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**Datasheet for the decision
of 15 November 2007**

Case Number: T 1359/05 - 3.4.03

Application Number: 01119351.3

Publication Number: 1158579

IPC: H01L 21/60

Language of the proceedings: EN

Title of invention:

Wire bonding capillary for forming bump electrodes

Applicant:

MATSUSHITA ELECTRIC INDUSTRIAL CO., LTD

Opponent:

-

Headword:

-

Relevant legal provisions:

EPC Art. 56, 84, 76(1), 123(2)

Keyword:

"Clarity - main request (no)"

"Inventive step - auxiliary request (yes)"

Decisions cited:

-

Catchword:

-



Case Number: T 1359/05 - 3.4.03

D E C I S I O N
of the Technical Board of Appeal 3.4.03
of 15 November 2007

Appellant: MATSUSHITA ELECTRIC INDUSTRIAL CO., LTD
1006, Oaza Kadoma
Kadoma-shi, Osaka-fu (JP)

Representative: Eisenführ, Speiser & Partner
Patentanwälte Rechtsanwälte
Postfach 31 02 60
D-80102 München (DE)

Decision under appeal: Decision of the Examining Division of the
European Patent Office posted 28 April 2005
refusing European application No. 01119351.3
pursuant to Article 97(1) EPC.

Composition of the Board:

Chairman: V. L. P. Frank
Members: G. Eliasson
J. Van Moer

Summary of Facts and Submissions

I. This is an appeal by the appellant applicant against the refusal of European patent application 01 119 351.3 being a divisional application of 97 116 886.9 for lack of inventive step in view of the prior art documents

D1: US 4 974 767 A;

D2: US 4 323 759 A; and

D7: EP 0 320 244 A.

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

Main request:

Claim 1 filed with the letter dated 11 October 2007
Claims 2 to 4 filed with the letter dated 26 August 2005

Auxiliary request:

Claims 1 and 2 filed at the oral proceedings,

Description pages 1 to 17 filed at the oral proceedings,

Figures 1A to 6C filed at the oral proceedings.

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

"1. A method of forming a bump electrode on an IC electrode, comprising:
operating a bonding capillary (113), having a capillary hole with a chamfered portion at a discharge end thereof, at a ball bond forming position to form a ball bond portion (115) on an IC electrode (104) at the end of a wire (101);

moving the bonding capillary (113) upward with respect to the IC electrode (104);

moving the bonding capillary sideways and then downward with respect to the IC electrode (104);

bonding a wire (101) to the ball bond portion (115); and

cutting the wire (101);

wherein the wire (101) is prevented from coming in contact with portions around the ball bond portion (115) other than the ball bond portion (115) itself

characterized by setting a chamfer angle (107) of the chamfered portion of the capillary hole not greater than 90 degrees to make the ball bond portion (115) have a height greater than a diameter of the wire (101) and to make the ball bond portion (115) have the shape of a sloping upper surface, so that the outer radius portion (108) of the bonding capillary (113) can be

brought in uniform contact with said slope of the ball bond portion (115)."

IV. Claim 1 of the auxiliary request reads as follows:

"1. A method of forming a bump electrode on an IC electrode, comprising:

operating a bonding capillary (113), having a capillary hole with a chamfered portion at a discharge end thereof, at a ball bond forming position to form a ball bond portion (115) on an IC electrode (104) at the end of a wire (101);

moving the bonding capillary (113) upward with respect to the IC electrode (104);

moving the bonding capillary sideways and then downward with respect to the IC electrode (104);

bonding a wire (101) to the ball bond portion (115); and

cutting the wire (101);

wherein the wire (101) is prevented from coming in contact with portions around the ball bond portion (115) other than the ball bond portion (115) itself

characterized by setting a chamfer angle (107) of the chamfered portion of the capillary hole not greater than 90 degrees to make the ball bond

portion (115) have a height greater than a diameter of the wire (101),

setting the chamfer diameter (109) of the chamfered portion of the capillary hole at the discharge end thereof greater than the diameter of the ball bond, and

making a tip end portion of an outer radius portion (108) of the bonding capillary (113) have a tapered thickness for concentration of a cutting force in the wire cutting step,

to make the ball bond portion (115) have a sloping upper surface, so that the outer radius portion (108) of the bonding capillary (113) cuts the wire (101) at the sloping upper surface of the ball bond portion (115)."

V. The appellant applicant presented essentially the following arguments in support of the main request:

It was stated at paragraph 0071 of the application as published that "the outer radius portion of the bonding capillary 113 comes in uniform contact with the slope of the ball bond portion 11". This meant that an angle "A" defined between the upper sloping surface of the bump 115 and the side surface of the capillary 113 should be equal to an angle "B" defined between the lower sloping surface of the bump 115 and the lower surface of the capillary 113. In order to surely cut the wire between the upper sloping surface of the bump 115 and the side surface of the capillary 113, the side edge of the capillary 113 must be brought into uniform

contact with the upper sloping surface of the bump 115. Hence the term "uniform contact" in claim 1 of the main request was consistent with the invention as disclosed.

Reasons for the Decision

1. The appeal is admissible.

2. *Main request*

2.1 Claim 1 of the main request specifies the ball bond portion (115) to have the shape of a sloping upper surface, so that the outer radius portion (108) of the bonding capillary (113) can be brought in "uniform contact" with the sloping surface of the ball bond portion. The meaning of the term "uniform contact" is not defined in the application but is used in conjunction with Figure 1B (paragraph 0071 of the application as published), where it is described that:

"As shown in Figure 1B, by setting the angle of the outer radius portion so that the outer radius portion of the bonding capillary 113 comes in uniform contact with the slope of the ball bond portion 115, the effect of bringing the bonding capillary 113 in contact with the Au wire is improved, so that the Au wire 101 can be stably cut."

