

TRAY FLATTENER

Field of Invention

The invention relates to the manufacture of semiconductor devices. More particularly,
5 the invention pertains to an apparatus and a method for un-warping trays used for containing semiconductor devices.

Background

Numerous types of semiconductor devices exist due to developments in the
10 semiconductor field. The semiconductor devices are typically manufactured by forming a strip constituting an integral unit containing numerous semiconductor devices. The semiconductor devices are then separated from the strip into individual units.

The semiconductor devices containing semiconductors are conventionally known as Chip
15 Scale Packages (CSPs). According to a definition recited in the IPC/Joint Electron Device Engineering Council (JEDEC) J-STD-012, "Implementation of Flip Chip and Chip Scale Technology", a CSP is defined as a microelectronic package that has an outline dimension 1.2 times greater than the outside dimension of an associated integrated circuit (IC). CSPs have experienced rapid growth in recent years due to heavy
20 demand for portable, handheld communication devices. Further, due to the continued miniaturization of semiconductors, technologies on CSPs are constantly being refined to obtain cost effective and high performance ways to interconnect, test and protect ICs. As a result, smaller sized CSPs are produced and hence improved methods are required for handling these CSPs.

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Once the semiconductor devices are singulated from the strip, the singulated semiconductor devices are then washed, dried and placed onto holding trays to be transferred to other locations for further processing. The holding trays are preferably JEDEC matrix trays commonly used and adapted for holding the singulated
30 semiconductor devices for the purpose of shipping and handling. FIG. 1 shows a JEDEC matrix tray (referred to hereinafter as tray) 102 and a singulated semiconductor device (referred to hereinafter as singulated unit) 104. The standard dimensions of a tray 102 are 322.6 mm by 135.9 mm by 7.62 mm. In addition, a wide variety of trays 102 are

available for holding singulated units 104 that come in different package types such as Ball Grid Array (BGA), Metric Quad Flat Package (MQFP), Quad Flat No Leads (QFN) and Plastic Leaded Chip Carrier (PLCC).

5 The singulated units 104 are typically placed onto the trays 102 by automated ICs handling equipment such as a turret equipped with a plurality of spring-biased, reciprocating vacuum nozzles (not shown). Each vacuum nozzle of the turret engages one singulated unit 104 via suction created using vacuum. The singulated unit 104 is then placed into a component pocket 106 on the tray 102 by initiating a purging action
10 from the vacuum nozzle. Typically, there are rows of component pockets 106 provided on the tray 102 for such purposes. In addition, the component pockets 106 on each row are spaced equally apart from each other. FIG. 2 shows a cross sectional view of the tray 102.

15 The singulated units 104 are then placed onto the trays 102 in a row sequence manner, filling up one row of component pockets 106 before the next row of component pockets 106 is subsequently filled. FIG. 3 shows an isometric view of the tray 102 in which the tray 102 is secured on a platform 302 using clamps 304 provided by the platform 302. The tray 102 is normally held in place on the platform 302 by securing the periphery of
20 the tray 102 using the clamps 304. However, there is a tendency for the tray 102 to warp at the centre (referred to hereinafter as tray warping) when being clamped at the periphery of the tray 102. Tray warping then leads to misalignment of the component pockets 106. Hence, as a result, placement of the singulated units 104 into the component pockets 106 on the tray 102 might not be accurate. Thus, the singulated units
25 104 are then easily displaceable from the component pockets 106 due to the inaccurate placement. FIG. 4 shows a cross-sectional view of the singulated units 104 improperly secured within the component pockets 106 of the tray 102 due to tray warping.

The inaccurate placement of the singulated units 104 into the component pockets 106 due
30 to tray warping is made worse due to the size of the singulated units 104. The singulated units 104 are typically of dimensions ranging approximately from 2 mm to 12 mm. Hence, when the singulated units 104 on a previous row are improperly secured within the component pockets 106 due to tray warping, the purging action initiated by the

vacuum nozzles for placing new singulated units 104 into the component pockets 106 on the neighbouring rows causes the singulated units 104 on the previous row to be displaced from the component pockets 106. Such a situation is undesirable since the semiconductor manufacturing process will be slowed down considerably as human
5 intervention is required to remove or reinsert displaced singulated units 104.

