

"WIRE BONDING APPARATUS"

The present invention relates to a wire bonding apparatus and, more particularly, to a system of moving a field of view of a recognition unit used in the wire bonding apparatus.

5           As shown in Figure 1, in a conventional wire bonding apparatus by using pattern recognition, in fabricating a semiconductor device such as an IC, a so-called wire bonding step is included in which electrodes (first bonding positions, pads) of a circuit  
10 element 1 of a semiconductor device pellet and the tips of leads 3 extending around the pellet 1 are connected by means of wires 5 such as gold wires and aluminum wires, through the wire bonding work. The bonding positions of those are previously set as reference  
15 positions. As a practical matter, however, the bonding positions are generally different from the reference positions due to the accuracy of mounting of the pellet 1 and the leads 3. Therefore, it is necessary to correct the bonding positions by measuring an amount  
20 of the displacement of the bonding positions from the reference ones. As one of the measuring methods, it has been proposed automatically to measure the amount of the displacement by a pattern recognition technology using an artificial visual sensing means such as a  
25 television camera.

For obtaining the respective positions of the bonding pads 2 on a pellet 1 displaced from the reference positions, a single or a plurality of recognition marks is placed within a field of view of an industrial television camera (ITV) and an amount of the displacement of the recognition mark from the reference position is automatically recognized thereby to correct the positions of the respective pads 2. This method is similarly applied for the measurement of the displacement of the leads. Accordingly, the description will proceed about the measurement of the pellet side alone. In this method, however, the position of the field of view of the ITV is fixed. Therefore, when the displacement of the bonding positions is large, it can not place the recognition mark within the field of view.

This will be described in more detail referring to Figure 2. In the figure, reference numeral 1 designates a pellet; 6 a pellet recognition mark, 7 a reference position of the field of view of the camera; 1' and 6' the displaced positions, i.e. the real positions, of the pellet and the pellet recognition marks; 8 an origin of the field of view.

In order to recognize the displacement of the bonding position correctly by using the conventional fixed view method, it is necessary to set the accuracy of the mounting of the pellet 1' within a fixed value

to prevent the pellet from being out of the field of view. In the case of the resin sealing package device in which the pellet is mounted on a metal frame through Au-Si eutectic alloy, the accuracy of the pellet mounting is controllable relatively easily. However, in the case of the glass sealing package device in which the pellet is mounted on a ceramic through a low melting point glass, it is very difficult to control the pellet mounting accuracy. This difficulty is always a problem in attempting fully to automate the wire bonding of the glass sealed element. The difficulty in controlling pellet mounting accuracy is particularly noticeable in the case of dual-in-line glass (referred to as DILG) sealing devices in which the pellet is mounted on a ceramic substrate through low-melting point glass. Therefore, this is always a problem in attempting to automate the recognition step in the wire bonding of the DILG sealing device.

With the view of eliminating the above-mentioned problems of the prior art, the present invention has as an object to provide a wire bonding apparatus allowing a good wire bonding.

According to the present invention there is provided a wire bonding apparatus for wire bonding a first group of bonding positions disposed on a first member with a second group of associates bonding positions disposed on a second member, one of said

first and second members having at least one recognition mark, the apparatus comprising: a recognition means having a field of view for detecting a presence of the recognition mark in the field of view and for identifying a position of the detected recognition mark in the field of view; means for successively moving the field of view of said recognition means in a predetermined manner when the recognition mark is not detected until such time the recognition mark falls within the field of view, and means for computing the positions of said bonding positions based on a detected position of the recognition mark in the control of the bonding apparatus to achieve a wire bonding. A preferred aspect of the invention provides a wire bonding apparatus for automatically wire bonding semiconductor devices loaded on a movable table, the apparatus comprising: an opto-electrical camera means having a field of view for viewing a recognition mark on a semiconductor device; a recognition means for detecting and recognizing a location of an image captured in the field of view of the camera means; position correction computing means for computing a location of the image in dependence upon a result of recognition supplied from said recognition means; and control means for judging a result of a computation supplied from the position correction computing means and, when a recognition mark is not detected in the field of

view, causing the field of view to move in a predetermined manner until such time the recognition mark falls within the field of view and controlling the bonding apparatus to achieve a wire bonding following recognition of the  
5 recognition mark in the field of view.

Preferably the control means moves the field of view successively in a series of steps when a recognition mark is not detected in the field of view. Preferably also the semiconductor device includes at least two  
10 recognition marks which are disposed at relatively fixed positions, and wherein said control means, after a first of the recognition marks has been detected, is adapted to move the field of view in dependence upon the result of the detection of the first recognition mark.

