SAWING AND SORTING SYSTEM

Inventors: Yong-Kuk Kim, Chungcheongnam-do (KR); Hyun-Ho Kim, Seoul (KR); Ho-Seong Kim, Seoul (KR); Yong-Kyun Sun, Chungcheongnam-do (KR); Tai-Kew Chol, Chungcheongnam-do (KR)

Correspondence Address:
MARGER JOHNSON & MCCOLLUM, P.C.
210 SW MORRISON STREET, SUITE 400
PORTLAND, OR 97204 (US)

Appl. No.: 11/220,784
Filed: Sep. 6, 2005

Foreign Application Priority Data
Sep. 8, 2004 (KR) 2004-71767

Publication Classification
B65H 1/00 (2006.01)

U.S. Cl. 414/806; 414/935

ABSTRACT

A sawing and sorting system combines a sawing apparatus and a sorting apparatus. The sawing and sorting system comprises a loader. The loader comprises a magazine receiving a plurality of strips. A mounting unit mounts the strip thereon. A plurality of transfer and sawing robots each comprises a picker unit. The picker unit comprises a rotatable chuck table. The transfer and sawing robot transfers the picker unit horizontally and vertically. The rotatable chuck table holds the strip. The picker unit rotates the rotatable chuck table. A plurality of sawing spindle units each comprises a rotary blade. The sawing spindle unit moves the blade horizontally to divide the strip into unit packages. A cleaning unit cleans the unit package. A test means inspects the unit package according to a test criteria. A sorting table mounts the unit package for sorting. An unloader provides trays. A sorting transfer robot sorts the unit packages into the trays.
FIG. 2
(Prior Art)
FIG. 8
SAWING AND SORTING SYSTEM

CROSS REFERENCE TO RELATED APPLICATIONS


BACKGROUND OF THE INVENTION

[0002] 1. Field of the Invention

[0003] The invention relates to an apparatus for manufacturing semiconductor chip packages and, more particularly, to a sawing and sorting system.

[0004] 2. Description of the Related Art

[0005] For a semiconductor chip package, for example a fine pitch ball grid array and a tape ball grid array, a substrate strip (hereinafter referred to as a strip) may be used during a die attaching process, a wire bonding process, and a molding process. The substrate strip, which may comprise a plurality of unit substrates, is divided into unit semiconductor chip packages (hereinafter referred to as unit packages). The unit packages are then tested and sorted into good or faulty packages.

[0006] A sawing and sorting system performs a sawing process and a sorting process. The sawing and sorting processes include a cleaning process to remove debris and/or moisture from the unit packages and a visual test process to inspect the appearance of the unit packages.

[0007] FIG. 1 is a schematic plan diagram of a conventional sawing and sorting system. FIG. 2 is a schematic cross-sectional diagram of a sawing process by a sawing apparatus of a conventional sawing and sorting system.

[0008] Referring to FIGS. 1 and 2, the conventional sawing and sorting system 300 comprises a sawing apparatus 303 and a sorting apparatus 301. The sawing apparatus 303 divides a strip 1 into unit packages 5. The sawing apparatus 303 includes a rotatable chuck table 335, a sawing spindle unit 361 having a blade 363, and a nozzle unit 365. The sorting apparatus 301 sorts the unit packages 5 according to their quality. The sorting apparatus 301 includes a loader 310, a transfer robot 330 having a picker unit 331, vision cameras 355 and 357, a cleaning unit 373, a drying unit 376, a turntable 375, a sorting table 381, a buffer table 377, a sorting transfer robot 385, and an unloader 393 having trays 7, 8 and 9. The sorting apparatus 301 and the sawing apparatus 303 may be installed adjacent to each other so that the sorting process and the sawing process may be performed consecutively.

[0009] In the conventional sawing and sorting system 300, the transfer robot 330 moves between the sawing apparatus 303 and the sorting apparatus 301. The rotatable chuck table 335 of the sawing apparatus 303 and the cleaning unit 373, the turntable 375, the drying unit 376, the buffer table 377, and the sorting table 381 of the sorting apparatus 301 are arranged along the traveling route of the picker unit 331 of the transfer robot 330.

