

PROCESSING SYSTEM AND METHOD FOR LARGE SCALE SUBSTRATES

Field of the Invention

5 The invention relates to the processing of substrates of integrated circuits (IC) units and the subsequent dicing of such substrates to singulate the individual IC units. In particular, the invention relates to a method and system to process large scale substrates such as 300 x 300 and 500 x 500 substrates.

10 **Background**

The key economic determinants in the processing of IC substrates are UPH (units per hour) and subsequent wastage. In order to economically manage a system a high rate of processing the units must be maintained with end customers seeking faster and faster
15 rates. However, whilst systems of the prior art sacrifice quality for UPH, it is nevertheless an important objective to minimise wastage.

For a fully automated system a misaligned IC unit at any stage in the process may result in rejection. In the past, systems handled large sized IC units within small scale
20 substrates. It follows that mishandling of the IC units was much less of a problem compared to other factors leading to rejection. However, with the advent of large scale substrates such as 300 x 300 and 500 x 500, the volume of units has increased dramatically leading to a higher probability of individual units being misaligned.

Further still, with the ever demanding goal of reducing the package size, the individual IC units themselves are substantially smaller than those of the prior art. Accordingly, faults such as incomplete vacuum seals, uncontrolled airflow, temperature variation and vibration are all factors that can lead to misalignment which in the past have not been
5 considered significant.

Summary of Invention

In a first aspect, the invention provides an alignment assembly for aligning a plurality of
10 IC units, the assembly comprising: a plate having vacuum apertures for receiving said IC units on an engagement surface; a first alignment member having a plurality of projections and recesses uniformly distributed along a first engagement edge; a second alignment member having a plurality of projections and recesses uniformly distributed along a second engagement edge; said first and second alignment members in sliding
15 contact with the engagement surface; wherein said first and second alignment members arranged to move relative to each other so as to intermesh said respective projections and recesses, said intermeshed projections and recesses arranged to define a linear array of rectangular apertures sized to fit said IC units in an aligned condition.

20 In a second aspect, the invention provides a method for aligning a linear array of IC units, the method comprising the steps of: providing first and second alignment members in sliding contact with a surface, said members having projections and recesses along respective first and second engagement edges; placing said IC units on

the surface intermediate the engagement edges; relatively moving first and/or second alignment members from a distal position and to an intermesh position, and so intermeshing said respective projections and recesses; said intermeshed projections and recesses surrounding said placed IC units, and; aligning said IC units within rectangular apertures defined by the intermeshed projections and recesses.

In a third aspect, the invention provides a picker assembly for engaging and moving IC units, the assembly comprising: a plurality of pickers mounted to a carriage, said carriage arranged to be mounted to a rail; each picker having a longitudinal actuator for extending and retracting the picker from a retracted position to a unit engagement position along a longitudinal axis of said picker; each of said pickers being in rotational engagement with said carriage, said carriage including a rotational actuator for rotating each of said pickers about each respective longitudinal axis.

In a fourth aspect, the invention provides a method for aligning an IC unit, the method comprising the steps of: engaging said IC unit in vacuum engagement by a picker; inspecting said unit and determining an alignment of said IC unit; comparing the alignment with a pre-determined alignment; communicating said alignment to said picker, and; rotating said picker, so as to rotate the IC unit to the pre-determined alignment.

In a fifth aspect, the invention provides a wash station for washing IC units, said station comprising: a housing washing tank having an aperture for coupling with a picker

assembly arranged to engage a plurality of IC units; at least one water jet directed at the aperture and arranged to spray water on the IC units engaged with the picker assembly coupled to said aperture; at least one air jet for projecting an air flow towards a basedownwards of said housing; a lifting holding table mounted to an actuator, said
5 actuator arranged to move the holding table from the base of the washing tank housing to a position proximate to the aperture; wherein said holding lifting table arranged to receive the IC units in vacuum engagement on release for the picker assembly and move to the base so as to permit the IC units to receive the air flow.

10 In a sixth aspect, the invention provides a method of washing IC units including the steps of: engaging said IC units with a picker assembly; coupling the picker assembly with an aperture of a washing tank; directing a water jet at the IC units; raising a holding table to receive the IC units from the picker assembly; the picker assembly disengaging the IC units then the lifting table engaging the IC units; lowering the
15 holding table; directing an air flow at the IC units.