15 The present invention will be further apparent from the following description taken in connection with the accompanying drawings, in which:

Fig. 1 is a plan view, illustrating a part of an arrangement of a pellet and leads in assembling a  
20 semiconductor device;

Fig. 2 is a plan view for illustrating a situation where a recognition mark can not be recognized when a conventional technique is used for fabricating the semiconductor device;

25 Figs. 3a and 3b are a plan view and a cross sectional view taken along line IIIb-IIIb of Fig. 3a

of a semiconductor device as an object to be bonded by the DILG sealing method to which the present invention is preferably applicable;

Figs. 4 and 5 are plan views illustrating examples of a method for moving a field of view according to the invention; and

Fig. 6 is a block diagram of a view control system for a fully automated wire bonder to which the present invention is incorporated.

Referring to the drawings, and more particularly to Figs. 3a and 3b, a ceramic package body 104 includes a semiconductor device pellet 101 provided with a semiconductor integrated circuit on which fourteen bonding pad electrodes 102a to 122n are arranged. The pellet is bonded on the ceramic package body 104 by means of a low-melting point glass 105 for fixing. Leads 103a to 103n leading to the exterior are provided corresponding to the fourteen pad electrodes 102a to 102n of the pellet 101. The leads are mounted to the ceramic package body 104 by means of a fixing means such as the low-melting point glass 106. The pellet and the leads are provided with recognition marks 116 and 117, respectively. Any recognition mark such as the wirings and the pellet can be adopted since if they have a clear brightness the edge thereof can be used as a mark. The DILG sealing method uses the low-melting point glass

- 7 -

particularly for a fixing agent while high precision is required in positioning the pellet and leads relative to the package body. This makes it difficult to precisely control a position of the pellet and also  
5 the leads. This often brings about a situation that the recognition marks 116, 117 of the pellet and also the leads fail to fall within a field of view of a camera.

A preferred embodiment of a wire bonding  
10 apparatus according to the invention, which is well adapted for the wire bonding of the semiconductor component by the DILG sealing method, will be described. A sequence of movements and positions of an origin  
8 of a field of view, and a range of the view are  
15 illustrated in Fig. 4. 8-0 is a reference position of the origin of the field of view which corresponds to the origin 8 of the field of view in Fig. 2. In Fig. 4, 8-1 to 8-4 are points located at the positions distanced from the reference position 8-0 by  $X/2$  and  
20  $Y/2$ , which represent  $1/2$  of the field of view in the X and Y directions, respectively. The movement of the view is performed in the following manner. The origin of the field of view is positioned at the first position 8-0 and is indicated on Fig. 4 by a dotted  
25 area. Under this condition, if a recognition mark 6' can not be recognized, the view origin is moved to a

position 8-1 ( $X/2, Y/2$ ), so that the field of view moves into an area hatched. If the recognition mark 6' can not be recognized at this position 8-1, the view origin is successively moved to positions, 8-2 ( $-X/2, Y/2$ )→  
5 8-3 ( $-X/2, -Y/2$ )→8-4 ( $X/2, -Y/2$ ), until the mark 6' is recognized. In this example in Fig. 4, the mark 6' is recognized at the position 8-4. For recognizing the recognition mark, the movement of the field of view and the recognition of the recognition mark 6' are  
10 repeated in this way. There are many methods to move the field of view. In this embodiment, the movement of the field of view is repeated a maximum of four times so that the effective field of view is expanded four times, compared to the use of conventional methods  
15 and an allowance for displacement of the pellet when it is mounted, is doubled. The above-mentioned manner successfully solves the problems of the prior art, and realizes a fully automatic wire bonding apparatus for the semiconductor component of the DILG sealing method.  
20 For measuring a displacement of one bonding position group, for example, pads, a plurality of recognition marks, not single, are often used for enhancing the positional accuracy. In this case, a plurality of reference positions of the field of view  
25 are required for the respective marks. When the recognition mark can not be recognized at a reference position, the view moving method like that of a single

recognition mark is employed for each recognition mark regardless of the preceding positional correction. (4 x the number of the recognition marks) times of the view movements may be necessary for all the recognitions of the marks. Thus, a long time must be taken for such recognitions. This problem was solved by the present invention. When a plurality of recognition marks are used, an amount of displacement of the recognition mark first recognized from the reference position is used to correct the reference positions of the second and subsequent recognition marks. As a result, the second and the subsequent recognition mark are surely within the field of view at the corresponding reference positions, respectively.

