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Case Number: T 1476/06 - 3.4.03

Application Number: 97950421.4

Publication Number: 0954208

IPC: H05K 3/32

Language of the proceedings: EN

Title of invention:
Method and device for mounting electronic component on circuit board

Applicant:
Panasonic Corporation

Headword:
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Relevant legal provisions:
-

Relevant legal provisions (EPC 1973):
EPC Art. 56

Keyword:
"Inventive step (no)"

Decisions cited:
-

Catchword:
-

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Case Number: T 1476/06 - 3.4.03

D E C I S I O N
of the Technical Board of Appeal 3.4.03
of 8 October 2009

Appellant: Panasonic Corporation
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Representative: Eisenführ, Speiser & Partner
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Decision under appeal: **Decision of the Examining Division of the European Patent Office posted 13 April 2006 refusing European patent application No. 97950421.4 pursuant to Article 97(1) EPC.**

Composition of the Board:

Chairman: G. Eliasson
Members: R. Q. Bekkering
J. Van Moer

Summary of Facts and Submissions

I. This is an appeal against the refusal of application 97 950 421 for lack of an inventive step, Article 56 EPC 1973 over

D2: DE 195 35 282 A and

D1: US 5 485 949 A.

II. At oral proceedings before the board, the appellant applicant requested that the decision under appeal be set aside and that a patent be granted on the basis of the following:

Main request:

Claim 1 of the main request submitted during the oral proceedings,
Claims 2 to 9 of the main request filed with letter dated 18 August 2006,

First auxiliary request:

Claim 1 of the first auxiliary request submitted during the oral proceedings,
Claims 2 to 9 of the auxiliary request filed with letter dated 18 August 2006,

Second auxiliary request:

Claims 1 to 5 of the second auxiliary request submitted during the oral proceedings.

III. Claim 1 of the main request reads as follows:

"*An electronic component mounting method comprising: aligning in position electrodes (5) of a circuit board (4) with bumps (3) formed by wire-bonding on electrodes (2) of an electronic component (1) characterized in that the positional alignment is executed after a solid thermosetting resin (6; 10; 66) is stuck to the circuit board (4); and*
that the bonding is executed by hardening with heat the thermosetting resin (6; 10; 66) interposed between the electronic component (1) and the circuit board (4) while correcting warp of the board (4) by pressurizing the electronic component (1) against the circuit board (4) with a pressure force of not smaller than 0.196133 N (20 gf) per bump, thereby bonding the electronic component (1) and the circuit board (4) together for electrical connection between both the electrodes (2, 5) thereof wherein the electronic component (1) is fixed on the circuit board (4) by the hardened thermosetting resin (6; 10; 66)."

IV. Claim 1 of the first auxiliary request corresponds to claim 1 of the main request with the following additional feature (highlighted by the board):

"*...that the bonding is executed by hardening with heat* ***in the range of 140°C to 230°C*** *the thermosetting resin (6; 10; 66)...*".

V. Claim 1 of the second auxiliary request corresponds to claim 1 of the first auxiliary request with the following additional feature (highlighted by the board):

"...*that the positional alignment is executed after a solid* ***insulative*** *thermosetting resin (6; 10; 66) is stuck to the circuit board (4)...*".

VI. The appellant in substance provided the following arguments:

The application concerned an electronic component mounting method in which the component was mounted on a substrate by thermo-compression bonding using a solid thermosetting resin and in which the component was only fixed to the substrate by the resin. In document D2, on the other hand, the chip was fixed by fusion of the gold ball bumps to the substrate contact pads. Additionally the chip was fixed to the substrate by the resin. In the invention there was no such fusion between the gold ball bumps and the contact pads of the chip. Furthermore, in the claimed invention the gold ball bumps were formed on the electronic component rather than on the substrate as in D2, thereby avoiding problems associated with bumping large substrate and reducing costs. Moreover, the bonding temperatures were lower than in D2. Accordingly, the presence of an inventive step had to be acknowledged.

Reasons for the Decision

1. The appeal is admissible.

2. *Main request*

2.1 *Novelty*

2.1.1 *Document D2*

Document D2 is concerned with a method of mounting an electronic component (chip) on a substrate. In particular, the method involves forming gold ball bumps on the contact pads of the substrate using a modified gold wire bonding process in which the wire is cut to a predetermined length after the ball is applied to the contact pad. This provides for a bump consisting of a gold ball base with a gold narrow cone tip (column 3, line 68 to column 4, line 28). A solid thermosetting insulative adhesive resin is stuck to the chip (column 5, line 50 to 65; column 6, lines 6 to 8 and 27 to 36; column 11, lines 27 to 63; figures 4.0 to 4.4). After positional alignment of the contact pads of the chip with the gold ball bumps on the substrate, the chip is mounted on the substrate by pressing the chip on the substrate and applying heat (thermo-compression bonding). The gold ball bumps are thereby forced through the resin and brought into contact with the aluminium contact pads of the chip. The tips of the gold ball bumps break and remove the native oxide on the aluminium contact pads of the chip and the gold ball bumps deform and bond with the aluminium contact pads of the chip. The applied pressure and heat causes the thermosetting resin to fill the space between the chip and the substrate and harden. As a result the chip is mechanically fixed to the substrate both by the bond between the gold ball bumps and the aluminium contact pads of the chip and by the hardened thermosetting resin (column 11, lines 27 to 63; figures 4.0 to 4.4).