In view of the foregoing deficiencies, there affirms a need for an apparatus and a method for un-warping trays used for containing semiconductor devices.

10 **Summary**

The present embodiment of the invention disclosed herein provides an apparatus and a method for un-warping trays used for containing semiconductor devices.

In accordance with a first aspect of the invention, there is disclosed a tray flattener
15 comprising a platform and a device. The platform supports a tray thereto and the tray has receptacles for receiving components. In addition, the tray is warped and the receptacles are misaligned when the tray wraps. The device engages a portion of the tray to displace the portion of the tray engaged thereby substantially towards the platform for correcting orientation of the misaligned receptacles in the portion of the tray thereby enabling
20 reception of the components thereinto.

In accordance with a second aspect of the invention, there is a tray flattening method comprising supporting a tray to a platform and the tray has receptacles for receiving components. In addition, the tray is warped and the receptacles are misaligned when the
25 tray wraps. Further, the tray flattening method comprises displacing a portion of the tray substantially towards the platform for correcting orientation of the misaligned receptacles in the portion of the tray thereby enabling reception of the components thereinto.

In accordance with a third aspect of the invention, there is disclosed a tray flattener
30 comprising a platform, a turret and a device. The platform supports a tray thereto and the tray has receptacles for receiving components. In addition, the tray is warped and the receptacles are misaligned when the tray wraps. The turret displaces the components into the receptacles, the turret being adapted for holding the components. The device

engages a portion of the tray to displace the portion of the tray engaged thereby substantially towards the platform for correcting orientation of the misaligned receptacles in the portion of the tray thereby enabling reception of the components thereinto.

5 **Brief Description Of The Drawings**

Embodiments of the invention are disclosed hereinafter with reference to the drawings, in which:

FIG. 1 an isometric view of a standard sized Joint Electron Device Engineering Council
10 (JEDEC) matrix tray according to the prior art;

FIG. 2 a cross-sectional view of the JEDEC matrix tray of FIG. 1;

FIG. 3 shows an isometric view of the JEDEC matrix tray of FIG. 1 being secured on a
15 platform using clamps;

FIG. 4 shows a cross-sectional view of semiconductor devices improperly secured within component pockets of the JEDEC matrix tray of FIG. 1 due to tray warping;

20 FIG. 5 shows a tray flattener according to an embodiment of the invention;

FIG. 6 shows the tray flattener of FIG. 5 being used for engaging the JEDEC matrix tray of FIG. 1;

25 FIG. 7 shows a cross-sectional view of the semiconductor devices properly secured within the component pockets of the JEDEC matrix tray of FIG. 1 when tray warping is substantially minimized using the tray flattener of FIG. 5;

FIG. 8 shows a first process flow diagram for placing the semiconductor devices on the
30 JEDEC matrix tray of FIG. 1 using the tray flattener of FIG. 5; and

FIG. 9 shows a second process flow diagram for placing the semiconductor devices on the JEDEC matrix tray of FIG. 1 using the tray flattener of FIG. 5.

Detailed Description

An apparatus and a method for un-warping trays used for containing semiconductor devices are described hereinafter for addressing the foregoing problems.

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For purposes of brevity and clarity, the description of the invention is limited hereinafter for un-warping trays used for containing semiconductor devices. This however does not preclude various embodiments of the invention from other applications of similar nature. The fundamental inventive principles of the embodiments of the invention remain
10 common throughout the various embodiments.

Exemplary embodiments of the invention described hereinafter are in accordance with FIGs. 5 to 9 of the drawings, in which like elements are numbered with like reference numerals.

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A tray flattener 500 according to an embodiment of the invention as shown in FIG. 5 is described. The tray flattener 500 comprises a carriage 502, actuators 504 and a roller 506. The actuators 504 interconnect the roller 506 to the carriage 502. Further, the carriage 502 is preferably mounted to a platform 508. In addition, the carriage 502 is
20 preferably detachable so that the carriage 502 is mountable to other like machines that require similar operating functionality.

