

DESCRIPTION

Title of the Invention

Apparatus for Measuring Height of Bonding Wire

Detailed Description of the Invention

Applicable Industrial Field

The present invention relates to an apparatus for measuring heights of bonding wires which connect an IC chip to lead frames.

Prior Art

Conventionally, in the technical field of this type, there has been known a so-called wire bonding which connects lead frames connected to external electrodes to an IC chip bonded on a lead frame with an adhesive, as shown in Fig. 3. Such wire bonding has been inspected as follows: namely, at the time of the trial step before production, bonding wires have been connected to lead frames by a wire bonding apparatus used in an actual production line, and the bonding state has been visually inspected using a loupe, microscope or the like.

In general, the height and the presence or absence of defects such as deformation of each of the trial bonding wires have been visually estimated, and at the time when it

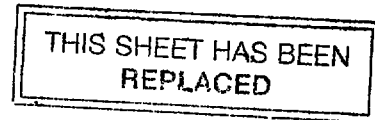
has been decided that wire bonding can be suitably performed even in the actual production line, the wire bonding has been started to be performed in the actual production line.

Problem to be Solved by the Invention

The method of visually inspecting a bonding state after connection of bonding wires is basically intended to observe the size of a ball, as a fused portion to each bonding wire, shape of crescent, and a gap between adjacent bonding wires in a plan view, and therefore, such a method is difficult to visually inspect in three-dimensions whether or not the height of each bonding wire is acceptable in the order of several ten μm .

If the connected bonding wires are improper in shape or gap, there occur problems that upon the next sealing/molding step, the bonding wires may be jumped from a resin sealing portion or deformed, to be entangled and short-circuited to each other, or to be brought in contact with an IC chip 6, thereby causing failures.

To solve the problems of the above-described prior art, the present invention has been made, and an object is to provide an apparatus for measuring a height of a bonding wire, which is capable of measuring the height of a bonding wire for connecting an IC chip to a lead frame, thereby



selecting defective parts.

Means for Solving the Problem

To achieve the above object, according to the present invention, a laser light generator having a laser focus mechanism is provided at a position over a bonding wire to be measured, and the height of the bonding wire is calculated on the basis of laser light which has been outputted from the laser light generator, reflected from the bonding wire to be measured, and received.

Function

With this configuration of the present invention, since laser light reflected from the plane of an IC chip can be received, it is possible to suitably measure and calculate a height of each of bonding wires over the plane of the IC chip and a gap (a portion with no height can be regarded as a gap) between the adjacent bonding wires.

Brief Description of the Drawings

Fig. 1(a) is a perspective view showing the measurement of the height of a wire bonding, and Fig. 1(b) is a view illustrating the height measurement using laser light;

Fig. 2 is a block diagram of an apparatus for

measuring the height of a bonding wire according to the present invention; and

Fig. 3 is a plan view showing a wire bonding state according to a prior art.

Embodiment

An embodiment of an apparatus for measuring the height of a bonding wire will be described with reference to Figs. 1(a) and 1(b) and Fig. 2.

Figs. 1(a) and 1(b) and Fig. 2 show the structure and the function of the embodiment, respectively.

First, the configuration of the embodiment will be described. In Fig. 1(a), reference numeral 21 denotes an apparatus for measuring the height of a bonding wire; 22 is a laser light generator; 23 is an IC chip; 24 is a lead frame; and 25 is a bonding wire. Laser light 22k is outputted from the laser light generator 22.

Fig. 1(b) shows the inside of a measuring unit 28 for receiving the laser light 22k having been outputted from the laser generator 22 and reflected from an object to be measured, and measuring the height of a bonding wire on the basis of the received laser light 22k.

In Fig. 1(b), reference numeral 22a denotes a semiconductor laser; 22b and 22c are half mirrors A and B, respectively; 22d is a light receiving element; 22e is a

pin hole; 22f is a collimator lens; 22g is an objective lens; 22h is a laser focus mechanism for driving the objective lens 22g such that a spot 22p of the laser light 22k vertically moves in accordance with the height of an object to be measured; 22n is a CCD camera for receiving the laser light 22k focused at the spot 22p and transmitting it to an arithmetic unit 29. Such a mechanism constitutes the measuring unit 28.

The laser generator, 22 and the measuring unit 28 are integrally mounted on an X-Y table (not shown), and they constitute the apparatus 21 for measuring the height of a bonding wire, which apparatus is to be driven over the bonding wires 25 mounted on a jig under the laser generator 22.

Next, the function of the apparatus 21 for measuring the height of a bonding wire will be described with reference to Fig. 2.