In a seventh aspect, the invention provides an inspection station for inspecting IC units, comprising: at least one pair of mirrors, said at least one pair of mirrors spaced to receive a picker having an IC unit engaged therewith, and positioned to direct vision of
20 at least two opposed sides of the IC units to a camera.

In a eighth aspect, the invention provides A method of inspecting an IC unit comprising the steps of: inserting a picker having the IC unit engaged therewith; directing vision of said IC unit to a camera via at least one pair of mirrors.

5 Accordingly, a dedicated alignment assembly has the advantage of eliminating misalignment factors upstream of the alignment assembly. Further still, it may allow for the removal of an inspection station whereby a prior art system may include an alignment inspection station to determine whether any IC units are to be rejected. By providing the alignment assembly any misaligned IC units upstream from the alignment
10 device will be corrected as part of the process.

Further still, by providing a picker assembly capable of rotation about a longitudinal axis of each picker means that individual IC units can be realigned based upon information received from an upstream alignment inspection station. The picker
15 assembly according to the present invention therefore allows for the processing of IC units in chaotic arrangement of misaligned IC units as part of the normal processing procedure. The degree of misalignment may be substantially irrelevant as the rotational realignment of each picker within the picker assembly may be up to 180 degrees with an incremental tolerance of 5 minutes.

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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.

Figure 1 is a plan view of a processing system according to one embodiment of the present invention;

Figure 2 is a flow chart for a process consistent with the system of Figure 1;

Figures 3A to 3F are various views of an alignment assembly according to one embodiment of the present invention;

Figures 4A to 4C are various views of a picker assembly according to one embodiment of the present invention;

Figure 5 is an isometric view of an inspection system according to one embodiment of the present invention;

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Figure 6 is an isometric view of an inspection system according to a further embodiment of the present invention;

Figures 7 is an elevation view of a washing station according to one embodiment of the present invention.

Detailed Description

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Figure 1 shows a plan view of a system for processing large scale substrates of integrated circuits. This system is generally divided into the onloader, sawing engine and handler. Figure 2 shows a flow chart of the process steps in processing the substrates through the system of Figure 1.

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A pusher 1 loads the magazine and subsequently loads a panel 2 onto the inlet rail. A first vision station checks 3 for orientation and the type of substrate before loading the panel onto the chuck table 4, 5. Here the panel is diced 5 by dicing saws and the units transferred to a washing station 8 whereupon a unit picker engages the units and drags
15 them across a brush to remove detritus left after the dicing process.

The units undergo a washing process 6, 7 and are then subjected to a hot air flow to remove excess water. The unit picker will place a half of units to first net block and then the units undergo a second vision to inspect the pad or ball on a net block 13, and the
20 same sequence to on a net block 14. The final placement on 14A and 14B stations can be combined or split depending on the IC chips design requirement or can be flipped 180 degree if live bug placement required as optional. The units are then pre-aligned to ensure that each IC unit is correctly aligned prior to packaging. The units undergo a

third inspection 15 before being sorted into a good unit tray or re-work unit tray and finally sorted to a tray or canister 17, 18 for eventual delivery to the end customer.

Of particular interest in this process is the potential for a new washing station, the pre-aligning assembly and the available alternatives for the unit picker assembly. A new inspection system may also be used within this process.

Figures 3A to 3F show an alignment assembly for aligning IC units. The alignment assembly 25 comprises a plate 95 having vacuum apertures for engaging IC units on the plate in a linear array. Typically the IC units are delivered to the alignment assembly by a unit picker which lowers the units to the plate 95 and disengages its vacuum source releasing the units to the plate 95. In sliding engagement with an engagement surface of the plate are two alignment members 30, 35 which move relative to each other from a distal position to an intermesh position whereby projections on each of the members intermesh with each other into corresponding recesses of the opposed alignment member. Movement of the alignment members is controlled by a motor 40 which has a belt drive 45, 50 to operate a pair of cams 70, 75. The cams are in contact with followers 80, 85 which are mounted to the first and second plates 30, 35 and are spring loaded so as to remain in contact with the cam. The followers are coupled to the alignment members so that on rotation of the cams the followers are either pushed outwards so as to place the alignment members in the distal position or drawn inwards by a spring loaded arrangement placing the two alignment members into an intermesh position. Figures 3D, 3E and 3F show the operation of the alignment assembly. Figure