[0010] The operation of the conventional sawing and sorting system 300 is now described. The sawing process begins with a magazine 3 having the strip 1 being provided in the loader 310. The strip 1 is mounted one after another on a guide rail 321 by a pusher 317 and a gripper 319. The strip 1 is moved to a pick up position of the picker unit 331 of the transfer robot 330, which transfers the strip 1 to the rotatable chuck table 335.

[0011] The rotatable chuck table 335 supports the strip 1 by vacuum. The blade 363 of the sawing spindle unit 361 saws the strip 1 in one direction. After sawing the strip 1 in one direction, the rotatable chuck table 335 rotates through 90 degrees. The blade 363 then saws the strip 1 in another direction. The strip 1 is divided into unit packages 5. The rotatable chuck table 335 also supports the unit package 5 by vacuum.

[0012] During the sawing process, debris may be generated. Debris remaining on the rotatable chuck table 335 may cause an operational error to a subsequent process and/or hinder a stable sawing operation and thus, should be removed.

[0013] The cleaning process begins with the nozzle unit 365, installed adjacent to the blade 363, ejecting a cleaning solution at a high pressure and removing the debris. Next, the picker unit 331 of the transfer robot 330 absorbs the unit package 5 by vacuum and moves the unit package 5 to the cleaning unit 373. The cleaning unit 373 cleans the unit package 5 using the cleaning solution and/or air. The cleaning operation is performed on one surface of the unit package 5, i.e., the surface opposite to the surface wherein the solder balls 6 are formed. After cleaning one surface of the unit package 5, the unit package 5 is transferred to and mounted on the turntable 375. The turntable 375, rotatable through 180 degrees, inverts the unit package 5 to allow the other surface to be cleaned and dried.

[0014] After sawing and cleaning, the unit packages are then tested and sorted into good or faulty packages. A first vision camera 355 inspects one surface of the unit package 5. The unit package 5 is temporarily mounted on the buffer table 377. The picker unit 331 transfers the unit package 5 to the sorting table 381. A second vision camera 357 inspects the other surface of the unit package 5. The sorting transfer robot 385 sorts the unit package 5 into, for example, the tray 7 for good packages or the tray 8 for faulty packages.

[0015] Thus, the conventional sawing and sorting system may have a sawing apparatus and a sorting apparatus formed separately and independently. If a target of operation is changed, a new tool and/or parameter may be set on each of the sawing apparatus and the sorting apparatus.

[0016] The conventional sawing and sorting system removes debris using a cleaning solution and air, which results in consumption of a considerable amount of cleaning solution and air and an increased cleaning time. The conventional sawing and sorting system also includes first and second cleaning operations, whereby resulting in reduced productivity and an inefficient cleaning operation.

[0017] Further, the conventional sawing and sorting system may include operations substantially unrelated to the sawing and sorting operations, for example a strip and/or unit package transfer operation, a visual test operation, a cleaning operation and a drying operation.

SUMMARY OF THE INVENTION

[0018] An exemplary embodiment of the invention is directed to a sawing and sorting system, in which a combi-
nation of a sawing apparatus and a sorting apparatus may facilitate change and/or maintenance of a tool and/or parameter.

[0019] Another exemplary embodiment of the invention is directed to a sawing and sorting system, in which the amount of a cleaning solution and/or air used in a cleaning operation may be reduced and the cleaning time may be reduced.

[0020] Another exemplary embodiment of the invention is directed to a sawing and sorting system, in which the time of operations other than sawing and sorting operations may be reduced, thereby improving productivity.

[0021] In an exemplary embodiment, a sawing and sorting system combines a sawing process and a sorting process. The sawing and sorting system comprises a loader having a magazine receiving a plurality of strips. A mounting unit, which may include a guide rail, mounts the strip on a plurality of transfer and sawing robots, each transfer and sawing robot comprising a picker unit having a rotatable chuck table, which holds the strip by vacuum. The picker unit is preferably movable in horizontal and vertical directions. The sawing and sorting system comprises a plurality of sawing spindle units, each having a rotary blade. The sawing spindle unit moves the blade horizontally to divide the strip into unit packages. A cleaning unit cleans the unit package. A sorting table mounts the unit package for sorting. A test means inspects the unit package according to predetermined test criteria. An unloader provides trays. A sorting transfer robot sorts the unit package into the trays according to the test results.

