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D E C I S I O N
of 8 July 2003

Case Number: T 1124/01 - 3.4.3

Application Number: 96903414.9

Publication Number: 0806056

IPC: H01L 23/373

Language of the proceedings: EN

Title of invention:
Glass bonding layer for a ceramic circuit board support substrate

Applicant:
Sarnoff Corporation

Opponent:
-

Headword:
-

Relevant legal provisions:
EPC Art. 56

Keyword:
"Inventive step (yes)

Decisions cited:
-

Catchword:
-

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Beschwerdekammern | Boards of Appeal | Chambres de recours

Case Number: T 1124/01 - 3.4.3

D E C I S I O N
of the Technical Board of Appeal 3.4.3
of 8 July 2003

Appellant: Sarnoff Corporation
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Princeton, NJ 08543-5300 (US)

Representative: Crisp, David Norman
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Decision under appeal: **Decision of the Examining Division of the European Patent Office posted 26 March 2001 refusing European application No. 96903414.9 pursuant to Article 97(1) EPC.**

Composition of the Board:

Chairman: R. K. Shukla
Members: V. L. P. Frank
J. H. P. Willems

Summary of Facts and Submissions

I. European patent application No. 96 903 414.9 was refused by the decision of the Examining Division dated 26 March 2001. The ground for the refusal was that the subject-matters of the claims according to the main and first to third auxiliary requests did not involve an inventive step having regard to the prior art documents:

D1: US-A-5 277 724,
D3: American Ceramic Society Bulletin, January 1993, Vol. 72, No. 1, pp. 90-95, and
D4: US-A-4 712 161

II. The appellant (applicant) lodged an appeal against the above decision on 24 May 2001, paying the appeal fee the same day. The statement setting out the grounds of appeal was filed on 19 July 2001.

III. Amended claims and pages of the description were filed by the appellant with the letter dated 10 June 2003 in response to a communication from the Board.

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

Claims: 1 to 6, filed with the letter of 10 June 2003

Description: pages 1, 2, 5 and 8, as originally filed
page 3a, filed with the letter of 9 November 1999

pages 3, 4, 6, 7, 9 and 10, filed with the letter of 10 June 2003

Drawings: Sheet 1/1, as originally filed.

The wording of the independent claim is as follows (emphasis has been added by the Board to indicate the amendments made to the claim during the appeal proceedings in relation to the independent claim according to the third auxiliary request before the Examining Division):

"1. A method of making a ceramic multilayer circuit board (10) comprising a stack of multiple layers of ceramic made from forsterite-cordierite-type glasses having circuitry thereon and a nickel plated ceramic, metal or metal alloy support substrate (12) comprising

depositing a bonding glass (18) on a surface of the substrate (12),

patterning the bonding glass (18) so that electrical contacts can be made between the circuits on the multiple ceramic layers to contacts and vias made in the substrate support (12),

aligning the bonding glass coated support substrate and the multilayer green tape stack (19) so that contact can be made between contacts or vias on the support substrate and circuitry in the green tape stack, and

firing the aligned coated substrate and green tape stack to a temperature so as to bond the green tape stack to the support substrate and form a ceramic from the forsterite-cordierite-type glasses, characterised in that,

the bonding glass comprises an oxide mixture of calcium, zinc and boron oxides having a sintering temperature from 25 to 250°C below that of the forsterite-cordierite-type glasses, such that the fired bonding glass coated support substrate limits shrinkage in the x and y lateral dimensions of the ceramic multilayer circuit board to not greater than 1%, and wherein the bonding glass comprises *the following components*: 45-55% by weight of zinc oxide, 30 to 40% by weight of boron oxide, 3 to 7% by weight of calcium oxide and 3 to 7% by weight of aluminium oxide, *and wherein the amounts of said components add up to 100% by weight*."

V. In the decision under appeal the Examining Division argued that the method according to claim 1 of the main and first to third auxiliary requests differed from the method disclosed in document D1 essentially in that the ceramic is made from forsterite-cordierite-type glasses and by the bonding glass composition. The skilled person would, however, apply the teaching of document D1 to the forsterite-cordierite-type glass disclosed in document D3. Document D4, moreover, discloses a large number of bonding glass compositions suitable to be used with a wide range of ceramics and substrates from which the skilled person would select according to the circumstances. The claimed bonding glass composition

was merely a selection of the bonding glasses disclosed in document D4. However, no unexpected effect was shown to exist for the bonding glass composition as claimed. According to the case law of the Boards of Appeal, a selection can only be regarded as being inventive if it is a purposive selection and not an arbitrary one.

VI. The arguments of the appellant in favour of inventive step can be summarized as follows:

Document D1 discloses a method for making a ceramic multilayer circuit board in which the ceramic green tape stack is bonded to a metallic substrate by a bonding glass to limit to less than 1% the shrinkage of the ceramic during the firing step. The bonding glass and the ceramics according to document D1 are, however, different from the ones disclosed in the application. The objective problem solved by the present invention is, therefore, the provision of a specific bonding glass for use with particular substrates and multilayer ceramic stacks. Document D4 discloses a large number of bonding glasses for bonding primarily alumina type ceramics to copper.

In order to establish that the bonding glasses according to claim 1 possess unexpected advantages over the broad range of glasses disclosed in document D4 a comparative test is submitted with the statement of grounds of appeal. In this test a glass composition falling within the scope of claim 1 is compared with a glass composition having the same elements but in amounts outside the scope of the claim. The ceramic formed during firing the green tape using the comparative glass composition exhibited a 5% shrinkage

in both lateral dimensions. On the other hand, the lateral shrinkage was limited to not more than 1% when using the bonding glass falling under the scope of the claim. This showed clearly that the composition according to the claim was not an arbitrary selection.

