

INVERTIBLE INTEGRATED CIRCUIT TRAY AND METHOD OF USING SAME

FIELD OF THE INVENTION

5 The invention relates generally to methods of inspecting integrated circuits. The invention is particularly useful for, but not necessarily limited to, improving integrated circuit inspection results through use of an invertible IC tray.

BACKGROUND OF THE INVENTION

10 Integrated Circuits (ICs) undergo optical and electrical tests and burn-in processes to improve quality control. ICs are generally processed in large batches and are therefore stored and moved in stackable trays during processing. The trays are frequently referred to as JEDEC trays as their
15 dimensions are defined by the Joint Electronic Device Engineering Council (JEDEC).

 IC device tests and inspections may employ in-tray methods or pick and place methods. In-tray methods generally involve optical inspections of ICs while the devices sit in tray pockets. Such methods are preferred as the devices
20 are never touched and thus damage due to handling by humans or machines is minimized.

 A disadvantage of in-tray optical inspection however is that some device defects are not readily detectable from a device's topside. Referring to FIG. 1, there is illustrated a cross-sectional side view of the lead wires of two
25 IC devices that have defects that may not be detectable using conventional in-

tray inspection. One of the leads 100 of the left-hand device includes a burr 105 on the underside of the lead 100, which burr 105 may not be detectable using optical beams 110. The device on the right includes a thick lead 115 that may be outside the design specifications and cause the device to malfunction; but again the optical beams 110 directed from above the device are unable to detect the defect.

Other problems with in-tray inspection include occlusions that are built into the JEDEC trays. Referring to FIG. 2, there is illustrated a cross-sectional side-view of a tray 200 comprising upper support walls 205 that define a pocket 215 in which an IC device 210 rests. The support walls 205 can block transmission of the optical beams 110 used during inspection of an IC device 210. The arrow in FIG. 2 shows the scanning direction used in the illustrated inspection. Inspections therefore need to be performed twice using different angles of view, which requires either the inspection equipment or the JEDEC trays to be rearranged. The rearranging and dual inspections increase the time required for inspection.

Pick and place inspection processes require individual IC devices 210 to be picked up from a JEDEC tray pocket 215, moved to an inspection station, inspected, and then replaced in the original JEDEC tray pocket 215. Thorough three-dimensional device inspections are therefore possible; however, this method involves significant delays and presents numerous opportunities for damaging the devices 210 during movement between the trays 200 and the inspection station. The IC leads 100 are particularly fragile and prone to damage anytime the devices 210 are moved. Further, the time delays are particularly problematic as the optical inspection systems remain idle while the

IC devices 210 are picked and placed between the inspection stations and the trays 200, thus greatly limiting the overall inspection throughput.

A method and apparatus is therefore needed that enables improved three-dimensional inspection of IC devices 210, while avoiding the time delays and device damage risks associated with prior art techniques.

SUMMARY OF THE INVENTION

According to one aspect, the present invention is a method of inspecting a tray of integrated circuits, the method comprising the steps of: placing a cover tray over a lower integrated circuit device tray, wherein the device tray includes a plurality of integrated circuit devices having an underside facing down and a topside facing up, and wherein said cover tray has a bottom side that rests adjacent said topside of said devices; inverting both said cover tray and said lower device tray; removing said lower device tray such that said devices rest on the cover tray and said underside of said devices faces up; inspecting the underside of said devices; replacing said lower device tray on said cover tray; inverting both said cover tray and said lower device tray a second time; and removing said cover tray.

In another form, the invention is a cover tray for retaining a plurality of integrated circuit devices in an inverted position, the cover tray comprising: a plurality of pockets, each pocket including a device centring area having a perimeter; a plurality of support walls adjacent each of said plurality of pockets; a plurality of retaining curbs located on said perimeter of each centring area; wherein said support walls are slidably engagable adjacent corresponding vertical members on a lower device tray that includes integrated circuit devices

having a top surface facing up, such that said cover tray may be nested over said lower device tray, and wherein both trays may then be inverted and the lower device tray removed so that said top surface of said devices faces down and rests on said centring area.

5 In this specification, including the claims, the terms “comprises,” “comprising” or similar terms are intended to mean a non-exclusive inclusion, such that a method or apparatus that comprises a list of elements does not include those elements solely, but may well include other elements not listed.

