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DICING SYSTEM AND METHOD

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Field of the Invention

The invention relates to the singulation of substrates containing a plurality of individual integrated circuit units. In particular, the invention relates to the system and method of processing such substrates where varying conditions are required including different types of substrates and different forms of singulation.

Background

In the processing of integrated circuit units for large volume of similar IC units, a key determinant for the processing equipment may be the speed and quality by which the units are processed.

In a different market where varying types of integrated circuit units or different requirements for their processing are necessary, then key determinants will also be quality but also the flexibility of the processing equipment.

For instance, in the dicing of substrates into individual IC units where the dicing or singulation system may need to deal with different conditions, the volume of substrates in any particular condition may be substantially reduced. Thus, speed may not be so critical and compared to the ability to manage this flexibility.

To date systems dealing with this flexibility involves multiple machines handling small volumes in order to achieve the desired result. The capital costs of having multiple machines is, however, extremely high and it would be preferable if a less capital intensive solution were available.

Summary of Invention

In a first aspect the invention provides a singulation system for dicing IC units from a substrate comprising; a block for receiving said substrate, said block movable from a substrate receiving station to a dicing station; a first dicing saw for dicing the substrate when at the dicing station; a second dicing saw for dicing the substrate when at the dicing station; wherein the first and second dicing saws are of different varieties so as to perform different dicing functions on said substrate.

In a second aspect the invention provides a method of dicing IC units from a substrate, the method comprising steps of: providing a singulation system comprising first and second dicing saws; moving the substrate to said second saw: partially cutting a metal layer of said substrate with said second saw; moving the substrate to the first saw completing the cut of the substrate using said first saw.

In a third aspect, the invention provides a processing system for processing substrate containing arrays of IC units the system comprising a loading station for saving a

plurality of different substrate types; a singulation system for dicing the substrates into individual IC units; the singulation system comprising at least two delivery systems for delivery the substrates to a plurality of dicing saws said dicing saws arranged to perform different dicing functions on said substrates.

Accordingly the invention provides flexibility by integrating different types of dicing saws within the singulation system. The use of such a system will provide an integrated approach where any one substrate requires different singulation processes, for instance, having different materials or different thickness of cuts applied to the substrate.

It will be appreciated that a control system may be included to recognise the different parameters required of a single substrate or for a collection of different substrate type within a specific batch.

For instance, the two dicing saws may be of different thickness where a single substrate or, alternatively, different substrates within a single batch require cuts of different thickness. Where a control system may be implemented, the control system will operate the movement of the substrate for instance on a chuck table so as to align the substrate relative to the dicing saw having the characteristics required of that particular cut.

The different conditions accommodated by the singulation system according to the present invention may include cuts of different thickness. Alternatively it may involve

cutting substrates of different materials either within the same substrate or within a batch processed by said singulation system.

In a still further embodiment, a third cutting device may be implemented such a third dicing saw. The benefit of a third cutting device may include a dicing saw having similar characteristics to either of the first or second dicing saw in order to increase capacity for that type of cut. Alternatively the third dicing saw may have a third characteristic so that the singulation system according to this embodiment may be able to provide three different types of cuts. In a still further embodiment the third cutting device may be a device appropriate for, profile cutting such as water jet or laser cutting.

In one embodiment the singulation system may be part of a larger processing system for the loading of substrates to the singulation system and the subsequent sorting of said singulated IC units into the various categories. Said processing system may include an inspection device at or near the loading section of said processing system. The inspection device may be arranged to inspect the quality dimensions or warping of the substrates being loaded to the system. Said inspection device may further have capability to identify different types of substrates. In the latter case, on identification of a particular substrate, said information may be communicated to the singulation system such that a predefined singulation process is implemented by the singulation system according to the required characteristics of said substrate.

In a further embodiment the substrate or different substrates within a batch may have different layers of different materials. In such a case the singulation system may include

dicing saws adapted to different types of materials, for instance, one saw having a greater advantage in cutting metal. In this case this process may be optimised in order to utilise the metal cutting saw for cutting metal either completely or partially so that the second saw may cut the reminder of the substrate or other substrate within the batch to which the second saw may be better suited. In optimising said system, the optimisation criteria may include speed of cut, longevity of cutting blades and/or costs of cutting blades. For instance whilst blades from both dicing saws may be capable of cutting a metal layer, the blade of one dicing saw may have greater longevity through being able to resist the abrasive nature of cutting said metal layer as compared to the blade of the second dicing saw.