2.1.2 The force applied during the thermo-compression bonding in D2 is 100 cN (ie 1 N) per ball bump in a first embodiment involving mounting a chip on a silicon substrate, and 50 cN (ie 0.5 N) per ball bump in a second embodiment involving mounting a chip on a ceramic substrate (column 10, lines 15 to 22 and column 10, line 66 to column 11, line 6). A comparable force is used in the embodiment discussed above involving the use of a resin sheet (column 11, lines 46 to 52). The force applied thus falls within the claimed range of "*not smaller than 0.196133 N (20gf)*".

In fact, according to the description of the application "*the maximum load may sometimes exceed 100 (gf)*" (ie about 1 N) (page 28, lines 2 to 3) and is, thus, comparable to the values indicated in D2.

Claim 1 moreover explicitly mentions correcting warp of the circuit board during bonding. According to the application this is obtained by a pressure during bonding not smaller than 20 gf (0.2 N) (page 29, lines 22 to 25). As the bonding pressure in D2 meets this condition, correcting warp inevitably also takes place in the method of D2.

2.1.3 In particular, having regard to claim 1 according to the main request, document D2 (see figures 4.0 to 4.4 and column 11, lines 26 to 63) discloses an electronic component mounting method comprising:
aligning in position electrodes (4) of an electronic component (5) with bumps (3) formed by wire-bonding on electrodes (2) of a circuit board (1), wherein

the positional alignment is executed after a solid thermosetting resin (17) is stuck to the electronic component (5), and
the bonding is executed by hardening with heat the thermosetting resin (17) interposed between the electronic component (5) and the circuit board (1) while correcting warp of the board (1) by pressurizing the electronic component (5) against the circuit board (1) with a pressure force of not smaller than 0.196133 N (20 gf) per bump, thereby bonding the electronic component (5) and the circuit board (1) together for electrical connection between both the electrodes (2, 4) thereof wherein the electronic component (5) is fixed on the circuit board (1) by the hardened thermosetting resin (17).

Hence, the subject-matter of claim 1 according to the main request differs from the method of document D2 in that the bumps are formed on the electrodes of the electronic component rather than those of the circuit board and the thermosetting resin is stuck to the circuit board rather than the electronic component.

2.1.4 The subject-matter of claim 1 according to the main request, thus, is new over document D2. It is also new over the remaining available, more remote prior art.

2.2 *Inventive step*

2.2.1 According to document D2 it is generally known to form gold ball bumps on the contact pads of a chip and to bond the chip with the bumps to the contact pads of a substrate (column 2, lines 4 to 20). Document D1 confirms that it is conventional to form gold ball

bumps (7) on the contact pads (13) of a chip (6) and to bond the chip with the bumps to the lead (12) of a substrate (column 7, line 61 to column 9, line 60 and figure 8).

However, according to D2 the formation of the gold ball bumps on the chip may damage the chip, increases costs and may prove difficult in cases where the chip is very small and thus hard to fix on the bonding tool. In this case it may be advantageous to deviate from the above conventional scheme and form the gold ball bumps on the substrate instead of the chip (column 7, lines 15 to 41).

2.2.2 The objective problem to be solved relative to D2, thus, is to select a suitable scheme from the above available two alternative mounting schemes.

To a skilled person working in the technical field of chip mounting, it would be obvious from document D2 to provide the gold ball bumps on the chip, and consequently to stick the resin sheet on the substrate, in cases where the above reasons for deviating from the above conventional scheme do not apply.

2.2.3 The appellant argued that providing the ball bumps on the chip had the advantage of reducing costs as the chips were typically supplied by a different manufacturer, as well as avoiding difficulties arising when ball bumping large printed circuit boards.

As to the cost argument, it is noted that the ball bumping costs are merely shifted to the chip manufacturer, and will obviously be reflected in the

cost of the chips. These considerations are self-evident to a person skilled in the art and can, therefore, not support inventive step.

As to the possible difficulties of ball bumping large printed circuit boards, it is noted that D2 suggests ball bumping the substrate rather than the chip for particular reasons. Clearly, where the size of the printed wiring board would be problematic, it would be obvious to the skilled person to adhere to the conventional scheme in which the chips are ball bumped.

