1, which differed from the process described in (2) by the following features:

- (i) forming the grooves by pressing edges of blades against the copper sheet, and
- (ii) a surface treatment of specular polishing and then whet honing of the ceramic substrate so that the warp is not more than 20 $\mu\text{m}/50 \text{ mm}$.

By the comparative examples in the affidavit filed with the Statement of Grounds, it was convincingly demonstrated that by forming the grooves by plastic deformation by pressing the edges of blades into the surface of the copper sheet (Example A) the grooves completely disappeared after bonding, whereas they remained if the grooves were formed by removal of material by etching the surface of the copper sheet (Example B). The differences were clearly visible in microphotographs ($\times 50$ and $\times 100$) of cross sections of joined specimens. The comparative examples are considered by the Board as being a fair comparison with the closest state of the art illustrated by (2). The alternative methods of forming grooves merely suggested

in (2) such as milling or embossing, were not sufficient detailed to allow a realistic comparison. It is clear that the removal of the grooves after bonding improves the bonding between the copper sheet and the ceramic substrate. Thus it can be accepted that the problem is solved by the process of Claim 1.

4.3 It remains therefore to be decided whether, in view of the prior art, the claimed method was obvious to solve said technical problem.

4.3.1 Although (2) describes in detail only a process whereby the grooves are formed by etching, it also indicates that as alternative to etching the grooves could be machined or embossed into the bottom of the metallic sheet (column 7, lines 34-36). Because no details are indicated, it is not clear to the skilled man what action is actually envisaged by the expression "embossing" in the context of (2). At any rate it was presented as an alternative to etching, so that the skilled man was not given any incentive that by forming the grooves by some kind of plastic deformation the bonding could be improved.

4.3.2 Document (1), which also discloses the forming of grooves in a copper sheet to be bonded by eutectic bonding to a ceramic substrate, indicates that the channels (grooves) may be formed by mechanical means, such as grinding, but that it is more convenient and economical to etch the channels in the metal (column 4, lines 57-63). This document therefore does not suggest to make the grooves by plastic deformation.

4.3.3 Of the documents mentioned in the Search Report, there is one other document DE-A-3 324 661 (3), which also discloses the forming of grooves in a copper sheet to be joined to a ceramic substrate by eutectic bonding. In

that case the grooves are relatively shallow (3 to 10 μm) compared with those of the present invention (at least 0.01 mm) and are made by brushing or grinding (page 4, lines 10-18). There is again no indication that the bonding can be improved by making the grooves by plastic deformation.

4.3.4 Thus the available prior art does not give the skilled man any incentive that the said technical problem could, let alone should, be solved by forming the grooves by the plastic deformation treatment as defined in present Claim 1. Under this circumstances it can be left aside whether distinguishing feature (ii) relating to the surface treatment of the ceramic substrate involves an additional inventive step.

4.4 For these reasons, the invention as claimed in present Claim 1 involves an inventive step. Since Claims 2 to 6 are dependent upon Claim 1, the same must apply to dependent Claims 2 to 6.

5. *Description*

The amendment on page 4, line 1, whereby original 0.10 mm for the minimum depth of the grooves (page 3, line 22) is replaced with 0.01 mm, is regarded as a correction of a clerical error under Rule 88 EPC. From the Example, according to which the groove depth is 0.1 mm, and original Claim 3, requiring a depth of not less than 0.01 mm, it was evident that an error was made and that the correct value should read 0.01 mm.

Order

For these reasons it is decided that:

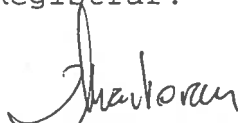
1. The decision under appeal is set aside.
2. The case is remitted to the first instance with the order to grant a patent in the following version:

Description: Page 1 filed with the letter of 11 May 1990. Pages 2, 2a filed with the letter of 19 December 1994. Page 3 filed with the letter of 30 March 1995. Page 4 filed with the letter of 12 January 1995. Pages 5, 6 filed with the letter of 24 May 1989.

Claims: No. 1 to 3 and 5 and 6 filed with the letter of 19 December 1994. No. 4 filed with the letter of 12 January 1995.

Drawing: Sheet 1/1 as originally filed.

The Registrar:



P. Martorana

The Chairman:



P. A. M. Lançon