In a further embodiment where the blades vary in the thickness of cut required, the two dicing saws may have one thick blade for instance, 1 mm thick and one thin blade for instance 0.3 mm. In a still further embodiment the flexibility of the singulation system may be further enhanced whereby if a cut not corresponding to the thickness of the first and second dicing saw is required but said thickness is greater than the thicknesses of the thinnest blade, then multiple passes of the thin blade may be included in the process so as to achieve a cut of the correct thickness. Thus in a further embodiment, selection of the blade thicknesses may be optimised so as to minimize the number of passes required as compared to accommodating typical common or standard thicknesses for the singulation of IC substrates.

The substrates may be homogenous in nature. Alternatively they may be layered having different layer materials. In a still further embodiment, multiple substrates may be placed one upon the other such that the singulation system may be required to accommodate multiple substrates laid to form devices of greater integration.

Brief Description of Drawings

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

Figures 1A and 1B are plan and elevation views of a singulation system according to one embodiment of the present invention;

Figures 2A and 2B are plan and elevation views of a singulation system according to a second embodiment of the present invention;

Figures 3A and 3B are plan and elevation views of a singulation system according to a third embodiment of the present invention;

Figure 4 is a plan view of a processing system according to a further embodiment of the present invention;

Figures 5A and 5B are plan views of an onloader of the processing system of Figure 4;

Figures 6A, 6B and 6C are various views of a chuck table arrangement of the processing system of Figure 4;

Figure 7 is an elevation view of the chuck table arrangement of Figure 6C;

Figure 8 is an elevation view of the chuck table arrangement of Figure 7;

Figure 9 is an elevation view of the chuck table and net table arrangement of the processing system according to Figure 4;

Figure 10 is an elevation view of the chuck table and net table arrangement of Figure 9;

Figure 11 is an elevation view of the chuck table and net table arrangement of Figure10;

Figures 12A, 12B and 12C are various views of the sorting system of the processing system of Figure 4;

Figures 13A, 13B, 13C and 13D are various views of the off loader of the processing system of Figure 4.

Detailed Description

In the following description, the terms dicing, sawing, cutting and singulation all refer to the separation, on partial separation, of IC units from a substrate.

In one aspect, the invention provides a singulation system comprising at least two dicing saws such that the dicing saws perform different functions so as to fulfill different purposes.

This is demonstrated in the different embodiments of Figures 1, 2 and 3 whereby a pair of dicing saws are provided in order to together achieve a cumulative result based upon different requirements of the substrates in question.

Figures 1A and 1B show different stages in the dicing of a substrate 31. The substrate 31 is located upon a block, such as a chuck table 30 which is capable of rotating so as to align the substrate 31 along the two cutting lines 45, 50 which defined the individual integrated circuits 32.

Accordingly in this embodiment the singulation system 5 comprises a pair of dicing saws 10, 15 being spindles having individual blades 20, 25 located thereon. The

substrate is an arrangement of individual integrated circuit units 32 formed within an overall substrate 31 which is to be diced along octagonal principle axis 45, 50.

Where the singulation system 5 according to this embodiment provides advantage relative to the prior art is the need for the integrated circuit units 32 to have the octagonal axis 45, 50 to be of different thickness. The short axis 45 requires a clearance 40 of 1 mm so as to separate the circuitry between adjacent IC units. The longitudinal axis 50, however, merely requires a standard clearance 35 of 0.30 mm. To achieve this the blade 20 of the first dicing saw 10 has a thickness matching the required clearance 40 being 1 mm thick. Accordingly Figure 1B shows the chuck table 30 having rotated so as to bring the short axis 45 in alignment with the first dicing saw 10 ready for the wider clearance 40. It will be appreciated that the actual thickness of the two blades may vary according to industry standards, economic volume of substrates to be processed and other specific operational criteria...

Either achieved prior to the first dicing cut or afterwards, the second dicing saw 15 as shown in Figure 1A aligns the blade 25 having a blade thickness 45 to match the required clearance 35 is aligned to cut the longitudinal axis 50. Thus a substrate requiring two different types of cuts is achieved with one singulation system 5 by providing two source 10, 15 having different characteristics, i.e. in this case, blades 20, 25 of different thickness.

