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D E C I S I O N
of 30 October 2001

Case Number: T 0840/97 - 3.4.3

Application Number: 90122397.4

Publication Number: 0430095

IPC: H01L 21/66

Language of the proceedings: EN

Title of invention:

Inner lead bonding inspecting method and inspection apparatus therefor

Applicant:

KABUSHIKI KAISHA TOSHIBA

Opponent:

-

Headword:

-

Relevant legal provisions:

EPC Art. 123(2), 84, 54, 56

Keyword:

"Additional subject-matter (no)"
"Clarity (yes)"
"Novelty (yes)"
"Inventive step (yes)"

Decisions cited:

-

Catchword:

-



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Boards of Appeal

Chambres de recours

Case Number: T 0840/97 - 3.4.3

D E C I S I O N
of the Technical Board of Appeal 3.4.3
of 30 October 2001

Appellant: KABUSHIKI KAISHA TOSHIBA
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Decision under appeal: Decision of the Examining Division of the
European Patent Office posted 18 March 1997
refusing European patent application
No. 90 122 397.4 pursuant to Article 97(1) EPC.

Composition of the Board:

Chairman: R. K. Shukla
Members: M. Chomentowski
M. Vogel

Summary of Facts and Submissions

1. European patent application No. 90 122 397.4 (Publication No. 0 430 095) was refused by a decision of the examining division dated 18 March 1997. The ground for the refusal was that the claims lacked clarity, contrary to the requirement of Article 84 EPC.

Moreover, the decision contained objections of lack of novelty of claim 5 (apparatus) having regard to document

D2: Patent Abstracts of Japan, vol. 1, No. 63, (E-025), 20 June 1977, & JP-A-52 003 487,

of lack of inventive step of claim 1 (method) having regard to document D2

and also of lack of inventive step both claims having regard to documents D2 and

D3: US-A-4 876 455.

- II. Claims 1 and 5 are the only independent claims of the set of five claims forming the basis of the decision of the examining division, and they read as follows:

"1. An inner lead bonding inspection method

characterized by

- irradiating an illumination light onto a surface of a region including a bonding portion between an inner lead and an electrode bump, said bonding portion being provided on a semiconductor pellet,

- obtaining an image of said region, recognizing the bonding portion and detecting the position of the bonding portion,
- opening a window in an upper surface of the bonding portion in said region,
- measuring the quantity of reflected light from the window,
- judging whether the bonding state of the inner lead bonding is good or bad by comparing the measured quantity of reflected light with a reference level."

"5. An inner lead bonding inspection apparatus

characterized by comprising:

- irradiation means (12) for irradiating an illumination light onto a surface of a region including a bonding portion between an inner lead and an electrode bump, said bonding portions being provided on a semiconductor pellet,
- means (13) for obtaining an image of said region,
- means (15) for recognizing the position of the bonding portion, for opening a window in an upper surface of the recognized bonding portion and for measuring the quantity of reflected light from the window, and
- means (51) for judging whether the bonding state of the inner lead bonding is good or bad by comparing the measured quantity of reflected light with a reference

level."

III. The reasoning of the examining division can be summarized as follows:

Clarity

In the inner lead bonding inspection method of claim 1, the feature that a window is opened in the upper surface of the bonding portion is ambiguous and may in particular be interpreted in a number of ways, for instance as meaning that a window is opened in the inner lead bonding itself, by removing a part thereof, e.g. by etching, or that a restricted area is selected in the image of the illuminated region for subsequent reflected light measurement. Since the claim has to be clear "per se", the applicant's arguments referring to the description and stressing that it is in the image of the region of the bonding portion that a window is opened are not found convincing; moreover, the disclosure in the description is unclear in this respect and can be interpreted to be consistent with opening a window in the image or with opening a window in the bonding portion.

The same objection applies to claim 5.

Therefore, the claims lack clarity.

Patentability

Moreover, following the applicant's interpretation of "opening a window", i.e., opening a window in the image obtained by irradiating an illumination light onto a surface of a region including a bonding portion between

an inner lead and an electrode bump, claims 1 and 5 are not patentable having regard to the cited prior art documents:

Document D2 describes a method of inspecting the quality of a bond by irradiating a laser onto a bonding portion and measuring the quantity of light reflected from the bond. The diffraction pattern detected at photodetecting tube (13) constitutes an image. It is implicit that the quantity of the measured light is compared to a reference level in order to decide whether the bond is judged to be good or bad. Furthermore, it is implicit that an alignment step is performed in order to place the bonding portion to be inspected in line with the laser beam. Furthermore, since any laser beam has a finite size, the region on the bonding portion from which the beam is reflected will, correspondingly, have a finite area and will, in this sense, represent a "window". In this respect, the second to fifth (final) feature of claim 1, and the corresponding ones in claim 5, can be read into document D2.