3D shows the two alignment members 30, 35 in the distal position with the IC units 85 are engaged with the vacuum apertures. Having being placed there by the unit picker, the units are uniformly spaced from each other, however, given the movement of the IC units during the upstream processing steps, the IC units may not all be in the correct rotational alignment. In order for the units to be packaged correctly they need to be within the pre-determined alignment, that is, in an aligned condition so as to avoid being rejected. On operation of the motor and subsequently the cams, the alignment members are brought into the intermesh position as shown in Figure 3E. Because of the arrangement of the cams and followers, the members move in an inclined direction 110, 115 towards each other. Looking at Figure 3F the effect can be seen more clearly whereby the engagement edges 82, 84 of the alignment members 30, 35 comprise recesses 95 and projections 105. The intention is to form a linear array of rectangular apertures of a size to fit the IC units with the projections 105 having alignment faces 100 to ensure that the IC units 85 are aligned correctly. By placing the IC units within the alignment assembly the movement of the alignment members brings all the IC units into a uniform alignment ready for packaging.

It will be appreciated that the alignment assembly will be of particular use not only in the system shown in Figure 1 but also any system where the alignment of IC units is a critical factor.

An alternative arrangement of the alignment assembly may include a central fixed anvil whereby two parallel rows of IC units may be placed in contact with the anvil and the

first and second alignment members move into an intermesh engagement with the anvil and thus aligning any misaligned IC units between the respective alignment member and the anvil.

5 A unit picker assembly is an important feature of any IC unit processing system. For the system of Figure 1 a conventional unit picker assembly may be used. Alternatively, a unit picker assembly as shown in Figures 4A to 4C may also be used. As can be seen in Figure 4C, the picker assembly 120 according to the present invention is arranged to engage IC units 170 from a net block 175 through a vacuum engagement nozzle 125 as
10 is the case with a conventional unit picker assembly. However, as seen in Figures 4A and 4B the unit picker assembly 120 according to the present invention allows for rotation 165 about the longitudinal axis 166 of each of the pickers 125. As with conventional picker assemblies, each unit picker 125 includes an actuator 135 having a pusher 140 mounted thereto which pushes against a spring 105 to extend the picker 125
15 to engage the IC unit. Once engaged, the actuator 135 is released and the spring 105 retracts the unit picker 125. For the present invention there is further mounted to the unit picker assembly 120 a motor 155, such as a programmable actuator, mounted to each of the pickers 125 through a belt drive 150. Bearings 160 allow the picker 125 to rotate 165 about axis 166 on operation of the belt drive 150. This is important because
20 it allows an IC unit that has been engaged by the picker to be rotated about the longitudinal axis 166 of the picker 125 and so re-align the unit into the desired orientation. As each of the pickers 125 within the unit picker assembly 120 have the rotational actuator 150, 155, each of the pickers 125 is capable of independently rotating

the IC units and so the unit picker assembly is capable of engaging a chaotic arrangement of IC units and individually re-aligning the IC units into the desired position. Thus, the unit picker assembly 120 according to the present invention is not merely a means of transport of individual IC units but becomes an alignment device as well. In a particular process, the unit picker assembly 120, on engaging a plurality of misaligned IC units, may pass an upward directed inspection station which identifies the misalignment of the IC units and communicates the required corrective rotation of each individual unit to the unit picker assembly which then applies to each IC unit according to the information provided.

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Figures 5 and 6 show two inspection stations according to two aspects of the present invention. For Figure 5 the principle involves using a four side inspection process whereby the unit picker assembly 180 sequentially moves each picker 185, each having an IC unit engaged therein, to insert 190 within the inspection station 195. Here, an orifice 205 has four mirrors about the picker whereby the inspection unit 195 provides vision based upon the four circumferential mirrors about the IC unit in order to get a full or surround view of the unit. Such an arrangement provides for detecting damage to the IC unit as well as alignment and cleaning issues and therefore is a versatile approach to inspection using both conventional unit picker assemblies 180 and the rotatable unit assembly according to the present invention.

