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Improved Method and Apparatus for an integrated circuit dicing device

Field of the invention

The present invention relates to a sawing and sorting system. The system interacts with, or includes, a dicing machine which saws ("dices") a substrate with many integrated circuits formed onto it to form individual integrated circuits. The invention further relates to apparatus and methods of use in such a sawing and sorting system.

Background of Invention

Conventionally a plurality of integrated circuits are formed simultaneously on a semiconductor substrate, and the substrate is then diced to form individual integrated circuits. Apparatus is know for feeding substrates into such a dicing machine, and for sorting the diced integrated circuits.

One type of integrated circuit which is becoming increasingly popular is one having an array of multiple electrical contacts (typically solder balls, known as a ball grid array packages, and pads in non-leaded packages, known as a Quad Flatpack Non-Leaded (QFN) packages) in an array on one of its major faces. The dicing of a substrate having a ball grid array on one of its surfaces is typically performed with the surface of the substrate carrying the balls facing upwards. It is known to perform a limited number of sorting operations on the singulated integrated circuit units to detect abnormal (faulty) units. This is performed using cameras under which the singulated units pass. The level of sophistication of such techniques is presently limited. In particular, it tends to be performed on the basis of a batch of units produced from the same substrate, and that batch of units is rejected as a whole if a fault is identified (e.g. because it is discovered that the alignment of the substrate with the lines cut by the dicing machine is not sufficiently accurate).

During this process, the units are handled by devices which touch the integrated circuits at the edges of their upper surfaces, at the margins which are outward of the area of the upper surfaces covered by the ball grid array. Contacting the circuits there reduces the risk of damage being done to the array of balls. However, this handling operation is a difficult one, and is becoming increasingly more difficult as the size of the integrated circuits falls and the margin around the ball grid array shrinks.

Summary of the Invention

The present invention aims to provide a new and useful system for supplying substrates to a dicing machine.

It further aims to provide a new and useful dicing system including a mechanism for supplying integrated circuits to the dicing machine.

In general terms, the invention proposes that in a dicing system in which a dicing machine operates with a chuck table a lifting assembly should be provided which substantially simultaneously deposits substrates to be singulated onto the chuck table and removes previously singulated units from the chuck table.

In a first aspect, the invention provides a method for dicing substrates to produce sorted singulated units, comprising the steps of loading said substrates to a rail system; delivering said substrates via the rail system to a chuck table arrangement for dicing said substrates; dicing said substrates to produce singulated units held within a predetermined spatial arrangement; flipping said substrates whilst maintaining the predetermined spatial arrangement; delivering the singulated units to a net block assembly to

separate and control individual units, and; sorting and categorizing the individual units so as to separate them by efficacy.

Therefore, the invention provides a complete system to receive a strip of integrated circuits at the front end, and deliver sorted singulated units ready for use, reworking and rejection. The system may be embodied within a unitary device, or alternatively within a modular construction, with each step connected through a delivery means.

In a preferred embodiment the dicing step may further include loading the substrates to a plurality of chuck tables located on tracks, passing the chuck tables along said tracks passed respective cutting means, singulating units from the substrates using the cutting means, and maintaining the relative position of the singulated units within the predetermined spatial arrangement corresponding to their position within the substrate prior to singulation.

With the commercial success of such systems significantly influenced by the Units per Hour (UPH) rate, embodiments which assist in the increasing the UPH have a significant advantage over the prior art. Thus, the system for this embodiment, the dicing station may include a plurality of chuck tables, and so be able to accept a plurality of strips.

In a further preferred embodiment the system may have a plurality of tracks, each supporting at least one chuck table.

In a more preferred embodiment, each track may support a plurality of chuck tables.

In a further embodiment, individual chuck tables may undergo the loading, passing, singulating and maintaining steps in a staggered sequence so as to minimise delay time between these steps.

Further increasing the UPH, this embodiment provides a staggered process

In a preferred embodiment, the singulated units delivered to the net block assembly are placed upon at least one net block. Alternatively, there may be a plurality of net blocks.

In a more preferred embodiment, each net block may be located on an individual track. Alternatively, each track may support and transport a plurality of net blocks.

In a still further embodiment the step of sorting and categorizing includes determining whether each singulated unit falls within the category of efficacious, non-efficacious or whether the singulated unit requires re-working.

In a second aspect the invention provides a system for dicing substrates to produce sorted singulated units, comprising cassettes for loading said substrates to a rail system, the rail system being in communication with a chuck table arrangement; said chuck table arrangement adapted to dice the substrates into singulated units held within a predetermined spatial arrangement; a flipper for flipping said substrates whilst maintaining the predetermined spatial arrangement; a net block assembly to separate and control individual units, and; a sorting and categorizing means for separating the singulated units by efficacy.

In a preferred embodiment the chuck table arrangement may include a plurality of chuck tables on to which are loaded the substrates, cutting means

for singulating the units from the substrates, and holding means for maintaining the relative position of the singulated units within the predetermined spatial arrangement corresponding to their position within the substrate prior to singulation.

