

METHOD AND SYSTEM FOR PACKAGE INSPECTION

Field of the Invention

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The invention relates to the inspection of semi-conductor packages. In particular, the invention relates to inspection of stacked packages.

Background

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In the inspection of semi-conductor packages it is necessary to establish the veracity of various manufacturing aspects including:

- (i) The bond for the solder ball;
 - 15 (ii) That the loop for the wire connection is of the correct height;
 - (iii) That the wire itself is both present and intact;
 - (iv) The solder ball neck;
 - (v) That the die stack is either uniformly symmetrical or offset depending upon the requirements of the package design.
- 20 To do so requires inspection in two dimensions and three dimensions, which must be done at an economically viable rate.

However, conventional methods of inspection are geared towards conventional package design, having only a single or double layer. Such inspection methods therefore may not provide a sufficiently high degree of image clarity for those layers falling outside the range of vision of conventional systems.

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Summary of Invention

In a first aspect the invention provides an inspection system for inspecting a semiconductor package, the system comprising: an inspection device having a vertically aligned imaging device and at least one pair of imaging devices in relative orthogonal orientation; said vertically aligned and at least one pair of orthogonally positioned imaging devices directed towards an inspection zone, said inspection zone arranged to receive said semiconductor package, and; a control system arranged to receive 2 dimensional images from the vertically aligned and orthogonally oriented pair of imaging devices; wherein the control system is arranged to create a 3 dimensional image from the 2 dimensional images captured by the orthogonal imaging devices, and further arranged to inspect the semiconductor package based upon the created 3 dimensional image and captured 2 dimensional images.

Accordingly, by providing imaging devices for both 2D and 3D images, stacked packages can be more readily inspected.

Brief Description of Drawings

It will be convenient to further describe the present invention with respect to the accompanying drawings that illustrate possible arrangements of the invention. Other arrangements of the invention are possible and consequently, the particularity of the accompanying drawings is not to be understood as superseding the generality of the preceding description of the invention.

Figures 1A and 1B show elevation views of a die stack for a semi-conductor package;

Figure 2 is a schematic view of an inspection system according to one embodiment of the present invention;

Figure 3A is an elevation view of a wire connection between a substrate and a die.

Figure 3B is a perspective view of an array of wire connections between a substrate and a die.

Figure 4 is a plan view of an inspection system according to one embodiment of the present invention.

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Detailed Description

The invention is directed to an inspection system including an inspection device arranged to capture 2D and 3D images of semi-conductor packages located in an inspection zone. It achieves this by incorporating a plurality of cameras along the primary axes so as to capture the relevant information from each direction and to
5 combine images so as to form 3D images of features of the package, as well as capture 2D images, these images then used for inspection.

Figures 1A and 1B show a die stack 5 whereby a substrate 10 has place thereupon a plurality of dies 15 stacked so as to achieve a multi-device package. Each die layer is
10 separated by tape so as to electrically isolate the die from the adjacent die. Each die is electrically connected to the substrate at a relevant point 25 through wires 20 connected to each die 30. It will be noted that having a die stack as shown in Figures 1A and 1B will require an asymmetric positioning 40, 45 of the dies so as to provide a sufficient platform to connect each of the wires 20.

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The example provided in Figures 1A and 1B therefore identifies the various features that can be damaged during manufacture, including the correct connection of the wires and in fact whether they are present. Further, the asymmetric positioning so as to provide a sufficient platform for wire connection is also an important characteristic that
20 requires inspection.

Figure 2 shows one embodiment of the present invention whereby a plurality of imaging devices 50, such as cameras, are positioned above and along principle axes 52 so as to

capture images of the die 60 from various positions. Each image captured along a principle axis can be used for the purpose of a 2D inspection of the die. The 2D images then communicated to a control system and assessed as to the veracity of the aspect captured by that image through an image processing module which may assess the feature and compare to a data base of images having expected results. In some cases the image processing module may perform a measurement function in order to inspect for package features that require a minimum of maximum dimension. Further, a missing or broken wire may be assessed by the image processing module identifying a discontinuity in the wire profile.

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As there are cameras 50 positioned along different principle axes 52, 2D images can be taken from all four sides above the package. Further, the substrate can also be inspected by a fifth camera 55 positioned below the inspection zone and thus 2 dimensional inspection images can be taken from five different positions.