Reasons for the Decision

1. The appeal is admissible.

2. *Amendments*

In the decision under appeal, there were no objections raised against the claims under Article 123(2) EPC, and the Board is also satisfied that the claims as amended during the examination proceedings complied with Article 123(2) EPC.

Claim 1 has been amended in the course of the appeal proceedings essentially in that the components of the bonding glass add up to 100% by weight. This amendment clarifies that no other components than the ones stated in the claim form the bonding glass and is supported by the whole disclosure of the application as filed.

The description was amended for consistency with the claims.

The Board is, therefore, satisfied that the amendments fulfill the requirement of Article 123(2) EPC.

3. Inventive step (Article 56 EPC)

The only issue in this appeal is that of inventive step.

3.1 It is common ground that document D1 represents the closest state of the art. This document discloses a method for manufacturing ceramic multilayer circuit boards in which a stack of layers of ceramic tapes 20 with circuitry on them are joined to a metal base 12. In this process a high temperature firing step is required for burning off the organic components present in the green tapes which form, after the firing step, the ceramic stack. The firing temperature selected for firing the circuit board, however, depends upon the metal of the base and the composition of the ceramic layers. The firing step also densifies the ceramic material and causes an overall shrinking of the tapes, typically from 10 to 15% in all dimensions. To restrain the lateral shrinkage of the green tape a bonding glass layer 18 is used to bond the ceramic laminate to the metal base so that almost all of the shrinkage occurs in the thickness dimension. According to this document, the use of a bonding glass layer limits the lateral shrinkage of the laminated ceramic layer to about 0.8% (cf. D1, column 1, lines 6 to 68; column 3, lines 44 to 47; column 4, lines 5 to 12 and 18 to 25 and Figure 1).

3.2 The method according to claim 1 of the application in suit differs therefore from the method disclosed in document D1 essentially in that

i) the stack is formed by layers of ceramic made from forsterite-cordierite-type glasses, and in that

ii) the composition of the bonding glass used for bonding the stack onto the support substrate is the one specified in the claim.

3.3 The technical problem addressed by the application is, therefore, the one stated originally in the application, namely, to provide a bonding glass composition to bond a forsterite-cordierite-type glass to a support substrate such that the lateral shrinkage is limited at the most to 1% (cf. page 3, lines 8 to 14; page 3, line 28 to page 3a, line 10; page 9 and Example 1 of the application).

3.4 The Examining Division argued in the decision under appeal that the glass composition specified in the claim was merely an arbitrary selection from the compositions disclosed in document D4. It did not involve an inventive step, because the operated selection has not been shown to possess unexpected effects (cf. point 3 of the Grounds for the Decision).

3.5 Document D4 discloses the bonding of a thin copper foil 14 on a ceramic substrate 12. The problem addressed in this document is to avoid the formation of blistering or bubbles at the interface between the foil layer and the ceramic substrate. To this effect a bonding glass 16 is interposed between the copper foil and the ceramic substrate. Document D4 discloses *expressis verbis* that "the glass may be selected from the group consisting of **silicate**, boro**silicate**, phosphate and zinc boro**silicate** glasses. Preferably, the glass selected is a boro**silicate** glass having the general composition $MO\text{-}B_2O_3\text{-}\mathbf{SiO_2}$, where MO = Al_2O_3, BaO, CaO, ZrO_2, Na_2O_3, SrO, K_2O and mixtures thereof"

(emphasis added by the Board; cf. column 3, line 65 to column 4, line 3; column 5, lines 55 to 60; claims 3 and 4 and Figure 1).

Document D4, therefore, clearly specifies that the bonding glass is a **silicate** based glass.

The glass composition specified in the claim is, however, formed by oxides of zinc, boron, calcium and aluminium and does not contain silica. For this reason, the bonding glass composition as claimed is not a selection, neither arbitrary nor purposive, from the list of the glasses disclosed in document D4.

3.6 Moreover, the skilled person could not expect, having regard to the disclosure of documents D1 and D4, that the bonding glass disclosed in the application in suit would limit the lateral shrinkage of a stack of forsterite-cordierite-type glasses when bonded onto a metal substrate, since these documents do not deal with forsterite-cordierite-type glasses and document D1 discloses that "the composition of the glass bonding layer is influenced by the composition of the metal core and its thermal characteristics, as well as the **composition of the ceramic laminate** and the sintering characteristics and the process employed for fabricating the co-fired, ceramic-on-metal circuit board" (emphasis added by the Board; cf. D1, column 2, line 64 to column 3, line 1).

The effect achieved by the bonding glass composition as claimed is illustrated by the comparative test submitted by the appellant. This test shows that by employing a bonding glass with the same elements but a

composition outside the scope of the claim a lateral shrinkage of 5% is obtained, but that with a glass composition according to the claim the lateral shrinkage is limited to not more than 1%.

3.7 For these reasons, it is the Board's judgment that the subject-matter of claim 1 involves an inventive step within the meaning of Articles 56 EPC.

The dependent claims concern further particular embodiments of the invention which are patentable for the same reasons.

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:

Claims: 1 to 6, filed with the letter of 10 June 2003

Description: pages 1, 2, 5 and 8, as originally filed
page 3a, filed with the letter of 9 November 1999
pages 3, 4, 6, 7, 9 and 10, filed with the letter of 10 June 2003

Drawings: Sheet 1/1, as originally filed.

The Registrar: The Chairman:

M. Beer R. K. Shukla