Figures 2A and 2B show a further embodiment of the singulation system 55 whereby the invention is applied to the problem of cutting different materials used on different types of substrates. In this case the substrate 80 is a plurality of QFN units having a first layer 85 made of copper and an underlying polymer mould 90. Not shown is a substrate of BGA units whereby a PCB of polymer is also placed upon a polymer mould. By providing source 60, 65 having blades 70, 75 of different materials, the singulation system 55 can be used to dice different types of substrates without causing undue wear on the blades 70, 75 of the dicing source 60, 65.

The singulation system 55 includes a first dicing saw 60 having a metal blade which is suited for dicing BGA units. The second dicing saw 65 has a resin bond blade 75 suitable for cutting the copper layer 85 for a QFN unit. Thus for this singulation system 55 to cut a BGA substrate may use the first dicing saw 60 along the orthogonal axis allowing the chuck table to rotate so as to align the corresponding blade. The metal blade against the polymer mould of the BGA substrate may last an extremely long time and so gain the benefit of longevity. However, the metal blade of the first dicing saw 60 will deteriorate quickly if it is applied to the copper layer of the QFN substrate. By first passing the QFN substrate 80 through the second dicing saw 65, the resin bond blade 75 which is adapted for cutting the copper layer 85. However, the second dicing saw will only perform a partial cut 95 of the copper layer 85. The partially cut substrate 80 is then directed to the first dicing saw 60 with the full cut 100 through the polymer mould 90 to complete the singulation of the substrate. The more expensive resin bond blade 75 is then not required to undergo unnecessary cutting of the polymer mould and so

providing a small increase in life of the resin bond blade 75. Thus the singulation system 55 through judicious use of the functionality of the different blades 70, 75 of the dicing saws 60, 65 achieve the dual purpose of being able to dice QFN, BGA and any other multi layer substrates whilst at the same time optimizing the life and costs of blades use.

Figures 3A and 3B show a further embodiment whereby the singulation system 105 can further increase functionality and application to the dicing of different types of substrates.

Here a substrate 120 is formed from a BGA substrate 125 mounted on a QFN substrate 130 to form a single substrate. The intention is to have a plurality of integrated units. However, to achieve this integration, singulation systems according to the prior art would suffer substantive wear as the dicing source would be of the same variety and therefore could not optimize the use of different types of source.

Thus the singulation system 105 again has a first 110 and second 115 dicing saws having different types of blades 135, 140. As in the embodiment of Figures 2A and 2B, the first dicing saw 110 has a metal blade suitable for cutting BGA substrates with the blade 140 of the second dicing saw 115 having a resin bond blade 140 suitable for cutting the copper layer of the underlined QFN substrate 130.

The method of operation is similar to that described in Figure 2A and 2B. However, with the BGA substrate 125 being on top, the partial cut 145 is performed on the BGA substrate by the metal blade 140 of the second dicing saw 115. The substrate 120 having the partial cut is then moved to the first dicing saw 110 having the resin bond blade 135. Here the cut is completed 150 as the resin bond blade 135 cuts through the remaining copper layer of the QFN substrate 130.

Figure 4 shows a processing system 160 into which the singulation system 190 is located. The processing system 160 includes a loading bay 165 for loading substrates into a singulation station 170. The singulation system 170 includes as mentioned the singulation 190 which receives substrates from a chuck table arrangement 185. An inspection zone 195 between the chuck table arrangement 185 and singulation system 190 is provided. The inlet rail (Substrate turntable) zone 180 aligns the substrate angle with the direction of the picker.

On singulation, the individual IC units are moved to a net table arrangement 200 which feeds the IC units into a sorting system 205. From here the IC units are then divided into various bins 210 for transportation to the end user.

Figures 5A and 5B show the onloading platform 165 which has been specially adapted to handle multiple substrate types. The onloader platform 165 includes a table 215 upon which a plurality of substrates 220 are sequenced. An onloader 226 which includes a pusher 225 is arranged to deliver the substrates 230 to a turntable 235. In Figure 5A a

BGA substrate is delivered to the turntable 235 which subsequently rotates 240 the substrate so as to align with a picker 245 for delivery to the chuck table arrangement (not shown). The turntable acts as a platform also for inspection by an inspection device 250 which is mounted to a rail with the picker 245. The picker 245 and inspection device 250 run along a rail 260 from the turntable so as to transport the substrate following inspection of the device type and orientation..