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Figure 6 shows an alternative inspection station for particular use with the rotatable unit picker assembly according to the present invention. Such a unit picker assembly 210 is

arranged to pass through two inspection blocks 215, 220. Each inspection block 215, 220 has a pair of mirrors 225 aligned parallel to the direction of movement 230 of the unit picker assembly 210. The unit picker assembly 210 passes through the first inspection block 215 and all of the IC units within the picker assembly 210 are

5 inspected by the side mirrors whereby the sides parallel to the direction of movement 230 are inspected. Having passed through the first block 215, each of the unit pickers rotate 245, 90 degrees in the intermediate zone 240. The unit picker assembly 210 then moves 235 through the second inspection block 220 whereby a second side inspection is conducted. However, as the unit pickers have now rotated, the sides not inspected in the

10 first block 215 are now subject to side inspection within the second block 220. As a result, having passed through the first and second blocks 215, 220, both sides of the IC units engaged within the unit picker assembly 210 have now been completely inspected.

Figure 7 shows a further aspect of the present invention, being a washing station 250

15 arranged to wash IC unit following singulation.

Here a unit picker 285 lowers into an aperture of a wash tank 295. The aperture may include a seal or gasket for sealing the unit picker in place, and so effectively sealing the washing tank. A water jet 255 then directs a spray onto the IC units 305 whilst still

20 engaged with the unit picker 285.

A holding table 279 rises from a base of the wash tank 295 until proximate with the unit picker 285. The vacuum of the unit picker releases the IC units which are then engaged by the holding table 270.

5 The holding table then lowers, with the IC units to the base so as to be immersed in a fluid. Ultrasonic generators 280 then project ultrasonic vibration within the immersion fluid 300, which may be water, so as to vibrate the IC units and subsequently loosen and remove particles.

10 Finally, the holding table 270 raises above the immersion fluid where is is subjected to a second water jet 260, followed by an air jet to remove excess water and any final particles still adhering to the IC units.

The holding table then rises to be proximate to the unit picker, where the IC units are
15 transferred back to the unit picker. The unit picker retracts from the aperture and continues processing.

Claims

1. An alignment assembly for aligning a plurality of IC units, the assembly comprising:
 - 5 a plate having vacuum apertures for receiving said IC units on an engagement surface;
 - a first alignment member having a plurality of projections and recesses uniformly distributed along a first engagement edge;
 - a second alignment member having a plurality of projections and recesses
 - 10 uniformly distributed along a second engagement edge;
 - said first and second alignment members in sliding contact with the engagement surface;
 - wherein said first and second alignment members arranged to move relative to each other so as to intermesh said respective projections and recesses, said
 - 15 intermeshed projections and recesses arranged to define a linear array of rectangular apertures sized to fit said IC units in an aligned condition.
2. The alignment assembly according to claim 1, wherein at least one of said alignment members having a follower in resilient contact with a cam and
- 20 arranged such that on rotation of said cam, the at least one plate moves from a distal position whereby the plates are separated to an intermesh position whereby the projections and recesses are intermeshed.

3. The alignment assembly according to claim 2, wherein the cam is arranged such that the relative movement of said alignment members is along a path inclined to an axis of said linear array.
- 5 4. The alignment assembly according to any one of claims 1 to 3, wherein said projections and recesses include alignment faces arranged contact and bias misaligned IC units so as to place said misaligned IC units into the aligned condition.
- 10 5. A method for aligning a linear array of IC units, the method comprising the steps of:
providing first and second alignment members in sliding contact with a surface, said members having projections and recesses along respective first and second engagement edges;
15 placing said IC units on the surface intermediate the engagement edges;
relatively moving first and/or second alignment members from a distal position and to an intermesh position, and so intermeshing said respective projections and recesses;
said intermeshed projections and recesses surrounding said placed IC units, and;
20 aligning said IC units within rectangular apertures defined by the intermeshed projections and recesses.