With respect to the nature of the bonding portion itself, an inner lead/electrode bump bond cannot be unambiguously derived from the English abstract of document D2 and the figures; however, the application of the laser irradiation of document D2 to such a bond is trivial. In any case, the irradiating means of document D2 is clearly suitable for illumination an inner lead/electrode bump bond and is, as such, undistinguishable from the irradiation means defined in claims 1 and 5.

Hence, the subject-matter of claim 5 lacks novelty and

that of claim 1 lacks an inventive step.

Furthermore, document D3 discloses a solder joint inspection method and apparatus, wherein light is irradiated onto a bonding portion, light reflected from said bonding portion is detected by a camera and the bond judged to be good or bad according to the reflected light received; it is mentioned that an image of the region including the bonding portion is obtained and the position of the bonding portion is detected. Furthermore, the entire bonding portion is illuminated and an image of the entire bonding portion is captured in the camera; however, only light reflected from selected areas is received and measured. these selected areas may be regarded as "windows".

Whilst the bonding portion in document D3 is not explicitly between an inner lead and electrode bump provided on a semiconductor pellet, this technique is clearly also applicable to a bond on a pellet and this difference is trivial. Furthermore, while document D3 employs the bond surface profile as the criterium for assessing bond quality, document D2 assesses the bond quality according to quantity of light reflected from the bond. The replacement of the sophisticated criterion of bond surface profile of document D3 by the simpler criterion of document D2 is regarded as an obvious measure, the skilled person being free to select the criterion to be employed in accordance with the extent of bond quality information required without resorting to inventive merit.

Indeed, point sources are used in document D3; however, the entire solder joint is illuminated by any given point light source. Moreover, those light rays

reflected towards the camera will produce a pattern corresponding to unit areas on the solder surface having a given orientation, so that each unit area may be considered to be a window within the illuminated solder joint.

Therefore, the subject-matter of the claim 5, but also the subject-matter of claim 1 lacks an inventive step having regard to documents D3 and D2.

IV. The appellant (applicant) lodged an appeal against the decision on 20 May 1997 paying the appeal fee on the same day, and filed a statement setting out the grounds of appeal on 18 July 1997.

V. In response to a communication of the Board, the appellant filed with a letter dated 19 September 2001 new claims 1 and 5 together with pages 2, 6, 9 and 10 of the description, and requested that the decision under appeal be set aside and that a patent be granted on the basis of the following patent application documents:

Description: Pages 1, 3 to 5 , 7 and 8 as filed;
Pages 2, 6, 9 and 10 filed with letter dated 19 September 2001;

Claims: Nos. 1 and 5 filed with letter dated 19 September 2001;
Nos. 2 to 4 as filed with applicant's letter dated 2 December 1995;

Drawings: Sheets 1/3 to 3/3 as filed.

VI. Claims 1 and 5 are the only independent claims of the

appellant's request, and they read as follows:

"1. An inner lead bonding inspection method

characterized by

- irradiating an illumination light onto a surface of a region including a bonding portion between an inner lead and an electrode bump, said bonding portion **having a planar upper surface and** being provided on a semiconductor pellet,

- obtaining an image of said region, recognizing the bonding portion and detecting the position of the bonding portion,

- opening a window in **said image of said planar** upper surface of the bonding portion in said region,

- measuring the quantity of reflected light **within** said window,

- judging whether the bonding state of the inner lead bonding is good or bad by comparing the measured quantity of reflected light with a reference level."

"5. An inner lead bonding inspection apparatus

characterized by comprising:

- irradiation means (12) for irradiating an illumination light onto a surface of a region including a bonding portion between an inner lead and an electrode bump, said bonding portion **having a planar**

upper surface and being provided on a semiconductor pellet,

- means (13) for obtaining an image of said region,

- means (15) for recognizing the position of the bonding portion, for opening a window in **said image of said planar** upper surface of the recognized bonding portion and for measuring the quantity of reflected light **within** said window, and

- means (51) for judging whether the bonding state of the inner lead bonding is good or bad by comparing the measured quantity of reflected light with a reference level."

(Emphasis added by the Board to the amendments distinguishing in substance the appellant's request from the claims forming the basis of the decision under appeal).

