IMPROVED SINGULATION SYSTEM AND METHOD

Field of the Invention

The invention relates to integrated circuits (IC) and the manufacture thereof. In particular, the invention relates to the singulation of IC's from a substrate containing a plurality of the IC's. More specifically, the IC's are those having complex plan shapes comprising a combination of linear and profile portions.

Background

A growing market for IC's is their application for memory cards such as micro SD cards used in a range of applications including cameras, PDA's, MP3 players etc. A characteristic of the micro SD card is the change in shape from a routinely square or rectangular IC to, instead, requiring a more complex shape including not only linear portions around the peripheral edge of the IC, but also portions having curve linear shape or more generally profiles. The profile portions of the SD cards include chamfers whereby a corner of the rectangle is removed, recesses to accommodate fittings within the device and curved portions again fittings of the device or even as aesthetic appeal.

Traditionally square and rectangular IC's are diced or singulated using a dicing saw which can efficiently cut long, linear edges of a substrate, singulating IC's quickly and efficiently. With the introduction of a profiled plan shape dicing saws are less efficient as, for instance, a chamfered corner must be angled at potentially non-standard angles. For more delicate actions, such as indenting a recess into the edge of an IC, dicing saws are poorly suited indeed. For curvi-linear shapes, it is in fact not feasible to use a dicing saw.

To overcome the shortcomings of a dicing saw, the IC's maybe punched whereby a suitably shaped die pushes into the substrate to shear the IC unit from the substrate. While achieving the desired shape can be quickly and efficiently removed from the substrate, such punching processes have the drawback of causing damage to the

substrate as well as localised damage along the edges of the IC's and so leading to excessive wastage.

Alternatively, a router maybe used, by guiding the cutting portion around the desired edge. Again this achieves the result, however, the tolerance required for a router is typically high and so reducing the effective numbers of IC's that can be incorporated onto a substrate. Further operating a router around a complex shape is extremely time consuming, as the process is relatively slow compared to that of a saw. The consequence of using a router is the reduction in the "units per hour" (UPH), which is the measure of efficiency of a dicing machine. Thus, whilst a router achieves the desired result, the UPH resulting from the router is typically below an economic threshold for the manufacturing process.

A further alternative is to use a water jet or a fluid jet cutting device. Here the jet nozzles which maybe in the range of 0.4 mm to 0.2 mm in diameter provide high velocity fluid such as water within a concentrated region at high pressure. The water may have an abrasive material to aid the cutting process, which also has a highly detrimental effect on the nozzle of the water jet requiring continual replacement proportional to use. A further drawback of a water jet system is the speed at which a water jet nozzle may be operated being consistently slower than a dicing saw, which must be balanced against the effectiveness of the water jet system to accommodate complex cutting. Further, repeated down time caused by clogging of the nozzles or damage through corrosion further limits the economic benefit of the water jet. Further still, special brackets and jigs are required to support an IC being cut by a water jet, as compared to simple vacuum arrangement of dicing saws.

Statement of Invention

It is therefore an object of the present invention to provide a system that can singulate an IC having a combination of linear and profile shaped edges, at a UPH in excess of the prior art systems.

In a first aspect the invention provides a system for singulating an IC unit from a substrate, said IC unit having a combination of linear and profile peripheral edges, said system comprising a profile cutting device for cutting the profile portions of the IC unit; a longitudinal cutting device for cutting the linear portions of the IC unit, said cutting means located within a singulation zone.

In a second aspect, the invention provides a method A method for singulating an IC unit from a substrate, said IC unit having a combination of linear and profile peripheral edges, said method comprising the steps of profile cutting the profile portions of the IC unit using a profile cutting device, and longitudinal cutting the linear portions of the IC unit using a longitudinal cutting device, said cutting steps occurring within a singulation zone.

Thus in addressing the IC's having a combination of linear and profile edges, the present invention addresses this by using a combination of cutting processes.

This has the advantage of optimising the speed of the longitudinal cutting device, and the flexibility of the profile-cutting device, so as to maximise UPH.

In a preferred embodiment, the present invention may further include a sorting means for sorting the singulated IC units into categories, said categories may comprise one or a combination of pass, reject and rework.

In a preferred embodiment, the present invention may further comprise a loading means for loading the substrate to the singulation zone.

In a preferred embodiment, the present invention may further include an off-loader for removing the singulated IC units from the singulation zone.

In a preferred embodiment, the profile-cutting device may include any one or a combination of water jet cutter, an air jet cutter and a laser cutter. The fluid-type profile cutters, such as water and air, suffer from considerable abrasion and wear.

Particularly if an abrasive grit is used in the fluid to enhance the cutting action. As a result, such a nozzle of the cutter may have a very limited life, in conventional circumstances. By using the profile cutter in combination with the longitudinal cutting device, the usage of the profile-cutting device per unit will be reduced, as a proportion of the IC will be cut by the longitudinal cutting device. Consequently, whilst the life of the profile-cutting device is short, the life measured "per IC unit" is considerably lengthened.

In a preferred embodiment, the longitudinal cutting device may include a dicing saw having a single or dual blade.

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 views of IC's having a combination of linear and profile edges;

Figure 2 is a schematic view according to a first embodiment of the present invention;

Figure 3 is a schematic view according to a second embodiment of the present invention.

Description of Preferred Embodiment

Figures 1a and 1b show two examples of IC's having a combination of profile and linear edges. Whilst shapes will differ considerably between end use applications, memory capacity and aesthetic requirements, the IC's shown provide typical elements that are common among similar devices.