2.2 Figure 1B of the application illustrates the step where the bonding wire 101 is bonded to the ball bonding portion 115 by bringing the bonding capillary 113 in contact with the sloping upper surface of the ball

bonding portion. It is shown in Figure 1B how the tapered tip end of the bonding capillary 113 cuts into the bonding wire 101 to reach into the underlying ball bonding portion 115. Thus, the pointed contact between the bonding capillary and the ball bonding portion illustrated in Figure 1B is anything but "uniform", as the expression "uniform contact" would suggest a contact with little fluctuations or variations (compare the expressions "uniform motion" and "uniform distribution" commonly used in physical sciences). Hence, the skilled person reading the application would be at loss as to how to interpret "uniform contact" in claim 1 of the main request.

- 2.3 The explanation given by the appellant applicant as to how the term "uniform contact" should be interpreted (see item V above) is firstly based on assertions which have no basis in the application as filed and secondly does not address the issue that Figure 1B illustrates a pointed contact which would be the opposite to what the skilled person would associate with the adjective "uniform".

For the above reasons, in the board's judgement, claim 1 of the main request is not clear contrary to the requirements of Article 84 EPC.

3. *Auxiliary request*

3.1 *Amendments*

3.1.1 Claim 1 of the auxiliary request is based on claims 1 to 3 as originally filed in combination with the disclosure on paragraphs 0057, 0058, 0067, 0069, and 0070 of the application as published.

3.1.2 With respect to the earlier application 97 116 886.9 from which the present application is a divisional application, claim 1 of the auxiliary request is based on a combination of independent claims 2 to 4 as originally filed and the disclosure in conjunction with Figure 2 showing an embodiment having all features of independent claims 2 to 4 (see column 13, line 38 to column 14, line 14 of the earlier application published as EP 0 834 919 A).

3.1.3 Therefore, in the board's judgement, claim 1 of the auxiliary request complies with Articles 76(1) and 123(2) EPC.

3.2 *Clarity*

3.2.1 The term "uniform contact" objected to in the main request has been replaced by a series of features (a sloping upper surface of the ball bond portion and a tapered thickness of the tip end of the outer radius portion of the bonding capillary), which together have the effect of concentrating the cutting force in the step of cutting the bonding wire. This is consistent with the disclosure in conjunction with Figure 1B.

Therefore, in the board's judgement, claim 1 of the auxiliary request complies with the requirements of Article 84 EPC.

3.3 *Novelty and inventive step*

3.3.1 Document D7 is considered the closest prior art and discloses a method of forming a bump electrode on an IC electrode comprising the following steps (see Figures 5a to 5g, column 6, line 54 to column 8, line 38):

- forming a bump bond portion 7 on an IC electrode (2) at the end of a wire 5 by a wire bonding apparatus having a bonding capillary 3 being positioned above said IC electrode, wherein the bonding capillary 3 is positioned in a ball bond forming position (Figure 5c, column 7, lines 37 to 48);
- moving the bonding capillary 3 sideways and then downward with respect to the IC electrode (Figures 5d and 5e, column 7, line 49 to column 8, line 15);
- bonding the wire to the ball bond portion (Figure 5f, column 8, lines 29 to 33); and
- cutting the wire (Figure 5g, column 8, lines 34 to 38).

3.3.2 The subject matter of claim 1 of the auxiliary request differs from the method of document D7 in that

- (a) the chamfer angle (107) of the chamfered portion of the capillary hole is not greater than 90 degrees to make the ball bond portion (115) have a height greater than the diameter of the wire (101), whereas document D7 does not disclose any value of the chamfer angle;
- (b) the chamfer diameter (109) of the chamfered portion of the capillary hole at the discharge end is set to be greater than the diameter of the ball bond to make the ball bond portion (115) have a sloping upper surface, whereas in the method of document D7, the chamfer diameter of the chamfered portion is smaller than the diameter of the ball bond in order to make a stepped ball bond portion;
- (c) the tip end portion of an outer radius portion (108) of the bonding capillary (113) is made to have a tapered thickness for concentration of a cutting force in the wire cutting step, so that the outer radius portion (108) of the bonding capillary (113) cuts the wire (101) at the sloping upper surface of the ball bond portion (115), whereas in document D7, the bond wire is bonded on a horizontal stepped surface of the ball bond portion and the wire is not cut by the bonding capillary but severed by pulling the capillary and the wire up after that the wire has been bonded to the ball bond portion (D7, Figure 5g; column 8, lines 34 to 38).

3.3.3 The above features (a) to (c) together contribute to making it possible to cut the wire using the periphery of the bonding capillary after that the wire has been bonded to the sloping upper surface of the ball bond portion, whereas in the prior art system, the wire is torn off by pulling the wire upwards (see D7, Figure 5(g); column 8, lines 34 to 38). This has the effect of reliably preventing the wire from contacting portions other than the ball bond portion itself, in particular the electrode 104 (see application as published, paragraphs 0070 and 0075).

3.3.4 As none of the available prior art documents suggests to cut the bonding wire using the bonding capillary, the board comes to the conclusion that a skilled person faced with the task of improving the method of document D7 would find no suggestion from the available prior art which would lead to the claimed invention.

3.3.5 For the above reasons, in the board's judgement, the subject matter of claim 1 of the auxiliary request involves an inventive step within the meaning of Article 56 EPC.

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 with the following documents:
 1. Claims 1 and 2 (Auxiliary Request)
 2. Description pages 1 to 17
 3. Figures 1A to 6C

Registrar

Chair

S. Sánchez Chiquero

V. L. P. Frank