VII. The appellant submitted essentially the following arguments in support of his request:

Clarity

The wording of the claims has been amended to clarify the meaning of the expression "opening a window". As disclosed in page 6, lines 22 to 36 of the description, this expression does definitely not refer to any structural modifications performed by etching; Figures 4 and 5 are mentioned as showing an image of the inner lead. Thus, the only reasonable interpretation of the claimed technique is such that "opening a window" refers to a restricted area in the

image of the illuminated region for subsequent reflected light measurement therein. Since the invention is disclosed as relating to an inner lead bonding inspection technique, an interpretation of "opening a window" whereby a portion of an upper surface of the bonding portion is removed is not only contradictory to the description and the purpose of the invention, but also to the preamble of claims 1 and 5.

Patentability

The expression "opening a window" refers to a restricted area in the image of the illuminated region, i.e. choosing a limited area of a larger image taken from the bonding contact. This is not suggested for the highly focussed laser beam used in the technique of document D2, and this may not be even possible. Thus, providing a bonding inspection technique whereby a large region including the bonding portion is irradiated and an image therefrom is obtained, and subsequently selecting a limited area ("window") within this image, is novel and inventive over the technique known from document D2.

In the technique of document D3, a fiber optic solder joint inspection system determines the quality of a specularly soldered joint. This is done by examining the shape of the joint surface using a series of point light sources and the associated highlight reflection from the joint surface. The light from the point light sources reflected from the solder joint is detected by a camera, and the bond quality is determined according to the received reflected light. Only light reflected from preselected areas (unit areas) is received and measured. Receiving light reflected from preselected

areas cannot be considered as providing a window in an image, since such unit areas are simply parts for reconstructing the entire solder joint surface. In contrast, in the present invention, the light intensity information obtained in the "window" represents the bonding quality of the bonding portion. Furthermore, in document D3, the quality of the bonding joint is judged depending on the appearance of the whole shape of the bond contract. In contrast thereto, the bonding inspection technique of the present invention is based on taking an image of the whole bonding portion and subsequently performing the judgement whether a contact is good or bad by measuring light intensity within a smaller area ("window"). This approach is however neither suggested nor obvious from document D3, which suggests to proceed in an opposite way.

Reasons for the decision

1. The appeal is admissible.
2. *Admissibility of the amendments*

The independent claims 1 and 5 result from amendments to the original independent claims 1 and 4 which are based on the application as filed (see page 6, lines 27 to 36; see also page 9, lines 1 to 17 and Figure 10) specifying that brightness is measured, in particular by the measurement device (15), in a predetermined region (20) encompassed by single dotted lines on the inner lead surface at the bonding portion from the above-mentioned images shown in Figures 4 and 5 and that, to realize this, in Figures 4 and 5, it is preferable to open a window (21) in the predetermined

region (20) to measure brightness only in that portion.

Moreover, according to the application as filed (see page 2, lines 18 to 36; claims 1 and 4; see also Figures 1, 4, 5, 8 and 9), in the disclosed technique, an illumination light is irradiated onto a planar or approximately planar surface of a bonding portion between an inner lead and an electrode bump.

The further amendments are for consistency with these amendments in claims 1 and 5.

Therefore, the application satisfies the requirement of Article 123(2) EPC that a European patent application may not be amended in such a way that it contains subject-matter which extends beyond the content the application as filed.

3. *Clarity*

The independent claims 1 and 5 now specify that brightness is measured in an image of the planar upper surface of the bonding portion in a region of a semiconductor pellet, said region including a bonding portion between an inner lead and an electrode bump. In this image, a window is opened and the quantity of light reflected therein is measured. Therefore, in claims 1 and 5, there is no ambiguity about the location of the window and thus about the location, where the reflected light is measured, i.e., in a restricted part of the image. This is in accordance with the information from Figures 4 and 5 and the corresponding text, that the predetermined region (20) shown is encompassed by single dotted lines on the inner lead surface at the bonding portion imaged as

images and that a window (21) is opened in the predetermined region (20) to measure brightness only in that portion. Taking into account that there is thus a single, unambiguous meaning of the term "image" of the claims, that following the further amendments the claims 1 and 5 define correctly the matter to be protected and that these claims are consistent with the description and drawings, the Board is satisfied that the claims are clear in the sense of Article 84 EPC.

4. *Novelty*

4.1 A method of testing for inspecting the bonding quality of a bond is known from document D2 (see the abstract); in this method, illumination light from a laser (9) is irradiated onto the surface of a sample (12) to be connected, the reflected diffraction pattern is received by a photodetecting tube (13) for recording on a recorder (14) annexed thereto; and the intensity of the reflect diffraction pattern is measured to judge the bonding quality.