Figure 1a shows an IC 5 having a substantially rectangular shape. The IC 5 has linear edges 15a to d. Detracting from the regular rectangular shape are a variety of profile portions. Whilst the linear portions may be conventionally diced by a dicing saw, the profile portions may be less easily accommodated. At two corners of the IC 5, are filleted corners 25a,b, having a set radius. Further one linear edge 15d is interrupted by an inclined portion 20a, similar to an inclined step in the edge 15d. A smaller discontinuity 30 is placed at a point along the opposed linear edge 15b.

Figure 1b shows an alternative IC 10. Again, the IC 10 is substantially rectangular in shape, having linear portions 18a to d. However, one edge of the IC 10 instead incorporates a circular portion 35 almost along one edge of the IC 10, with only very short linear portions 45a,b on either side finishing the edge. Further, a rectangular recess 40, having steps 50a,b indenting the recess 40 into the IC 10, and so dividing one edge into two linear portions 18a,b. Lastly, one corner has been chamfered 20b.

Figures 2 and 3 show alternative embodiments 55, 80 of the invention. In Figure 2, the system 55 includes an onloader 60 for loading the substrate to a singulation zone (not shown) ready to be processed. The substrate is cut using a profile cutting device, in this case a water jet cutter 65, which cuts the profile portions of the IC for the entire substrate. The remaining portions of the IC's, being the longitudinal linear edges are cut using an appropriate cutting device, in this case a dicing saw 70, which completes the singulation process.

The singulated IC's are then sorted in terms of quality, such as "pass", "reject" and "rework" then offloaded to the appropriate station or a reject bin.

The system is adaptable to a range of singulation devices, such as that disclosed in PCT/SG2005/000288, the contents of which are incorporated herein reference. By making suitable modification to the chuck table and dicing machine, designated as "4" and "Z" respectively in Figures 1(a) and 1(b), the system according to the present invention can be incorporated to accommodate IC's having a profile edge, whilst maintaining an acceptable UPH.

It will be clear to the skilled addressee that the system according to the present invention could include incorporated within other types of dicing machine, and so reference to the device of PCT/SG2005/000288 shall not be construed as limiting but merely illustrative.

Profile cutters of this type include laser cutters, such as pulse-excited solid-state lasers, water jet cutters, including those with and without abrasives in the water jet, and air jet cutters.

Figure 3 shows an alternative arrangement where the longitudinal cutter 90 is implemented first, and then the profile cutter 95 next. Similar to the previous embodiment, the first cutter in this case a dicing saw 90, partially cuts the peripheral edges of the IC's. The profile cutter, such as a water jet 95, finishes the job by cutting the remaining profile edges.

There are a number of parameters that need to be met for such a system. One such issue includes the proportion of the peripheral edge to be cut by the longitudinal cutter as compared to the profile cutter. To determine this the shape of the required IC must be known. This may be "hard-wired" into the controller of the device, and so there may be visual recognition due to a camera arrangement identifying "fiducial" marks on the substrate. In this case, the proportion of longitudinal cuts to profile cuts may be well established.

As profile-cutting devices are considerably slower than longitudinal cutting devices, for instance a comparison between a water jet and a dicing saw, it will be preferable to minimise the use of the water jet so as to increase UPH. Further, the greater the use of the water jet, the higher the abrasion on the after jet nozzle and so shorten the life of the water jet compared with the overall life of the system. However, the effectiveness of a dicing saw to cut, for instance, the longitudinal portions 45a,b of Figure 1b, may make tooling and tolerance difficult, outweighing the benefit of the

speed of cut. The longitudinal portions 18a,b of Figure 1b, being longer may, in the determination of performance, be better suited to longitudinal cutting.

Alternatively, the detection system may identify the shape of each IC, or batch of IC's, and determine the proportion based on speed of process, maintenance costs and complexity of shape. Thus, a processor within the controller may be capable of determining an optimum proportion, based on pre-determined parameters, such as total production run, proportion of profile edges to linear edges, required speed of production, type of profile cutting device used etc.

The claims defining the invention are as follows:

1. A system for singulating an IC unit from a substrate, said IC unit having a combination of linear and non-linear peripheral edges, said system comprising
A profile cutting device for cutting the non-linear portions of the IC unit;
A longitudinal cutting device for cutting the linear portions of the IC unit, said cutting means located within a singulation zone.

2. The system according to claim 1, further including a sorting means for sorting the singulated IC units into categories, said categories comprising one or a combination of pass, reject and rework.

3. The system according to claim 1 or 2, further comprising a loading means for loading the substrate to the singulation zone.

4. The system according to any one of the preceding claims, further including an off-loader for removing the singulated IC units from the singulation zone.

5. The system according to any one of the preceding claims, wherein the profile cutting device includes any one or a combination of water jet cutter, an air jet cutter and a laser cutter.

6. The system according to any one of the preceding claims, wherein the longitudinal cutting device includes a dicing saw having a single or dual blade.

7. A method for singulating an IC unit from a substrate, said IC unit having a combination of linear and non-linear peripheral edges, said method comprising the steps of:

profile cutting the non-linear portions of the IC unit using a profile cutting device, and

longitudinal cutting the linear portions of the IC unit using a longitudinal cutting device, said cutting steps occurring within a singulation zone.

8. The method according to claim 7, further comprising the step of sorting the singulated IC units into categories, said categories comprising one or a combination of pass, reject and rework.

9. The method according to claim 7 or 8, further comprising the step of loading the substrate to the singulation zone,

10. The method according to any one of claims 7 to 9, further comprising the step of removing the singulated IC units from the singulation zone.