2.2.4 Furthermore, the appellant argued that in the application the electronic component was fixed on the circuit board by the hardened thermosetting resin alone, whereas in D2 the electronic component was also fixed on the circuit board by a fusion bond between the gold ball bumps and the aluminium contact pads of the substrate.

Indeed, according to D2 the bonds between the gold ball bumps on the chip and the contact pads on the substrate provide an electrical connection between the chip and the substrate and at the same time provide a mechanical fixing between chip and substrate. An additional mechanical fixing between chip and substrate is provided by the embedded adhesive sheet (column 6, lines 37 to 56). This, however, is no different in the application. According to application description "*the IC chip 1 is fixed on the circuit board 4 by the hardened thermosetting resin 6s*" (cf eg page 30, lines 21 to 24). Moreover, the "*outflow thermosetting resin or thermosetting adhesive 6 becomes the encapsulation material (underfill) to remarkably*

improve the reliability of the bonding of the bumps 3 to the electrodes 5" (page 36, lines 21 to 24). Accordingly, also in the application fixing between the chip and the substrate is provided both by a bond between gold ball bumps and contact pads, and by the embedded adhesive resin. Furthermore, as expounded in D2, bonding between the materials of the ball bumps and the contact pads takes place under the influence of pressure and temperature (column 5, lines 11 to 17). As discussed above, comparable forces are applied during thermo-compression bonding in both D2 and the application. Furthermore, comparable temperatures are used.

Given that at least comparable materials, temperatures and forces are involved during the thermo-compression bonding process in both D2 and the application, unless special measures are adopted to avoid any bonding, in substance the same bonding occurring in D2 is bound to take place in the application. At no point in the application there is any indication that such bonding does not occur, let alone that any measures are taken to avoid the materials to bond.

2.2.5 Accordingly, the subject-matter of claim 1 of the main request is obvious to a person skilled in the art and thus lacks an inventive step in the sense of Article 56 EPC 1973.

The appellant's main request is, therefore, not allowable.

3. First auxiliary request

3.1 Claim 1 of the first auxiliary request, with respect to that of the main request, includes the additional feature that the heat is in the range of 140 ^{o}C to 230 ^{o}C.

In document D2 the temperature during the thermo-compression bonding in the embodiments is 320 ^{0}C (column 10, lines 15 to 22 and column 10, line 66 to column 11, line 6).

This further distinguishing feature is unconnected to the above distinguishing feature concerning the mounting scheme and is, thus, considered separately for the purposes of assessing inventive step.

Having regard to this feature, the partial objective technical problem to be solved relative to document D2 is to select an appropriate temperature for bonding the electronic component to the substrate.

3.2 In the above embodiments of D2 the substrate is either silicon or a ceramic and thus heat resistant. Document D2 notes, however, in the context of the gold ball bumping process that the conventional bonding temperatures of 300 to 450 ^{o}C are generally too high for temperature sensitive substrates such as FR-4 printed wiring boards (typically made of epoxy resin with glass cloth). These high temperatures degrade the mechanical and chemical characteristics of these printed wiring boards and in extreme cases result in the destruction of the printed wiring board. Suitable temperatures for

printed wiring boards lie between about 170 °C and 230 °C (column 4, lines 36 to 43).

It would, however, be obvious to the skilled person that not only during the above gold ball bumping process, but also during the subsequent thermo-compression bonding in which the chip is mounted on the printed wiring board, the temperature of the printed wiring board should not exceed the above temperature of 230 °C.

Hence, when mounting electronic components on such conventional printed wiring boards (as is also the case in the application (see page 29, lines 7 to 10)), the skilled person would select bonding temperatures not exceeding 230 °C, thereby arriving at bonding temperatures falling within the claimed range.

Although according to D2 bonding to low temperature substrates may be achieved by only heating the chip and relying on a relatively low thermal conduction to the substrate so as to avoid overheating it (column 5, lines 28 to 49), it would be readily apparent to the skilled person that for thermo-compression bonding in its simple form in which a uniform temperature is provided during bonding, the considerations above apply.

3.3 Accordingly, also the subject-matter of claim 1 according to the first auxiliary request is obvious to a person skilled in the art and thus lacks an inventive step in the sense of Article 56 EPC 1973.

The first auxiliary request is, therefore, not allowable either.

4. Second auxiliary request

Claim 1 of the second auxiliary request corresponds to claim 1 of the first auxiliary request with the sole addition that the solid thermosetting resin is insulative.

In document D2 the adhesive sheet (17) is electrically insulating (column 11, lines 27 to 35).

The subject-matter of claim 1 according to the second auxiliary request, thus, also lacks an inventive step in the sense of Article 56 EPC 1973.

The second auxiliary request is therefore not allowable either.

Order

For these reasons it is decided that:

The appeal is dismissed.

Registrar Chair

S. Sánchez Chiquero G. Eliasson