10 BRIEF DESCRIPTION OF THE DRAWINGS

In order that the invention may be readily understood and put into practical effect, reference will now be made to a preferred embodiment as illustrated with reference to the accompanying drawings, wherein like reference numbers refer to like elements, in which:

15 FIG. 1 is a cross-sectional side view of the lead wires of two IC devices that have defects that may not be detectable using conventional in-tray inspection according to the prior art;

FIG. 2 is a cross-sectional side-view of a prior art tray comprising upper support walls that define a pocket in which an IC device rests;

20 FIG. 3 is a schematic process flow diagram illustrating a method for performing, according to one embodiment of the present invention, an optical inspection of an IC device;

FIG. 4 is a schematic illustration of a prior art 4x8 device tray that holds 32 IC devices and that could be used for the purposes of the method of the present invention;

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FIG. 5A is a cross-sectional schematic illustration of one embodiment of a modified cover tray according to the present invention that is stacked on top of a lower device tray; and

FIG. 5B is a cross-sectional schematic illustration of an inverted modified cover tray according to the present invention that also shows a device that is restrained horizontally by retaining curbs.

DETAILED DESCRIPTION OF A

PREFERRED EMBODIMENT OF THE INVENTION

Referring to FIG. 3, there is a schematic process flow diagram illustrating a method 300 for performing, according to one embodiment of the present invention, an optical inspection of an IC device 210. First, at step 305, a cover tray 310 is placed over the top of a lower integrated circuit device tray 200. In the present embodiment, the cover tray 310 is a JEDEC tray that is identical to the lower IC device tray 200. The trays 200 are designed to be stackable and therefore the cover tray 310 nests smoothly into the lower device tray 200. As shown in dashed outline at step 305, the outer surfaces of the upper support walls 205 of the lower device tray 200 slidingly engage the inner surfaces of lower support walls 315 on the cover tray 310. Typically the cover tray 310 is moved over the top of the lower device tray 200 using automated positioning equipment (not shown). For example, the method 300 may occur at a quality control (QC) station in a semiconductor fab where the device trays are moved along a conveyor belt from an earlier processing station into the QC station (not shown). After the trays 310, 200 are stacked according to step 305, the IC device 210 is restrained in the vertical direction because it is sandwiched

between the cover tray 310 and the lower tray 200. The device 210 is also restrained in the horizontal direction by retaining curbs 320 located around the perimeter of a centring area 325.

Those skilled in the art will readily understand that the illustrations provided in FIG. 3 represent only a single pocket 215 of a tray 200 that consists of a plurality of pockets 215, wherein each pocket 215 is designed to hold a single IC device 210. Referring to FIG. 4, there is a schematic illustration of a prior art 4x8 device tray 200 that holds 32 IC devices 210 and that could be used for the purposes of the method 300 of the present invention. Each device 210 is positioned in the centring area 325 of a pocket 215. Those skilled in the art will further appreciate that the trays 200 may be scaled up or down to include any number of rows and columns, the product of which determines the device capacity of the tray 200.

Referring again to FIG. 3, after the trays 310, 200 are stacked, the method 300 continues to step 330 where the stacked trays 310, 200 are inverted. The inversion process also typically uses automated robotic processing equipment (not shown). Next, at step 335, the lower device tray 200, which now rests on top of the IC device 210, is removed. That exposes the lower side of the devices 210 including the lower side of the leads 100 that are typically prone to damage and imperfections, such as the above described burrs 105 and thick leads 115, and require close inspection.

The method 300 then continues to step 340 where optical 3D inspection of the device 210 occurs. Because the device leads 100 are generally curved downward when they rest in the lower device tray 200, the leads 100 will be pointed upward when the trays 310, 200 are inverted. That causes the leads

100 to be lifted away from the lower support walls 315 of the cover tray 310 and thereby avoids the occlusion problems of the prior art. The optical beams 110 of the inspection equipment are thus able to scan the entire underside of the device 210.

5 Next, at step 345, the lower device tray 200 is replaced on top of the cover tray 310. The method 300 then continues to step 350 where the trays 200, 310 are again inverted. Finally, at step 355, the cover tray 310 is removed and the inspected devices 210 are ready to be moved to the next station in the fab.