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The actuators 504 are used for displacing the roller 506 towards and away from the platform 508. When the actuators 504 displace the roller 506 towards the platform 508,
the roller 506 engages the tray 102 disposed between the platform 508 and the roller 506. Notably, the roller 506 preferably engages the tray 102 along the width of the tray 102. The roller 506 then depresses a portion of the tray 102 being engaged (referred to hereinafter as engaged portion) towards the platform 508 to un-warp the engaged portion of the tray 102. The actuators 504 are preferably resiliently biased by a spring-loaded
30 mechanism 510 to avoid over-application of pressure on the tray 102 by the actuators 504 via the roller 506 when engaging the tray 102. Alternatively, the actuators 504 are pneumatically biased. In addition, the platform 508 further comprises a rubber cushion 512 installed at a location on which the tray 102 is placed during engagement of the tray

102 by the roller 506. The rubber cushion 512 is preferably permanently fixed to the platform 508 and serves to provide a damping effect to the tray 102 when the turret engages the component pockets 106 for placing singulated units 104 in the component pockets 106.

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FIG. 6 shows the tray flattener 500 being used for engaging a tray 602. As seen from FIG. 6, the actuators 504 lower the roller 506 until the roller 506 engages a portion of the tray 602 for un-warping the portion of the tray 602. In addition, with reference to the surface of the section of the tray 602 being engaged by the roller 506, the roller 506 is aligned obliquely to the arrangement of the rows of component pockets 106 located along the length of the tray 602. The rows of component pockets 106 are for holding the singulated units 104. Furthermore, the component pockets 106 located on each row are equally spaced apart from each other. The oblique alignment of the roller 506 prevents the roller 506 from directly engaging and pressing on any singulated units 104 that are already previously secured within the component pockets 106. As a result, the likelihood of the roller 506 damaging the singulated units 104 when engaging the tray 602 is minimized by the oblique alignment of the roller 506 with respect to the arrangement of the rows of component pockets 106.

20 The roller 506 then preferably engages different portions of the tray 602 by moving the tray 602 progressively along the platform 508. Alternatively, the roller 506 engages different portions of the tray 602 by positioning the roller 506 along the length of the tray 602 while fixing the tray 602 on the platform 508. By using the tray flattener 500 to un-warp the tray 602, the misaligned component pockets 106 are re-aligned when the surface of the engaged portion of the tray 602 is substantially aligned with the plane of the platform 508. Hence, the singulated units 104 can then be accurately positioned and secured into the component pockets 106.

30 In addition, by un-warping the engaged portion of the tray 602, the flexure created when the turret engages the component pockets 106 is substantially impeded to avoid disturbance to the singulated units 104 already secured in neighbouring rows of component pockets 106. Further, the actuators 504 also displace the roller 506 gradually towards (or away) from the platform 508 during engagement (or disengagement) of the

tray 602 in order not to provide abrupt disturbances to the tray 602 which might otherwise result in displacement of singulated units 104 out of the component pockets 106.

- 5 The roller 506 is preferably sufficiently long for engaging the tray 602 along the width of the tray 602. With reference to the engaged portion of the tray 602, the length of the roller 506 is preferably either as wide or approximately half of the width of the tray 602. Additionally, the roller 506 is preferably lined with a shock absorbing material (not shown) such as urethane rubber, polyurethane or silicon rubber. The shock absorbing
10 material provides shock absorption when used in conjunction with the actuators 504. Furthermore, the roller 506 preferably also allows free-rolling displacements. Yet alternatively, the roller 506 does not allow free-rolling displacements.