[0022] The sawing spindle unit, the cleaning unit and the sorting table are preferably arranged in order, spaced from the mounting unit. In an exemplary embodiment, there are two transfer and sawing robots. The picker units of the transfer and sawing robots preferably face in opposite directions to avoid a collision.

[0023] In an exemplary embodiment, there are two sawing spindle units. The sawing spindle units preferably move perpendicularly to the traveling direction of the picker unit. Preferably, each sawing spindle unit independently moves in horizontal and vertical directions.

[0024] In an exemplary embodiment, the sawing and sorting system includes a plurality of the sorting tables.

[0025] The sawing and sorting system further comprises a vision camera and an alignment table located between the mounting unit and the sawing spindle unit.

[0026] In an exemplary embodiment, the transfer and sawing robots may perform separate operations. While one of the transfer and sawing robots may perform a sawing operation, the other transfer and sawing robot may perform cleaning, drying and sorting operations and start an alignment operation for a new strip.

**BRIEF DESCRIPTION OF THE DRAWINGS**

[0028] **FIG. 1** is a schematic plan diagram of a conventional sawing and sorting system.

[0029] **FIG. 2** is a schematic cross-sectional diagram of a sawing process by a sawing apparatus of a conventional sawing and sorting system.

[0030] **FIG. 3** is a schematic perspective diagram of a sawing and sorting system in accordance with an exemplary embodiment of the invention.

[0031] **FIG. 4** is a schematic plan diagram of a sawing and sorting system in accordance with an exemplary embodiment of the invention.

[0032] **FIG. 5** is a schematic perspective diagram of a transfer and sawing robot of a sawing and sorting system in accordance with an exemplary embodiment of the invention.

[0033] **FIG. 6** is a schematic perspective diagram of a sawing spindle unit of a sawing and sorting system in accordance with an exemplary embodiment of the invention.

[0034] **FIG. 7** is a schematic cross-sectional diagram of a sawing process by a sawing and sorting system in accordance with an exemplary embodiment of the invention.

[0035] **FIG. 8** is a timing chart illustrating the operation of a sawing and sorting system in accordance with an exemplary embodiment of the invention.

[0036] These drawings are provided for illustrative purposes only and are not drawn to scale. The spatial relationships and relative sizing of the elements illustrated in the various embodiments may have been reduced, expanded, or rearranged to improve the clarity of the figure with respect to the corresponding description. The figures, therefore, should not be interpreted as accurately reflecting the relative sizing or positioning of the corresponding structural elements that could be encompassed by an actual device manufactured according to the exemplary embodiments of the invention.

**DETAILED DESCRIPTION OF THE EMBODIMENTS**

[0037] The invention will be described below with reference to the accompanying drawings, in which exemplary embodiments of the invention are illustrated. It will be appreciated that the invention may be embodied in many different forms and should not be construed as limited to the particular embodiments set forth herein. Rather, the disclosed embodiments are provided so that this disclosure will be thorough and complete, and will fully convey the scope of the invention to those skilled in the art.

[0038] Well-known structures and processes have not been described or illustrated in detail to avoid obscuring the invention. For simplicity and clarity of illustration, some elements illustrated in the figures may not be drawn to scale. For example, the dimensions of some of the elements may be exaggerated or reduced relative to other elements for clarity.

[0039] Referring to FIGS. 3 and 4, an exemplary embodiment of a sawing and sorting system **100** combines a sawing process and a sorting process. The sawing and sorting system **100** comprises transfer and sawing robots **30** and **40**, sawing spindle units **61** and **62**, cleaning units **71** and **72**, and sorting tables **81** and **82**. The sawing and sorting system...
100 further comprises a loader 10, a guide rail 21, an unloader 93 having trays 7, 8 and 9, and vision cameras 55 and 57.

[0040] The functions of the elements of the sawing and sorting system 100 are now described.