In a further preferred embodiment each chuck table may be located on a respective track for movement of the chuck table, and consequently the substrate, independently from the other chuck tables.

In a more preferred embodiment the chuck table arrangement may be adapted to permit the loading of a substrate on one chuck table as an independent function from cutting of a substrate on another chuck table.

In a preferred embodiment at least two chuck tables may be located on the respective track for movement of the chuck tables, and consequently the substrate, independently from the other chuck tables.

In a more preferred embodiment, the chuck table arrangement may be adapted to permit the loading of substrates on the at least two chuck tables as an independent function from cutting of substrates on the another chuck tables.

In a more preferred embodiment, the cutting means may include any one or a combination of laser cutting, water jet cutting or blade cutting.

In a still further preferred embodiment, blade cutting may include the use of at least one gang blade located on a single spindle

In a further embodiment, the cutting means may include a plurality of spindles, each having a gang blade of multiple blades for increasing the rate of dicing of the substrates.

In a still further preferred embodiment, at least one spindle may be associated with a respective track. Alternatively, each track may have associated with it a plurality of spindles, possessing at least one blade per spindle, or possibly a plurality of blades in a gang blade arrangement.

Brief Description of The Figures

It will be convenient to further describe the present invention with respect to the accompanying drawings which 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.

Fig. 1 is a top view of an integrated circuit sawing and sorting system according to one embodiment of the present invention;

Fig. 2 is a flow chart of the process according to the embodiment of Figure 1;

Fig. 3 is a flow chart of a process according to a second embodiment of the present invention;

Fig. 4 is a detailed view of a chuck table according to a third embodiment of the present invention.

Detailed Description of the embodiments

Figures 1 and 2 show the overall construction of an integrated circuit sawing and sorting system and the underlying process by which the system functions, in a preferred embodiment of the present invention. In Figure 1, the system is viewed from above. It is composed of two sections, a dicing section and a sorting section. Two horizontal directions are marked X and Y.

The sawing and sorting system is for sawing and sorting substrates which include a plurality of integrated circuits. The system is particularly suitable for integrated circuits each of which is provided with an array of contacts on a side of the substrate which is initially facing upwards (however the system may be modified for other sorts of integrated circuits, as described below). The substrates are inserted into the system from cassettes using a loader assembly 1. From the loader assembly 1 the substrates are carried to an inlet rail assembly 2. At this stage the substrates are examined using a first camera 3, mainly to check that the substrates are of a type suitable for use in the sawing and sorting system.

As described in detail below, the substrates pass to a twin chuck table 4, from which they are carried into a dicing machine indicated generally as Z, and shown in more detail in Figure 3. This dicing machine Z can be formed according to known designs, and so will not be described here in detail.

The diced substrates pass via a brush unit 5 where the singulated units are brushed, and a cleaner unit 6, to a heating block assembly 7. From there, the units pass to a flipper unit 8, where, as described in detail below, the units are turned over so that each ball grid array faces downwards. The singulated units are then received by an idle unit assembly 9, including a second camera. Subsequently, the singulated units pass to a net block assembly 10.

Accordingly, Figure 2 shows the above briefly described process. A strip is delivered 20 to the sawing machine using a cassette magazine. Delivery through the system, and to which the cassette delivers the strip, is a rail passing through each station of the system. Prior to delivery of the strip, it undergoes 30 a first inspection (or vision) and is subsequently delivered to the rail.

The strip, or strips, are sequentially placed on available chuck tables 40a & 40b which are located in the dicing machine Z of Figure 1. To accelerate the flow, the chuck tables 40a & 40b are sequentially staggered, such that a strip is passed to the next available chuck table, and passed through the dicing machine. This has the advantage of emulating a continuous process, rather than a batch process, whereby a backlog of strips may cause a bottleneck in the process waiting upon the dicing of each strip. Thus, whilst the prior art may require a delay of 30 seconds whilst waiting to load the next strip, the sequentially staggered chuck tables 40a & 40b reduce this to about 12 seconds in this embodiment. In further embodiments, there may be a plurality of chuck tables, such that any delay, instead of being as a result of the dicing process may be caused by the delivery time of new strips. In this embodiment, the processing delay may approach, but may never reach a purely continuous process, that is a zero second delay. It is therefore the intent of the invention to increase the Unit per Hour (UPH) rate of the process, as compared to the prior art.

The singulated units resulting from the dicing process are then brushed and cleaned 45, and heated 50 to remove moisture.

The singulated units, which are held in the spatial arrangement defined by the strips, are flipped 55 so as to have, preferably, the ball grid array facing downwards 60.

The singulated units in the new orientation are further inspected 65, prior to delivery to a net block assembly, whereby they may be divided between available net blocks 70a & 70b, each net block being located on a respective track, ready for a picker to sort said singulated units. Consequently, the singulated units are inspected 75 a final time to determine their efficacy, that is their ability to perform the required functions. This inspection, being substantially visual, then determines whether each individual unit is to categorized as "good" 80, "reworkable" 85, or a "reject" 90.