Following inspection the BGA substrate is removed from the turntable by the picker 245 and replaced by in this case, a QFN substrate 265 which is also pushed by the pusher 225 to the turntable.

The inspection device operates in a manner similar to that of the prior art. However, the inspection device may also be able to identify the category of substrate based on direct vision and so inform the downstream singulation system to adopt a different process corresponding to the identified substrate. Identification may be from known characteristics of the substrate which may also include a barcode which the inspection device may also include a barcode reader. In a further embodiment the substrate may include an RFID device which may be read by an RFID reader (not shown) which again will communicate to the singulation system that a substrate of a certain type is being delivered.

Figures 6, 7 and 8 show the chuck table arrangement acting as a delivery system to the singulation system. In this case, as mentioned the processing system 160 (Figure 4) is

configured to process substrates and integrated circuits according to the embodiment of the singulation system shown in Figure 2. Accordingly the processing system 160 is geared to process two different types of substrates. In this case the two substrates being considered are for bold grid array units having solder balls on an underside of the IC unit for direct mounting to the packaging. The second type are quad flat no lead units. The BGA units are characterised by a polymer printed circuit board laid upon a polymer mould. The QFN units are made from a copper layer laid upon a similar polymer mould. In this case the processing system 160 is arranged to handle both types of substrates which it follows will require different dicing saws to handle both the substantially polymer BGA units and copper QFN units. Thus returning to Figures 6, 7 and 8 the chuck table arrangement involves delivering the BGA and QFN substrates from the turntable 235 to respective chuck tables 266, 271. As mentioned a picker 245 engages whichever substrate is on the substrate turntable 235 and delivers this along a linear rail 260 to the appropriate chuck table 266, 271. As the substrate is delivered one at a time, the substrate picker 245 delivers these sequentially alternating between the BGA and QFN tables 266, 271. At the same time inspection is performed by the inspection device 250 as previously mentioned. Figure 6C shows substrates delivered to the respective chuck table 266, 271 with Figure 7 showing the BGA substrate 267 delivered to the singulation system 268. In this case, a first and second dicing saw 269, 273 are provided. As with the arrangement shown in Figure 2, the first dicing saw 269 is arranged to cut through the polymer layers with the second dicing saw 273 arranged to cut through the copper layer. On singulating a BGA substrate 267, either saw may be used and this will be subject to capacity and bottleneck issues.

Figure 8 shows the withdrawal of the singulated BGA substrate and the delivery of the QFN substrate to the singulation system 268. The method by which the QFN substrate may be diced has been described in relation to Figure 2 and so shall not be repeated here.

During singulation of the QFN substrate, the BGA units are then transported to a cleaning station 280 by a unit picker 275 which in this case travels along the same linear rail 260 as that of the substrate picker 255. Figure 9, 10 and 11 show the next stages by which a new BGA substrate 279 is delivered to the singulation system 268 following the dicing and withdrawal of the singulated QFN units. The first BGA substrate, in the interim, has been transferred to the sorting section comprising a dry block 300 upon which the singulated units are deposited. The dry block functions to act as an interface between the sorting station 200 following the cleaning station 280 with both BGA and QFN units residing on the dry block 300 prior to further sorting. Within the sorting station 200 is a dual unit picker having one side dedicated to BGA units 335 and the other side dedicated to QFN units 330. The dual unit picker delivers the units from the dry block 300 to the flipper 315 and then individually to either the BGA net table 310 or QFN net table 325, using the respective BGA picker 335 as shown in Figure 10 or the QFN picker 330 as shown in Figure 11.

The dual unit picker further includes an inspection device 340 so as to inspect the individual units whilst on the idle block 320.

The inspection device 340 may include inspecting the quality of the IC units following singulation. It may also confirm that there are no missing units within the singulated array or perhaps displaced from the original position. The inspection device may further detect any detritus caused by the singulation process that may still remain trapped between the singulated units.