[0041] The loader 10 is preferably installed at one end of the sawing and sorting system 100. The loader 10 comprises a magazine 3 for receiving the strip 1. The loader 10 further comprises an elevator 15, which moves the magazine vertically, and a pusher 17, which pushes the strip 1 received in the magazine 3 to the guide rail 21. The guide rail 21 mounts the strip 1 on the transfer and sawing robots 30 and 40 by guiding the strip 1 to a pickup position of the first and second transfer and sawing robots 30 and 40. The guide rail 21 may use an air pressure cylinder or a belt driven by a motor.

[0042] A first vision camera 51 and an alignment table 37 are preferably located at one side of the guide rail 21. The first vision camera 51 and the alignment table 37 are preferably installed and movable on their operating rails 52 and 58, respectively, which extend in the Y direction. Reference numeral 39 is a tool station.

[0043] The transfer and sawing robots 30 and 40 extend in the X direction and comprise picker units 31 and 41, respectively. In an embodiment, the picker unit 31 is preferably configured as shown in FIG. 5. The picker units 31 and 41 each comprise a rotatable chuck table 35. The strip 1 and/or a unit package 5 may be held under the rotatable chuck table 35 by vacuum. The picker units 31 and 41 are preferably movable in the X and Z directions and face in opposite directions so that the transfer and sawing robots 30 and 40 may perform separate operations. The picker units 31 and 41 also preferably have rotation axes 33 and 43, respectively, to change the sawing orientation and adjust the sawing position.

[0044] Referring back to FIGS. 3 and 4, the sawing spindle units 61 and 62 are located in the traveling route of the picker units 31 and 41. The sawing spindle units 61 and 62 are preferably of a so-called twin type to allow a double sawing performance. The sawing spindle units 61 and 62 are also preferably movable in the X, Y and Z directions to adjust their vertical and horizontal separation. The movement direction of each of the sawing spindle units 61 and 62 may be adjustable, if necessary. For example, the sawing spindle unit 61 may be movable in the Z direction and the sawing spindle unit 62 may be movable in the X direction.

[0045] In the embodiment shown in FIG. 6, the sawing spindle units 61 and 62 are installed and movable on guide axes 65 and 66, respectively, which extend in the Y direction. The guide axes 65 and 66 may be modifiable to various types, for example a rail type.

[0046] As shown in FIG. 4, the cleaning units 71 and 72 are preferably located adjacent to the sawing spindle units 61 and 62. The cleaning units 71 and 72 clean and dry the top and bottom surfaces of the strip 1. The cleaning and drying processes may be performed consecutively.

[0047] Referring again to FIGS. 3 and 4, the sorting tables 81 and 82 are preferably located adjacent to the cleaning units 71 and 72. The sorting tables 81 and 82 are installed and movable on sorting table rails 83 and 84, respectively, which extend in the Y direction. A second vision camera 55 is located above the sorting tables 81 and 82 along the traveling route of the sorting tables 81 and 82. The second vision camera 55 is installed and movable on a second camera rail 56, inspects one surface of the unit package 5.

[0048] A tray guide rail 91, located adjacent to the sorting tables 81 and 82, guides the movement of the trays 7 and 8. A tray transfer unit 95 transfers the trays 7 and 8 from the tray guide rail 91 to the unloader 93. When trays 7 and 8 are already filled with packages, tray 9 may be provided for receiving packages next. The tray transfer unit 95 also transfers the tray 9 to the tray guide rail 91.

[0049] A third vision camera 57, located between the tray guide rails 91, inspects the other surface of the unit package 5. The third vision camera 57 is installed and movable on a third camera rail 58, which extends in the Y direction. A sorting transfer robot 85 moves between the sorting tables 81 and 82 and the tray guide rail 91. The sorting transfer robot 85 sorts the unit package 5 according to the test results.

[0050] The operation of a sawing and sorting system in accordance with the exemplary embodiment of the invention will be described. The magazine 3 receiving the strip 1 is provided in the loader 10. The strip 1 is mounted on the guide rail 21 and then moved to a pickup position of the first and second transfer and sawing robots 30 and 40. The picker units 31 and 41 of the first and second transfer and sawing robots 30 and 40 absorb the strip 1 by vacuum and transfer the strip 1 above the first vision camera 51. The first vision camera 51 inspects the strip alignment on the picker units 31 and 41. If the strip alignment is incorrect, the picker units 31 and 41 place the strip 1 on the alignment table 37. The strip alignment is adjusted by rotating the picker units 31 and 41 along the rotation axes 33 and 43, respectively. If the strip alignment is correct, the picker units 31 and 41 move the strip 1 to the sawing spindle units 61 and 62.

