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D E C I S I O N
of 3 February 2004

Case Number: T 0154/01 - 3.4.3

Application Number: 89303986.7

Publication Number: 0339881

IPC: H05K 3/26

Language of the proceedings: EN

Title of invention:
Method of making a circuit board

Patentee:
KABUSHIKI KAISHA TOSHIBA

Opponent:
IXYS Semiconductor GmbH

Headword:
Method of making a circuit board/KABUSHIKI KAISHA TOSHIBA

Relevant legal provisions:
EPC Art. 56, 123(3), 100(1)

Keyword:
"Inventive step (no) - routine experiments"
"Extension of protection conferred (yes)"

Decisions cited:
-

Catchword:
-

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Beschwerdekammern | Boards of Appeal | Chambres de recours

Case Number: T 0154/01 - 3.4.3

D E C I S I O N
of the Technical Board of Appeal 3.4.3
of 3 February 2004

Appellant: (Proprietor of the patent)
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Decision under appeal: **Decision of the Opposition Division of the European Patent Office posted 7 December 2000 revoking European patent No. 0339881 pursuant to Article 102(1) EPC.**

Composition of the Board:

Chairman: R. K. Shukla
Members: E. Wolff
J. P. B. Seitz

Summary of Facts and Submissions

I. This is an appeal from a decision of the opposition division, dispatched on 7 December 2000, to revoke European patent No. 0339881 pursuant to Article 102(1) EPC for lack of an inventive step having regard to the prior art disclosed in the following documents

D1: J. Materials Science, Vol. 21, pages 522 to 528, 1986;

D2: "A Scientific Guide to Surface Mount Technology", C. Lea, page 321, Electrochemical Publications Ltd, Scotland, 1988;

D3: BBC-Druckschrift D HL 2669 82 D, Sonderdruck aux BBC-Nachrichten, Jahrgang 64, Heft 7/1982, pages 196 to 200;

D4: EP-A-0 237 739;

II. The appellant (proprietor) filed a notice of appeal and paid the appeal fee on 1 February 2002. The statement setting out the grounds of appeal was filed on 3 April 2001.

The appellant requested that

- that the decision under appeal be set aside,

- that the patent be maintained on the basis of any one of the main and first to third auxiliary requests submitted during the opposition proceedings or on the basis of the fourth

auxiliary request filed with the statement of the grounds of appeal.

Oral proceedings were requested in the event the Board considered not granting any of the appellant's requests.

III. The respondent (opponent) requested that the appeal be dismissed.

IV. In a communication dated 28 October 2003 which accompanied the summons to oral proceedings set for 3 February 2004, the Board informed the appellant of its preliminary view that neither the main request nor any of the first to fourth auxiliary requests complied with the requirements of the EPC.

In response, the appellant filed on 5 January 2004 a new set of claims as fifth auxiliary request.

V. Following withdrawal during the oral proceedings of the main request and the first to fourth auxiliary requests, the former fifth auxiliary request became the sole remaining request, of which claim 1 has the following wording:

"1. A method of making a circuit board comprising a ceramic composite substrate, the method comprising:

applying one face of a copper member having opposite faces and a thickness of 0.25mm - 0.6mm to one surface of a ceramic substrate having opposite surfaces to form a pre-bonded assembly,

heating said assembly to a temperature in a range of 1065°C to 1083°C thereby forming a copper-oxygen eutectic direct bond between the copper member and the substrate to form a heat-bonded copper member on the ceramic substrate, the copper member including oxygen in a range of 100ppm to 3000ppm, and

characterized by

chemically etching the other face of the heat-bonded copper member to form a predetermined circuit pattern having at least one mounting area and at least one electrode area on the ceramic substrate,

removing a surface layer of the circuit pattern by chemically polishing the circuit pattern, such that the median surface roughness (Ra) of the circuit pattern is not greater than 4µm and the maximum surface (Rmax) thereof is not greater than 18µm, and

mounting at least one electrical element on said at least one mounting area by soldering and electrical connecting a bonding wire to said at least one electrical element and said at least one electrode."

VI. The appellant's argument in support of his request can be summarized as follows.

The invention relates to a method of making a circuit board on composite substrates in which a copper foil is

directly heat-bonded to a ceramic substrate, and an electronic component is secured and electrically connected to the copper surface of the composite substrate by soldering.

The inventors found that device failures were attributable to overheating caused by gaps having formed between the copper sheet and the component. The inventors further found that wettability of the copper sheet by the solder played a crucial part in the formation of these gaps.

There is also the further problem of particles of photo resist being left on the copper surface after the circuit pattern has been etched.

To reduce device failures, the invention provides a method of manufacturing the circuit board such that the surface roughness of the copper sheet lies in a pre-defined range which ensures high wettability of the copper by the solder. The required median surface roughness of not more than 3 µm and the maximum surface roughness 18 µm, which ensures optimum wettability, is achieved by chemical polishing, which also has the effect of removing remaining particles of photo resist. It is this whole combination of features which needs to be considered in assessing whether the invention involves an inventive step. Since this combination is not suggested by the prior art, the invention involves an inventive step.