An X-Y table 26 on which the laser light generator 22 and the measuring unit 28 are integrally mounted is driven on the basis of a command about a passing track along the peripheral edge portion of the IC chip 23, a running speed, and the like supplied from a control unit 27. The passing track may be set such that the X-Y table 26 moves any times around the periphery edge portion of the IC chip 23 or moves along a curved track depending on the

height relationship between the IC chip 23 and the lead frames 24. In any case, the passing track is controlled such that the X-Y table 26 passes through main portions from which the heights of the bonding wires 25 based on a virtual plane of the IC chip 23 can be measured.

In linkage with the drive of the X-Y table 26, four outputs (laser ON, hold, offset, peak set) from the laser light generator 22a and an analog output from the laser focus mechanism 22h are transmitted to the measuring unit 28. These outputs are matched with coordinate data transmitted from the control unit 27, to be then transmitted to the arithmetic unit 29.

The data processed in the arithmetic unit 29 are displayed, as shown by an output display example 29a, in the form of positions of the bonding wires 25 (or gaps each between the adjacent bonding wires 25), the peak hold of the height, numerical data, and the like. The arithmetic unit 29 feeds back part of the processed data to the control unit 27 which in turn transmits a command for repeating the measuring action to the X-Y table 26.

The arithmetic unit 29 is, of course, allowed to judge the acceptability of the measured data on the basis of standard values inputted therein and to output a command, for example, "rejection" for the defective product.

The laser focus mechanism 22h will be described

below. As shown in Fig. 1(b), the laser light 22k outputted from the semiconductor laser 22a forms the spot 22p on the surface of the IC chip 23 to be measured, being reflected therefrom, and is returned to the light receiving element (note: the laser light is shown by the solid line).

Next, when the laser light 22k forms the spot 22p on the bonding wire 25 and reflected therefrom, the reflected light is not returned to the light receiving element 22d because the position of the spot 22p is higher than the surface of the IC chip 23. In this case, the laser focus mechanism 22h drives the objective lens 22g such that the reflected light of the spot 22p (note: the laser light is shown by the broken line) passes through the pin hole 22e and is returned to the light receiving element. Accordingly, the driven amount of the objective lens 22g is used for measurement as a value indicating the height of the bonding wire.

The above-described embodiment was confirmed by an experiment performed under the following setting conditions. As a result, very accurately measured values were obtained.

In Regard To Laser Light Generator:

- * diameter of laser spot: $\Phi 2.0 \mu\text{m}$
- * measurement range: $\pm 0.3 \text{ mm}$
- * operating distance: 5 mm
- * response time: 2.2 ms

In Regard To Measurement:

- * drive speed of X-Y table: 3-5 mm/s
- * display = peak, peak hold, digital data

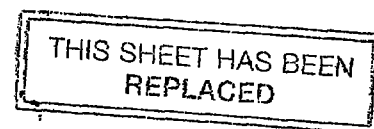
Standard Value (height of bonding wire: μm)

- * $200 \pm 5\%$

Effect of the Invention

By use of an apparatus for measuring the height of a bonding wire according to the present invention, it is possible to immediately confirm whether or not the height of each bonding wire and a gap between the adjacent bonding wires are within respective suitable ranges.

Such judgement of acceptability is effective to prevent a defective component from being supplied to the next step, and to take early measures in collation with a data base regarding causes of failure. As a result, it is possible to reduce the percent defective.



Claims

1. An apparatus for measuring the height of a bonding wire in a structure in which bonding wires fused to the upper surface of an IC chip extend upward, being curved mountainously, and extend downward to the surfaces of lead frames, characterized in that

a laser light generator having a laser focus mechanism is provided at a position over said bonding wire to be measured in order to measure the height of said bonding wire; and said apparatus receives laser light which has been outputted from said laser light generator and reflected from said bonding wire to be measured, and calculates the height of said bonding wire on the basis of the laser light thus received.

2. An apparatus for measuring the height of a bonding wire according to claim 1, wherein at least three corner portions of the upper surface of said IC chip are measured on the basis of the laser light reflected therefrom and received by said apparatus, to thereby calculate a virtual plane of said IC chip; and

said X-Y table is driven such that the laser light moves along the outer periphery of said IC chip.

3. An apparatus for measuring the height of a bonding wire according to claim 1 or 2, wherein said



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apparatus is provided with a control unit for supplying commands regarding the operational function of said X-Y table and coordinate data to the associated units, a measuring unit for comparing an analog output based on the laser focus amount with the coordinate data, and an arithmetic unit having arithmetic and display functions.

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