[0051] To begin the sawing process, either the picker units 31 and 41 move downward or the sawing spindle units 61 and 62 move upward. The rotary blades 63 and 64 then saw the strip 1 in one direction, together with the Y-axis movement of the sawing spindle units 61 and 62. After the strip 1 is sawn in one direction, the blades 63 and 64 are withdrawn from the strip 1. To begin sawing in the other direction, the picker units 31 and 41 rotate through 90 degrees by rotation of the rotation axes 33 and 43. Next, either the picker units 31 and 41 move downward or the sawing spindle units 61 and 62 move upward. The rotary blades 63 and 64 then saw the strip 1 in the other direction. The operation of the two sawing spindle units 61 and 62 may allow a reduced time of the sawing process.

[0052] In the case of a flexible substrate such as a tape type or film type, a strip carrier or frame (not shown) may support the substrate strip. However, the strip carrier supporting the strip 1 may be unnecessary after the sawing process. Thus, after the sawing process, the strip carrier supporting the strip 1 is received in a carrier box 79.

[0053] During the sawing process, debris may be generated. Conventionally, debris generated during the sawing process was separated from the strip 1 and/or unit packages 5 using a cleaning solution. In some instances, debris may drift onto the unit packages 5 due to the spraying of the cleaning solution. Thus, the conventional art may require a considerable cleaning time to completely separate debris from the unit packages 5.
In the exemplary embodiment of the sawing and sorting system 100, debris generated during the sawing process may be removed during the sawing process. Contrary to the conventional art as shown in FIG. 2, in the sawing and sorting system 100, the unit packages 5 may be held below the rotatable chuck table 35 by vacuum as shown in FIG. 7. A nozzle unit 67 installed adjacent to the blade 63 sprays a cleaning solution toward the unit packages 5. Therefore, debris generated during the sawing process is also separated from unit packages 5 by gravity. Thus, the use of gravity in the sawing and sorting system 100 may decrease the amount of debris that remains on the unit packages 5, thereby reducing the cleaning time required.

After the sawing process, the picker units 31 and 41 pick up the unit packages 5 and move the unit packages 5 to the cleaning units 71 and 72. The cleaning units 71 and 72 clean and dry the top and bottom surfaces of the unit packages 5 to remove debris and moisture from the unit packages 5. The cleaning units 71 and 72 are preferably located apart from the other units, thereby preventing the cleaning solution from splashing to the other units.

After cleaning, the picker units 31 and 41 transfer the unit packages 5 to the sorting tables 81 and 82. The vision cameras 55 and 57 inspect the unit packages 5 according to the inspection criteria. The sorting transfer robot 85 sorts the unit packages 5 into, for example, the tray 7 for good packages or the tray 8 for faulty packages.

In the exemplary embodiment of the invention, each of the transfer and sawing robots 30 and 40 may perform separate operations. For example, while the transfer and sawing robot 30 and the sawing spindle units 61 and 62 divide the strip 1 into the unit packages 5, the transfer and sawing robot 40 cleans and dries the unit packages 5, transfers the unit packages 5 to the sorting tables 81 and 82, and then picks up a new strip 1 from the guide rail 21 and performs a subsequent process. Further, while the transfer and sawing robot 40 and the sawing spindle units 61 and 62 divide the strip 1 into the unit packages 5, the transfer and sawing robot 30 cleans and dries the unit packages 5, transfers the unit packages 5 to the sorting tables 81 and 82, and then picks up a new strip 1 from the guide rail 21 and performs a subsequent process. In other words, while one of the transfer and sawing robots 30 and 40 performs a sawing process, the other of the transfer and sawing robots 30 and 40 performs any process other than a sawing process.

Thus, the exemplary embodiment of the sawing and sorting system combines a sawing apparatus and a sorting apparatus, which may facilitate changes and/or maintenance of a tool and/or parameter.

The sawing and sorting system comprises a twin blade type sawing spindle unit, thereby reducing the time of the sawing process. The sawing and sorting system may also reduce the amount of the cleaning solution and air used in the cleaning process.