VII. The arguments put forward by the respondent can be summarised as follows.

Article 123(3) EPC

Claim 1 as granted required a selection of the pre-bonded surface roughness such that the specified surface roughness would be obtained after heat-bonding (claim 1, paragraph c)). This dependence between the material characteristics before heat-bonding and those following heat-bonding is wholly absent from claim 1 of the request. The amended claim 1 of the request therefore contravenes the provisions of Article 123(3) EPC.

Inventive step

The formation of a composite substrate in which a copper sheet of is directly heat-bonded to a ceramic base is known from Document D3, which constitutes the closest prior art. Heat-bonding takes place in a furnace heated to between 1065 and 1082°C.

Using soldering to mount electronic components on such substrates is a standard technique in the field. Properly defined, the aim of the invention is therefore to provide reliable solder connections between substrates and components. The skilled person would furthermore know that in order to obtain satisfactory solder connections, good wettability is required between copper and solder.

The skilled person encountering problems with solder connections would know in general terms from document D2 (page 321, last paragraph, and page 322, first and second lines) that surface roughening usually causes an increase in the contact angle and hence a decrease in

wettability. The skilled person would then be taught by document D1, in particular its table 1, that for an increase in the median roughness (Ra) from 0.62 µm to 4.94 µm, the contact angle between copper and tin increases from 51.5° to 56.5° when heated for 1 minute, and from 30.5° to 43° when heated for 45 minutes.

Since the skilled person would also know that the surface roughness can be controlled by polishing including chemical polishing, it would be obvious to arrive at the invention. Specifying that both median and maximum surface roughness conditions need to be satisfied does not contribute anything further as these two parameters are intimately linked.

Reasons for the Decision

1. The appeal is admissible.

2. *Article 123(3)*

2.1 Claim 1 as granted stated in paragraph c) that

"the copper member has an initial, pre-bonded surface roughness such that, if necessary when adjusted by polishing after heat bonding, the median surface roughness (Ra) of the heat-bonded copper member is not greater than 3µm, and its maximum surface roughness (Rmax) is no greater than 18µm,".

Thus, as argued by the respondent, according to the granted claim 1 the initial, i.e. pre-bonded surface roughness of the copper member must be chosen to yield

the claimed median and maximum surface roughness after bonding.

3. Claim 1 of the sole remaining request of the appellant does not mention the requirement for the initial surface roughness of the copper member. Claim 1 as amended therefore extends the protection conferred by the patent which is contrary to the provisions of Article 123(3) EPC.

4. However, even if the claim would have been further amended to meet the provisions of Article 123(3), its subject matter would not, in the Board's view, have fulfilled the requirement of involving an inventive step as required by Article 56 EPC for the following reasons.

4.1 Document D3 discloses the fabrication of a composite substrate in which a copper sheet of 0.5 mm (page 6, left-hand column, second paragraph) is directly heat-bonded to a ceramic base at temperatures around 1070°C (page 5, centre column, penultimate line) in a furnace heated to between 1065 and 1082° (page 5, right-hand column, fourth paragraph). There can be no doubt that soldering is routinely used to mount electronic components on such substrates. There is also in the Board's view no doubt that, faced with device failures, the skilled person would have routinely checked the solder connection between the device and the substrate would have discovered the gaps in the solder connection referred to in the patent (page 3, lines 6 to 12), and would have correctly identified these defective solder connections being the cause for impaired heat conduction.

4.2 Given therefore, that the problem to be solved is thus to provide a more reliable solder connection, the skilled person would have been aware that good wetting of the copper by the solder is an important precondition for a good quality solder connection.

4.3 The respondent had argued that the disclosure in document D2 was inconclusive in that it did not inform the skilled person what precisely the effect of increasing the surface roughness would be. However, it is clear from the contents of point 10.3.3 on pages 320 to 322 of document D2, which is a textbook, that the skilled person would have known that surface roughness has an effect on wetting, even if the effect in the particular case was not specifically disclosed. In these circumstances it can be expected of the skilled person to perform routine experiments to evaluate the effect of surface roughness on wetting, including, if required varying the surface roughness by well-known techniques such as polishing.

4.4 In the Board's view, such routine experimentation would have led the skilled person directly to a satisfactory solder connection and thus to a median surface roughness not exceeding about 3 µm. The second requirement of the claim is that the maximum surface roughness is not greater than 18 µm. The Board considers persuasive the respondent's argument that the close relationship between median and maximum surface roughness would inevitably have caused this second requirement to be fulfilled when the requirement for a median surface roughness not exceeding about 3 µm was met.

4.5 The preference for chemical polishing over mechanical polishing to obtain a median surface roughness not exceeding 3 µm is also not considered by the Board to contribute to an inventive step, because there are only two options to choose from. Moreover, in the light of the common general knowledge that solder connections must be clean, the skilled person will routinely consider using chemical polishing since doing so also removes various impurities from the copper surface. The Board thus considers that the skilled person would have arrived at the subject matter of claim 1 merely by following a logical sequence of routine investigations.

5. For the foregoing reasons, in the Board's judgement the patent does not comply with the requirements of Articles 56 and 123(3) EPC.

Order

For these reasons it is decided that:

The appeal is dismissed.

The Registrar:	The Chairman:
D. Meyfarth	R. K. Shukla