10 Note that the underside of standard JEDEC trays 200 generally do not include corresponding retaining curbs 320 that could restrain horizontal movement of the devices 210 when the trays 200, 310 are inverted. That means that it is particularly important that the cover tray 310 not be moved at any time between steps 335 and 345 when the lower device tray 200 is removed. Any
15 movement of the cover tray 310 could cause the devices 210 to slide out of position. Damage to the leads 100 could then occur when the device tray 200 is replaced on top of the cover tray 310. A further embodiment of the present invention therefore includes a modified cover tray 310 designed to restrain
horizontal movement of the devices 210 between steps 335 and 345 of the
20 above described method 300.

Referring to FIG. 5A, there is a cross-sectional schematic illustration of one embodiment of a modified cover tray 310 that is stacked on top of a lower device tray 200. The cover tray 310 includes retaining curbs 320 on its lower surface. Therefore, when the trays 200, 310 are inverted according to step 330
25 above, the retaining curbs 320 on the cover tray 310 restrain horizontal

movement of the inverted devices 210. Referring to FIG. 5B there is a cross-sectional schematic illustration of an inverted modified cover tray 310 including a device 210 that is restrained horizontally by the retaining curbs 320. Just as the retaining curbs 320 on the original JEDEC trays restrain horizontal movement of the non-inverted devices 210, the retaining curbs 320 on the underside of the modified cover trays 310 enable the inverted trays 310 to be moved without dislocating the devices 210. The modified cover trays 310 may be manufactured using various automated techniques such as stamping or polymer moulding.

Those skilled in the art will readily appreciate that the retaining curbs 320 on the underside of the cover trays 310 may be of various shapes and in a variety of positions. For example, some embodiments of the present invention may locate the retaining curbs 320 around an entire rectangular perimeter of a centring area 325. Other embodiments may locate the retaining curbs 320 only at the corners of a centring area 325.

The above detailed description provides a preferred exemplary embodiment only, and is not intended to limit the scope, applicability, or configuration of the present invention. Rather, the detailed description of the preferred exemplary embodiment provides those skilled in the art with an enabling description for implementing the preferred exemplary embodiment of the invention. It should be understood that various changes can be made in the function and arrangement of elements and steps without departing from the spirit and scope of the invention as set forth in the appended claims.

WE CLAIM:

1. A cover tray for retaining a plurality of integrated circuit devices in an inverted position, the cover tray comprising:

a plurality of pockets, each pocket including a device centring area

5 having a perimeter;

a plurality of support walls adjacent each of said plurality of pockets;

and

a plurality of retaining curbs located on said perimeter of each centring area;

10 wherein said support walls are slidably engagable adjacent corresponding vertical members on a lower device tray that includes integrated circuit devices having a top surface facing up, such that said cover tray may be nested over said lower device tray, and wherein both trays may then be inverted and the lower device tray removed so that said top surface of said devices faces
15 down and rests on said centring area.

2. The cover tray of claim 1, wherein the lower device tray is a JEDEC tray.

20 3. The cover tray of claim 1, wherein said plurality of retaining curbs are located on four sides of said centring area.

4. The cover tray of claim 1, wherein said plurality of retaining curbs are located at corners of said perimeter of said centring area.

5. The cover tray of claim 1, wherein said cover tray is made of a moulded polymer.

6. A method of inspecting a tray of integrated circuits, the method
5 comprising the steps of:

placing a cover tray over a lower integrated circuit device tray, wherein the device tray includes a plurality of integrated circuit devices having an underside facing down and a topside facing up, and wherein said cover tray has a bottom side that rests adjacent said topside of said devices;

10 inverting both said cover tray and said lower device tray;

removing said lower device tray such that said devices rest on the cover tray and said underside of said devices faces up;

inspecting the underside of said devices;

replacing said lower device tray on said cover tray;

15 inverting both said cover tray and said lower device tray a second time;

and

removing said cover tray.

7. The method of claim 6, wherein said cover tray and said lower device
20 tray are identical JEDEC trays.

8. The method of claim 6, wherein said cover tray includes a plurality of retaining curbs on said bottom side for preventing horizontal movement of said devices when said lower device tray is removed from said cover tray.

9. The method of claim 6, wherein said cover tray is not moved during said inspecting step.

10. The method of claim 6, wherein said method is performed as part of an automated quality control process in a fab.

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