Further, the sawing and sorting system may reduce the time of a process other than a sawing process and a sorting process. For example, the strip and/or unit package transfer, the cleaning, and the drying processes require reduced time compared with a conventional system. Particularly, the efficiency of the cleaning process may be improved.

Having described exemplary embodiments of the invention, it is noted that modifications and variations can be made by persons skilled in the art in light of the above teachings. Therefore, it is to be understood that changes may be made to the embodiments of the invention disclosed that are nevertheless still within the spirit and scope of the invention as defined in the appended claims.

What is claimed is:
1. A sawing and sorting system comprising:
a plurality of transfer and sawing robots to position a substrate strip in the system, each transfer and sawing robot comprising:
a chuck table to hold the substrate strip; and
a pick up unit movable in a vertical and horizontal direction to rotate the chuck table;
a plurality of sawing spindle units, each sawing spindle having a rotary blade to divide the substrate strip into unit packages;
a cleaning unit to clean the unit package; and
a testing and sorting unit to sort the cleaned unit packages.
2. The system of claim 1, further comprising:
a loader having a magazine to receive a plurality of substrate strips; and
a mounting unit to mount the substrate strips individually from the loader to the plurality of transfer and sawing robots.
3. The system of claim 1, further comprising:
an alignment unit to align the substrate strip in the picker unit.
4. The system of claim 3, wherein the alignment unit comprises:
a camera to check the alignment of the substrate strip; and
an alignment table to adjust the alignment of the substrate strip, wherein the camera and the alignment table are installed between the mounting unit and the sawing spindle units.
5. The system of claim 1, wherein the testing and sorting unit to sort the cleaned unit packages comprises:
a sorting area to receive the cleaned unit packages from the cleaning unit;
a test unit to inspect the cleaned unit packages in the sorting area according to a test criteria; and
a sorting transfer robot to sort the inspected unit packages according to the test results.
6. The system of claim 5, wherein the sorting area comprises a plurality of sorting tables.
7. The system of claim 5, wherein the test unit comprises a plurality of cameras.
8. The system of claim 5, wherein the sawing spindle unit, the cleaning unit and the sorting table are arranged in order, spaced from the mounting unit.
9. The system of claim 1, comprising two transfer and sawing robots arranged in parallel to each other.
10. The system of claim 1, wherein the picker units of the transfer and sawing robots face in opposite directions.
11. The system of claim 1, comprising two sawing spindle units, wherein the sawing spindle units move perpendicularly to the movement direction of the picker unit.
12. The system of claim 1, wherein each sawing spindle unit moves vertically and horizontally.
13. The system of claim 9, wherein one of the transfer and sawing robots and the sawing spindle units performs a sawing process and the other of the transfer and sawing robots performs any process other than the sawing process.
14. The system of claim 1, wherein the substrate strip is held underneath the chuck table.
15. A method of sawing substrate strips into unit packages and sorting the unit packages, comprising:
   - mounting substrate strips individually on a plurality of transfer and sawing robots;
   - transferring the substrate strips to a plurality of sawing spindle units;
   - dividing the substrate strips into a plurality of unit packages;
   - cleaning the unit packages;
   - inspecting the unit packages; and
   - sorting the unit packages.
16. The method of claim 15, wherein dividing the substrate strips comprises:
   - sawing the substrate strips in a first direction;
   - rotating the substrate strips in a second direction perpendicular to the first direction; and
   - sawing the substrate strips in the second direction.
17. The method of claim 15, wherein cleaning the unit packages comprises:
   - cleaning top and bottom surfaces of the substrate strips at the same time; and
   - drying the top and bottom surfaces of the substrate strips at the same time.
18. A sawing and sorting system, comprising:
   - a means for positioning a substrate strip in the system;
   - a means for dividing the substrate strip into unit packages;
   - a means for cleaning the unit packages; and
   - a means for sorting the cleaned unit packages.
19. The system of claim 18, further comprising:
   - a means for receiving a plurality of substrate strips;
   - a means for mounting the substrate strips individually to the means for positioning the substrate strip in the system.
20. The system of claim 18, further comprising:
   - a means for aligning the substrate strip before dividing the substrate into unit packages.

* * * * *