Figure 3 shows one embodiment of the dicing machine Z, indicated previously in Figure 1. Here, the dicing machine 95 comprises two tracks 105a & 105b, each supporting a pair of chuck tables 100a & 100b.

The tracks 105a & 105b operate in a linear direction, so as to pass by cutting stations 110a & 110b. These cutting stations 110a & 110b are designed to also operate linearly, but at right angles to the direction of the tracks. hence, the combination of the two movements of the cutting stations 110a & 110b and the tracks 105a & 105b provide an action whereby two dimensional cutting action of the strips resident on the chuck tables 100a & 100b is possible.

A distinction of the embodiment shown in Figure 3 is the use of the pair of chuck tables 100a & 100b on the tracks. thus, whereby the UPH using the sequentially staggered process previously described is increased, the UPH is considerably further increased by doubling the capacity of the diving machine.

Any even further distinction, again aiding the increase in UPH is the use of gang blades 110a & 110b at the cutting stations. Having the extra blade again

doubles the rate of dicing of the strips, and so directly contributing to the increase in UPH.

Figure 4 shows a more detailed process according to a third embodiment. whereby the activities in each station are more closely defined.

Claims

1. A method for dicing substrates to produce sorted singulated units, comprising the steps of :

Loading said substrates to a rail system;
Delivering said substrates via the rail system to a chuck table arrangement for dicing said substrates;
Dicing said substrates to produce singulated units held within a predetermined spatial arrangement;
Flipping said substrates whilst maintaining the predetermined spatial arrangement;
Delivering the singulated units to a net block assembly to separate and control individual units, and;
Sorting and categorizing the individual units so as to separate them by efficacy.

2. The method according claim 1 wherein the dicing step further includes the steps of :

loading the substrates to a plurality of chuck tables, at least one chuck table located on a respective track;
moving the chuck tables along the tracks, passed respective cutting means;
singulating units from the substrates using the cutting means, and;
maintaining the relative position of the singulated units within the predetermined spatial arrangement corresponding to their position within the substrate prior to singulation.

3. The method according to claim 2 wherein individual chuck tables undergo the loading, passing, singulating and maintaining steps in a staggered sequence along the respective tracks so as to minimise delay time between these steps.

4. The method according to claim 1 wherein the step of sorting and categorizing includes determining whether each singulated unit falls within the category of efficacious, non-efficacious or whether the singulated unit requires re-working.

5. A system for dicing substrates to produce sorted singulated units, comprising:

Cassettes for loading said substrates to a rail system, the rail system being in communication with a chuck table arrangement;
Said chuck table arrangement adapted to dice the substrates into singulated units held within a predetermined spatial arrangement;
A flipper for flipping said substrates whilst maintaining the predetermined spatial arrangement;
a net block assembly to separate and control individual units, and;
A sorting and categorizing means for separating the singulated units by efficacy.

6. The system according claim 5 wherein the chuck table arrangement includes :

a plurality of chuck tables on to which are loaded the substrates, at least one chuck table located and movable on a respective track;
cutting means for singulating the units from the substrates, and;

holding means for maintaining the relative position of the singulated units within the predetermined spatial arrangement corresponding to their position within the substrate prior to singulation.

7. The system according to claim 6 wherein each chuck table is located on a respective track for movement of the chuck table, and consequently the substrate, independently from the other chuck tables.

8. The system according to claim 7 wherein the chuck table arrangement is adapted to permit the loading of a substrate on one chuck table as an independent function from cutting of a substrate on another chuck table.

9. The system according to claim 6 wherein at least two chuck tables are located on a respective track for movement of the chuck tables, and consequently the substrate, independently from the other chuck tables.

10. The system according to claim 9 wherein the chuck table arrangement is adapted to permit the loading of substrates on the at least two chuck tables as an independent function from cutting of substrates on the another chuck tables.

11. The system according to any one of claims 5 to 10 wherein the cutting means include any one or a combination of laser cutting, water jet cutting or blade cutting.

12. The system according to claim 11 wherein blade cutting includes the use of at least one spindle upon which at least one blade is located.

13. The system according to claim 12 wherein at least one spindle is associated with each respective track.

14. The system according to claim 13 wherein two or more spindles are associated with each respective track.

15. The system according to any one of claims 12 to 14, wherein each spindle uses a gang blade.

16. The system according to any one of claims 5 to 15 wherein the net block assembly includes at least one net block located on at least one track for movement of the singulated units.

17. The system according to claim 16 wherein the net block assembly includes a plurality of net blocks located on the at least one track.

18. The system according to claim 16 or 17 wherein there is a plurality of tracks.

19 The system according to claim 18 wherein the net blocks located on the plurality of tracks are sequentially staggered in position relative to net blocks located on the other tracks. on the various other tracks.