FIG. 8 shows a first process flow diagram for placing the singulated units 104 on the tray
15 602 using the tray flattener 500. In a step 802, the tray 602 is first positioned on the platform 508. The tray 602 is then secured to the platform 508 using clamps 604. In a step 804, the actuators 504 displace the roller 506 towards the platform 508 to enable the roller 506 to engage a portion of the tray 602 to thereby un-warp the portion of the tray 602. Tray un-warping is achieved by displacing the portion of the tray 602 by the roller
20 506 towards the platform 508 to substantially reduce flexure at the portion of the tray 602. Next, in a step 806, the singulated units 104 are positioned into a row of component pockets 106 located at the portion of the tray 602 by the turret equipped with the plurality of spring-biased vacuum nozzles that are extendable and retractable into the turret. When the row of component pockets 106 is filled, the actuators 504 then displace the
25 roller 506 away from the platform 508 to thereby disengage the roller 506 from the portion of the tray 602 in a step 808. The tray 602 is moved into a new position on the platform 508 to allow another portion of the tray 602 to be engaged by the roller 506. The steps 804 to 808 are subsequently repeated until all the rows of component pockets 106 along the length of the tray 602 are filled up with the singulated units 104 in a step
30 810. The tray 602, after being completely filled with the singulated units 104, is then transferred to other locations for further processing to be performed on the singulated units 104.

Alternatively, a second process flow diagram for placing the singulated units 104 on the tray 602 by using the tray flattener 500 is shown in FIG. 9. The steps 802 to 806 of the first process flow of FIG. 8 are included as part of the second process flow. When the row of component pockets 106 is filled, the actuators 504 displace the roller 506 away from the platform 508 to thereby disengage the roller 506 from the portion of the tray 602 in a step 902. However, instead of moving the tray 602 into a new position as in the first process flow of FIG. 8, the tray flattener 500 is displaced for positioning the roller 508 over another portion of the tray 508 for subsequent engagement. The tray 602 is fixed on the platform 508 throughout execution of the second flow process. The steps 804 to 902 are subsequently repeated until all the rows of component pockets 106 along the length of the tray 602 are filled with the singulated units 104 in a step 904. The tray 602, after being completely filled with the singulated units 104, is then transferred to other locations for further processing to be performed on the singulated units 104.

In the foregoing manner, an apparatus and a method for un-warping trays used for containing semiconductor devices are described according to embodiments of the invention for addressing the foregoing disadvantages of conventional techniques. Although only a few embodiments of the invention are disclosed, it will be apparent to one skilled in the art in view of this disclosure that numerous changes and/or modification can be made without departing from the scope and spirit of the invention.

Claims

1. A tray flattener apparatus comprising:

a platform for supporting a tray thereto, the tray having receptacles for receiving components, the tray being warped, the said receptacles being misaligned when the tray is warped; and

a device for engaging a portion of the tray at a time across its width to displace the said portion of the tray thereby engaged substantially towards and against the platform to unwarp the said portion of the tray and to correct the orientation and alignment of at least one misaligned empty receptacle in the said portion of the tray, thereby enabling placement of the component into at least one aligned receptacle in the said portion of the tray.

2. The tray flattener apparatus as in claim 1, wherein the device is a roller.

3. The tray flattener apparatus as in claim 2, wherein the roller has at least one portion of its surface in contact with the tray when the roller engages the tray, the roller being covered with a shock absorbing material.

4. The tray flattener apparatus as in claims 2 or 3, wherein the roller is obliquely aligned to the receptacles when engaging the tray, the receptacles being formed and arranged in a plurality of rows in the tray, a lengthwise axis of the roller being parallel to the plane of the tray.

5. The tray flattener apparatus as in claim 1, 2 or 4, wherein the tray comprises a matrix of receptacles conforming to a standardized size.

6. The tray flattener apparatus as in claim 5, wherein the platform comprises a plurality of clamps to secure the peripheries of the tray to the platform.

7. The tray flattener apparatus as in claims 1, 2, 5 or 6, wherein the surface of the platform is permanently fixed with a rubber cushion to provide a damping effect to the tray during engagement by the device.

8. The tray flattener apparatus as in claim 1, 2, 5 or 7, wherein the platform is fixed in position and the device is coupled to a carriage movably positionable over the tray.