Figure 12A, B and C show the next phase whereby the BGA net table 310 and QFN net table 325 move along linear slides so as to bring them into proximity with parallel linear rails 390, 395, 400. The linear rails have associated with them unit pickers again dedicated to respective IC types. For instance, the BGA net table 310 comes into proximity with two linear rails 390, 395 having three BGA pickers 360, 370, 380 mounted thereto. The pickers 360, 370, 380 are arranged to engage units on the net table 310 and deliver these to BGA racks 425, 430 which then deliver the BGA units to dedicated BGA bins 405, 410. The BGA pickers 360, 370, 380 may be in communication with the previous inspection device 340 and so may be pre-programmed to deliver damage units to a secondary bin for reject or rework. One of said pickers 370 further includes an inspection device for performing a final inspection which may primarily be focused on missing or misaligned units on the net table 310. It will be further noted that in proximity with the linear rails 390, 395, the net table 310 may rotate on a turntable 350 so as to ensure all of said IC units are accessible by the three unit pickers 360, 370, 380.

Figure 12A, 12B and 12C further show a parallel system for QFN units whereby the QFN net table 325 comes into proximity with two linear rails 395, 400. It will be noted that a central linear rail 395 accommodates both a BGA and QFN picker 360, 375 for convenience or efficiency. It will further be appreciated that each of the linear rails may act independently or together subject to the requirements of the finished processing system.

Thus the QFN net table 325 travels along a linear rail so as to be accessible by three QFN pickers 365, 375, 385 so as to deliver the QFN units to two racks 435, 440 which deliver the QFN units to bins 415, 420.

The rack to bin communication can be seen in Figures 13A, B, C and D whereby the racks travel along linear rail so as to deliver the units bins 450, 455, 460, 465. On filling the respective bins with the racks, said racks can be removed as a cassette allowing further capacity to receive the respective units.

Claims

1. A singulation system for dicing IC units from a substrate comprising;

a block for receiving said substrate, said block movable from a substrate receiving station to a dicing station;

a first dicing saw for dicing the substrate when at the dicing station;

a second dicing saw for dicing the substrate when at the dicing station;

wherein the first and second dicing saws are of different varieties so as to perform different dicing functions on said substrate.

2. The singulation system according to claim 1 wherein a first blade mounted to the first dicing saw has a thickness greater than a second blade mounted to the second dicing saw

3, The singulation system according to claim 1 said system arranged to partially cut said substrate by the second dicing saw and complete the partial cut by the first dicing saw.

4. The singulation system according to claim 3 wherein said partial cut includes a complete cut of a metal layer located on said substrate.

5. The singulation system according to anyone of the preceding claims wherein a first blade mounted to the first dicing saw is a metal blade and a second blade mounted to the second dicing saw is a bond resin blade.

6. A method of dicing IC units from a substrate, the method comprising steps of:

providing a singulation system comprising first and second dicing saws;

moving the substrate to said second saw:

partially cutting a metal layer of said substrate with said second saw;

moving the substrate to the first saw completing the cut of the substrate using said first saw.

7. The method according to claim 6 further including the step of moving the substrate to the first saw and partially cutting a top layer of said substrate prior to the step of moving the substrate to the second saw.

8. A method of dicing IC units from a substrate, said IC units spaced in a rectangular array having a different lateral to the longitudinal, spacing the method comprising the steps of:

providing a singulation system having a first saw and a second saw said first and second saws having blades mounted thereto of different thicknesses;

moving said substrate so as to align a blade of the first saw along the lateral axis and sawing along said lateral axis;

moving said substrate to the second saw so as to align the longitudinal axis with a blade on the second saw and sawing said longitudinal axis.

9. A processing system for processing substrate containing arrays of IC units the system comprising:

a loading station for saving a plurality of different substrate types;

a singulation system for dicing the substrates into individual IC units;

the singulation system comprising at least two delivery systems for delivery the substrates to a plurality of dicing saws said dicing saws arranged to perform different dicing functions on said substrates.

10. The processing system according to claim 9 further including a sorting station for receiving the diced IC units and dividing this into separate batches for sorting.

11. A processing system for dicing integrated circuit units from a plurality of substrate comprising:

a loading station for loading substrates of different varieties;

a singulation system for saving said substrates said singulation system according to any one of claims 1 to 8.