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Given the projected arrangement of a stacked package, as compared to a package having a single or double layer, the positioning of the cameras, both radially disposed and elevated provide significant advantage to conventional inspection systems. The present invention also provides for a range of three dimensional images to be captured by combining captured two dimensional images. The image processing module is arranged to create a three dimensional image from the two dimensional images captured by any of the orthogonal cameras, and so at least four 3D images can be created for each package.

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Thus, two dimensional images can be captured from five different directions and three dimensional images can be created based upon combining orthogonal cameras providing four different three dimensional images based upon the available combinations. Accordingly, the inspection system according to the present invention provides a clear multi-directional inspection system in both two dimensions and three dimensions.

The stereo vision optical 2 dimensional images, which are also used to create the 3 dimensional images, may, by example, provide critical information such as that shown in Figures 3A and 3B. Figure 3A shows a 2 dimensional image 81 of a wire bond 70 connected to a die, with Figure 3B showing in 3 dimensions for an array of wire bonds 82. Returning to Figure 3A, a wire bond 70 to a die 75 from a substrate 80 can be imaged in two dimensions and three dimensions to determine the presence of the wire, whether the wire is broken or not, as well as dimensional information such as the height of the wire loop. In this case, where the loop 70 is positioned above a cross wire 85, the loop height may be calculated by the control system by knowing the dimension (D) as well as the inspection wire (d) and measuring the distance between the two cross wires 85 that is, the loop height can be calculated by the control system based upon information received from the image processing module.

Figure 4 shows the inspection system 100 according to one embodiment of the present invention. Here, an input station 105 includes an array of input racks 110 for receiving

substrates. A pusher 115 sequentially pushes each substrate 120 into the device which is engaged by the drawer 125 for drawing the substrate into a substrate boat 130. The substrate boat 130 delivers the substrate along a bi-directional slide 135 so as to position the substrate within the inspection zone 150.

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Located about the inspection 150 is an inspection device 140, which includes four imaging devices 145 positioned radially about the inspection zone and a central vertical camera 152. All of the imaging devices, or cameras, 145, 152 comprise the image capture portion of the inspection device 140. Not shown is the control system for

10 controlling the capture of the two dimensional images, or the image processing module within the control system, for combining the two dimensional images to form a plurality of three dimensional images. The control system is also arranged to then compare the two dimensional and three dimensional images in order to determine the veracity of the substrate under inspection.

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Once inspected, the substrate 160 is delivered to a second substrate boat 170 which is moved by a second bi-directional slide 155 so as to position the substrate for offloading into the output station 180, by a pusher 165. As before, the output pusher 165 pushes the substrate 160 into a receiving boat 175, which is subsequently pushed by a pusher

20 into the offloading rack 185 for subsequent delivery, or rejection, subject to the result of the inspection.

CLAIMS

1. An inspection system for inspecting a semiconductor package, the system comprising:
 - 5 an inspection device having a vertically aligned imaging device and at least one pair of imaging devices in relative orthogonal orientation;

said vertically aligned and at least one pair of orthogonally positioned imaging devices directed towards an inspection zone, said inspection zone arranged to receive said semiconductor package, and;
 - 10 a control system arranged to receive 2 dimensional images from the vertically aligned and orthogonally oriented pair of imaging devices;

wherein the control system is arranged to create a 3 dimensional image from the 2 dimensional images captured by the orthogonal imaging devices, and further arranged to inspect the semiconductor package based upon the created 3
15 dimensional image and captured 2 dimensional images.
2. The system according to claim 1, wherein the inspection device includes four imaging devices in relative orthogonal orientation.

3. The system according to claim 1 or 2, wherein the said orthogonally oriented imaging devices are positioned radially about, and elevated above, the inspection zone.
- 5 4. The system according to any one of claims 1 to 3, wherein the control system includes an image processing module, said module arranged to create the 3 dimensional image.
- 10 5. The system according to any one of claims 1 to 4, further including an input station for introducing a semiconductor package into the inspection device.
6. The system according to any one of claims 1 to 5, further including an output station for removing a semiconductor package from the inspection device.