However, as convincingly argued by the appellant, in the known method, after obtaining an image of the region including a bonding portion, (i) there is no step of recognizing the bonding portion and detecting the position of the bonding portion, and (ii) there is no step wherein a window is opened in said image of an upper surface of the bonding portion in the region, i.e., wherein a window corresponding to a limited area within the region shown in the image is opened, and wherein it is with respect to this limited area that the succeeding method steps of measuring and judging are executed.

The apparatus known from document D2 does not in particular comprise means related to a step of opening a window in an image of an upper surface of a bonding portion in said region and further working in relation therewith.

Therefore, present claims 1 and 5 are distinguished over the method and apparatus known from document D2.

- 4.2 An automated solder joint inspection method is known from document D3 (see column 2, line 53 to column 3, line 2; see also Figures 1A to 1C, 3, 4 and 7A to 7D). The method determines the quality of a specular soldered joint by examination of the shape of the joint surface using illumination by a series of point light sources generated through optical fibers (38) and the associated highlight reflections from the joint surface. The light is reflected in a pattern from the solder joint to an array of light responsive transducers, such as a camera (26), at a fixed location. Utilizing the intensity values from the light responsive transducer array, a binary grid map is generated and using known surface features of solder joints along with curves fitting techniques, a series of grid maps are mathematically interpreted to reconstruct the solder joint surface. A rule-based system, through comparison with acceptable solder joint surface features, evaluates and classifies the joint for an acceptability determination.

However, in said known method, there is in particular no method step of opening a window in the image of a region of an upper surface of the bonding portion and measuring the quantity of reflected light within said window.

It has been argued in the decision under appeal that, in document D3 (see column 6, lines 15 to 20), it is specified that although the image captured by the camera (26) is that of the entire solder joint and any given point light source illuminates the entire solder joint, only light rays reflected from the solder joint toward the camera (26) lens will generate highlights and excite the transducers.

However, in the present application, opening of the window is done in the image itself, whereby said window corresponds to a limited area of a broader region shown in the image, and it is with respect of this limited area that the succeeding method steps of measuring and judging are executed. In the system of document D3, on the contrary, only light rays reflected from the solder joint toward the camera (26) lens generate highlights and excite the transducers. This step, therefore, corresponds to the method step of forming the image, and not to the method step of selecting a limited part of said image.

4.3 Therefore, since the further prior art documents are less relevant, the subject-matter of the claims 1 and 5 does not form part of the state of the art and is thus new in the sense of Article 54 EPC.

5. *Inventive step*

As convincingly argued by the appellant, the technique of document D2, using a focussed laser beam, is primarily not adapted for providing an image wherein a window, i.e. a restricted part of the image, is to be chosen for measurement of the intensity of the reflected light.

As further convincingly argued by the appellant, the technique of document D3, using illumination by a series of point light sources generated through optical fibers (38) and the associated highlight reflections from the joint surface, the light being reflected in a pattern from the solder joint to an array of light responsive transducers, such as a camera (26), at a fixed location, is also not adapted for providing an image wherein a window, i.e. a restricted part of the image, is to be chosen for measurement of the intensity of the reflected light. In any case, there is no indication for such a selection of a restricted area of an "image".

The further prior art documents are less relevant.

It is also to be noted that, since document D3 is concerned with testing solder joints, and not inner lead bonding, and since the test is done by identifying the shape of the solder meniscus and comparing it to known solder meniscus shapes, it cannot be considered as a relevant starting point for the invention as defined in claims 1 and 5, wherein in particular only a quantity of reflected light is taken out from an restricted part of the image of the bonding portion.

Therefore, to the skilled person, the subject-matter of claim 1 is not obvious having regard to the state of the art, and, thus, it involves an inventive step in the sense of Article 56 EPC.

Moreover, the subject-matter of claim 5 defines the same invention in terms of an apparatus and, since the arrangement of the means is closely related to the method and since as set forth here above these means

are not obvious having regard to the state of the art, this subject-matter also involves an inventive step.

Consequently, a patent can be granted on this basis (Art. 97(2) EPC).

6. Therefore, oral proceedings, requested auxiliarily, were not necessary.

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 on the basis of the following patent application documents:

Description: Pages 1, 3 to 5 , 7 and 8 as filed;
Pages 2, 6, 9 and 10 filed with letter dated 19 September 2001;

Claims: Nos. 1 and 5 filed with letter dated 19 September 2001;
Nos. 2 to 4 as filed with applicant's letter dated 2 December 1995;

Drawings: Sheets 1/3 to 3/3 as filed.

The Registrar:

The Chairman:

D. Spigarelli

R. K. Shukla