6. The method according to claim 5 wherein the relatively moving step includes the steps of:
- rotating at least one cam, said at least one cam in contact with at least one follower mounted to the first alignment member;
- 5 moving said follower by said cam rotation and so moving the first alignment member.
7. The method according to claim 5 wherein the relatively moving step includes the steps of:
- 10 rotating a first and second cam, said cams in contact with followers respectively mounted to the first and second alignment members;
- moving said followers by said cam rotation and so moving the first and second alignment members.
- 15 8. A picker assembly for engaging and moving IC units, the assembly comprising:
- a plurality of pickers mounted to a carriage, said carriage arranged to be mounted to a rail;
- each picker having a longitudinal actuator for extending and retracting the picker from a retracted position to a unit engagement position along a longitudinal axis
- 20 of said picker;
- each of said pickers being in rotational engagement with said carriage, said carriage including a rotational actuator for rotating each of said pickers about each respective longitudinal axis.

9. The picker assembly according to claim 8, wherein said picker assembly in communication with an inspection station arranged to inspect IC units engaged by said pickers;
said inspection station arranged to measure an alignment of said IC units and communicate said alignment corresponding to a respective picker;
said picker assembly arranged to adjust an alignment of misaligned IC units through rotation of said respective picker.

10. A method for aligning an IC unit, the method comprising the steps of:

engaging said IC unit in vacuum engagement by a picker;
inspecting said unit and determining an alignment of said IC unit;
comparing the alignment with a pre-determined alignment;
communicating said alignment to said picker, and
rotating said picker, so as to rotate the IC unit to the pre-determined alignment.

11. A method for aligning an IC unit wherein said picker is at least one of said pickers within the picker assembly of claim 9 or 10.

12. A wash station for washing IC units, said station comprising:

a washing tank having an aperture for coupling with a picker assembly arranged to engage a plurality of IC units;

5 at least one water jet directed at the aperture and arranged to spray water on the IC units engaged with the picker assembly coupled to said aperture;

at least one air jet for projecting an air flow downwards;

a holding table mounted to an actuator, said actuator arranged to move the holding table from the base of the washing tank to a position proximate to the aperture;

10 wherein said holding table arranged to receive the IC units in vacuum engagement on release for the picker assembly and move to the base so as to permit the IC units to receive the air flow.

15 13. The washing station according to claim 12, further including a second water jet directed downwards and arranged to direct water onto the holding table when above the immersion fluid.

14. The washing station according to claim 12 or 13, further including an ultrasonic generator mounted within the washing tank, said washing tank arranged to receive a retain a volume of immersion fluid sufficient to immerse the holding table, said ultrasonic generator arranged to emit ultrasound through the immersion fluid.

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15. A method of washing IC units including the steps of:

- 5 engaging said IC units with a picker assembly;
coupling the picker assembly with an aperture of a washing tank;
directing a water jet at the IC units;
raising a holding table to receive the IC units from the picker assembly;
the picker assembly disengaging the IC units then the lifting table engaging the
10 IC units;
lowering the holding table;
directing an air flow at the IC units.

16. The method according to claim 15, further including the steps, after the directing

- 15 step, of:
immersing the lifting table in an immersion fluid;
generating ultrasonic waves into the immersion fluid to vibrate the IC units.

17. The method according to claim 16, further including the steps, after the

- 20 generating step and before directing an air flow, of raising the holding table
above the immersion fluid and directing a water jet onto said holding table.

18. An inspection station for inspecting IC units, comprising:

at least one pair of mirrors,

said at least one pair of mirrors spaced to receive a picker having an IC unit engaged therewith, and positioned to direct vision of at least two opposed sides of the IC units to a camera.

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19. The inspection system according to claim 18, wherein there are two pairs of mirrors in a rectangular orientation and spaced to receive the picker having the IC unit;

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said two pairs of mirrors arranged to direct vision from four sides of the IC unit to a camera.

20. The inspection system according to claim 19, wherein said two pairs of mirrors are positioned in a block having an aperture arranged to receive the picker.

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21. The inspection system according to claim 18, further including two pairs of mirrors, each pair positioned within two respective blocks, each block having a passage intermediate the mirrors.

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22. A method of inspecting an IC unit comprising the steps of:

inserting a picker having the IC unit engaged therewith;

directing vision of said IC unit to a camera via at least one pair of mirrors.

23. The method according to claim 22, wherein the inserting step includes moving the picker through a passage intermediate a first pair of mirrors, and the directing step including directing vision of a pair of opposed sides of the IC unit to the camera, then;

5 rotating the IC unit and moving the picker through a passage intermediate a second pair of mirrors and then directing vision of a second opposed sides of the IC unit to a second camera.

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