9. The tray flattener apparatus as in claim 8, further comprising a movable support structure coupled to each of the platform and the device, thereby configured to position the device to engage a first portion of the tray and a next portion of the tray and to displace said portion of the tray thereby engaged substantially towards and against said platform to unwarp said portion and said next portion of the tray.

10. The tray flattener apparatus as in claim 8 or 9, wherein the movable carriage is detachable.

11. The tray flattener apparatus as in claim 1, 2, 5 or 7, wherein the device is substantially fixed in a position and the platform on which the tray is secured thereto is movable relative to the device, to position said tray and to allow the device to engage a first portion and a next portion of the tray to displace said first portion of the tray and the next portion of the tray engaged thereby substantially towards and against said platform.

12. The tray flattener apparatus as in claim 8, 9, 10 or 11, wherein the device is actuated by actuators for spatial displacement in a direction substantially perpendicular to the platform, the actuators being operable to displace the device towards and against the platform to engage the portion of the tray secured to the platform.

13. The tray flattener apparatus as in claim 12, wherein the actuators are resiliently biased to avoid over-application of pressure on the tray.

14. The tray flattener apparatus as in claim 13, wherein the resiliently biased actuators are one of spring-operated and pneumatically operated.

15. A tray flattening method comprising the steps of:

securing a tray to a platform, substantially fixed in a position, the tray having empty receptacles for receiving components, the tray being warped, the receptacles being misaligned when the tray is warped;

moving a device to a first position to displace a first portion of the tray across the width of the said first portion of the tray thereby engaged substantially towards and against the platform to unwarp the said first portion of the tray and to correct orientation and alignment of at least one misaligned receptacle in the said first portion of the tray thereby enabling placement of the component into at least one aligned receptacle in the said first portion of the tray; and

repeating the previous steps by moving said device to a second position to displace a second portion of the tray across the width of the second portion of the tray thereby engaged substantially towards and against the platform.

16. The tray flattening method as in claim 15, wherein the device is a roller.

17. The tray flattening method as in claim 16, wherein the roller has at least one portion of its surface in contact with the tray when the device displaces the first portion of the tray across the width, the roller covered with a shock absorbing material.

18. The tray flattening method as in claims 16 or 17, further comprising aligning the roller obliquely to the receptacles when the device displaces the first portion of the tray, a lengthwise axis of the roller being parallel to the plane of the tray.

19. The tray flattening method as in claims 15, 16 or 18, wherein the tray comprises a matrix of receptacles conforming to a standardized size.

20. The tray flattening method as in claim 19, wherein the platform comprises a plurality of clamps to secure the peripheries of the tray to the platform.

21. The tray flattening method as in claims 15, 16, 19 or 20, wherein the surface of the platform is permanently fixed with a rubber cushion to provide a damping effect to the tray during engagement by the device.

22. The tray flattening method as in claim 15, 16, 19 or 21, further comprising fixing the platform in position, and coupling the device to a carriage movably positionable over the tray.

23. The tray flattening method as in claim 22, further comprising coupling the carriage to the platform, for positioning the device to engage a portion of the tray and a next portion of the tray and to displace said portion of the tray thereby engaged substantially towards and against said platform to unwarp said portion and said next portion of the tray.

24. The tray flattening method as in claim 22 or 23, wherein the movable carriage is detachable.

25. The tray flattening method as in claim 15, 16, 19 or 21, further comprising fixing the device in a position and configuring the platform on which the tray is secured thereto to be movable relative to the device, to position said tray and to allow the device to engage a first

portion and a next portion of the tray to displace the first portion of the tray and the next portion of the tray engaged thereby substantially towards and against said platform.

26. The tray flattening method as in claims 22, 23, 24 or 25, further comprising actuating the device by actuators for spatial displacement in a direction substantially perpendicular to the platform, the actuators being operable to displace the device towards and against the platform to engage the portion of the tray secured to the platform.

27. The tray flattening method as in claim 26, wherein the actuators are resiliently biased to avoid over-application of pressure on the tray.

28. The tray flattening method as in claim 27, wherein the resiliently biased actuators are one of spring-operated and pneumatically operated.