15           An example using two recognition marks, as an embodiment of the invention, will be described referring to Fig. 5. In the figure, like numerals are used to designate like portions in Fig. 4. In Fig. 5, a pellet 1 positioned at the reference position has previously set view reference positions (origin); one 8-0 for a first recognition mark 6-1 and the other 9-0 for a second recognition mark 6-2. For measuring a displacement of an actual pellet, i.e. a displaced pellet 1', the field of view advances to the reference position 8-0 for recognizing a first mark 6'-1. Since the mark 6'-1 is not recognized within the field of view, the field of view is successively moved through

- 10 -

a route 8-0 → 8-1 → 8-2 → 8-3 → 8-4 in the above-mentioned moving manner. At the reference position 8-4, the mark is recognized within the field of view, represented by the cross-hatched area in Fig. 5, at the position 8-4. Following the recognition of the mark 6'-1, the field of view is moved for recognizing the second mark 6'-2. In this case, the field of view is moved not to the previously set reference position 9-0 but to a field of view, represented by the dotted area in Fig. 5, at a new reference position corrected by X and Y directional displacements  $\Delta x$  and  $\Delta y$  from the reference position 6-1 of the first mark 6'-1. In this way, the second mark 6'-2 is surely recognized in the first set field of view. Accordingly, there is no need for the successive movements of the field of view, which are needed for the first recognition mark, so that time for the recognition of all the marks is shortened. This operation is correspondingly applicable for the case using three recognition marks or more.

Turning now to Fig. 6, there is an example of a control system for a fully automated ultrasonic wire bonding apparatus with the view moving system according to the invention. In the figure, an X and Y directional table 11 is provided for moving the field of view of a video camera 13 with a  $\theta$  directional

rotatary table 12 being provided for rotating a semiconductor device 22. A sequence of controls will be described by way of example. A table control unit 19 controls the tables 11 and 12 to move the field of view to a reference position previously set. Then, in response to a recognition command 20, a recognition unit 15 electrically recognizes a video signal 14 from the camera 13 to recognize the mark. The result of the recognition denoted as 16 is corrected by a position correction computing unit 17 which in turn feeds back the result of computation as a signal 18 to the table control unit 19. The control unit 19 judges the result of feedback signal 18 applied further to repeat the table movement and the mark recognition or to complete the recognition task.

The present invention is not limited to the above-mentioned embodiments but applicable for other suitable view movements and view movement ranges.

As described above, the present invention is very effective when applied for the position detection of the pellet or leads in wire bonding the semiconductor device by the DILG sealing method. It is evident that the present invention is applicable to semiconductor devices manufactured by other sealing methods.

25



-12-

CLAIMS

1. A wire bonding apparatus for wire bonding a first group of bonding positions disposed on a first member with a second group of associated bonding positions disposed on a second member, one of said first and second members  
5 having at least one recognition mark, the apparatus comprising: a recognition means having a field of view for detecting a presence of the recognition mark in the field of view and for identifying a position of the detected recognition mark in the field of view; means for  
10 successively moving the field of view of said recognition means in a predetermined manner when the recognition mark is not detected until such time the recognition mark falls within the field of view; and means for computing the positions of said bonding positions based on a detected  
15 position of the recognition mark in the control of the bonding apparatus to achieve a wire bonding.
2. A wire bonding apparatus according to claim 1, wherein said means for moving the field of view successively moves the field of view to locations which  
20 are spaced by a predetermined portion of a size of the field of view.
3. A wire bonding apparatus according to claim 2, wherein said predetermined portion is one-half of a width of the field of view in an x direction and one-half  
25 of a width of the field of view in a y direction.



-13-

4. A wire bonding apparatus according to claim 1, 2 or 3, wherein at least two recognition marks are provided, and wherein the apparatus further includes means for correcting a manner of moving the field of view for enabling  
5 a detection of the second recognition mark after a detection of the first recognition mark has been completed in dependence upon a detected result of the first recognition mark.

5. A wire bonding apparatus for automatically  
10 wire bonding semiconductor devices loaded on a movable table, the apparatus comprising: an opto-electrical camera means having a field of view for viewing a recognition mark on a semiconductor device; a recognition means for detecting and recognizing a location of an image captured in the  
15 field of view of the camera means; position correction computing means for computing a location of the image in dependence upon a result of recognition supplied from said recognition means; and control means for judging a result of a computation supplied from the position correction  
20 computing means and, when a recognition mark is not detected in the field of view, causing the field of view to move in a predetermined manner until such time the recognition mark falls within the field of view and controlling the bonding apparatus to achieve a wire bonding  
25 following recognition of the recognition mark in the field of view.

27



-14-

6. A wire bonding apparatus according to claim 5, wherein said control means moves the field of view successively in a series of steps when a recognition mark is not detected in the field of view.

5 7. A wire bonding apparatus according to claim 6, wherein the semiconductor device includes at least two recognition marks which are disposed at relatively fixed positions, and wherein said control means, after a first of the recognition marks has been  
10 detected, is adapted to move the field of view in dependence upon the result of the detection of the first recognition mark.

8. A wire bonding apparatus constructed and arranged to operate substantially as hereinbefore  
15 described with reference to and as shown by the accompanying drawings.

The text of the specification has been reproduced by photocopying the applicants original typescript. It may contain a few amendments which are difficult to read. The original typescript containing these amendments may be inspected on the premises of the Patent Office