United States Patent

[11] **3,565,306**

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[54] **METHOD FOR DICING AND CLEANING SEMICONDUCTOR SLICES**
9 Claims, 5 Drawing Figs.

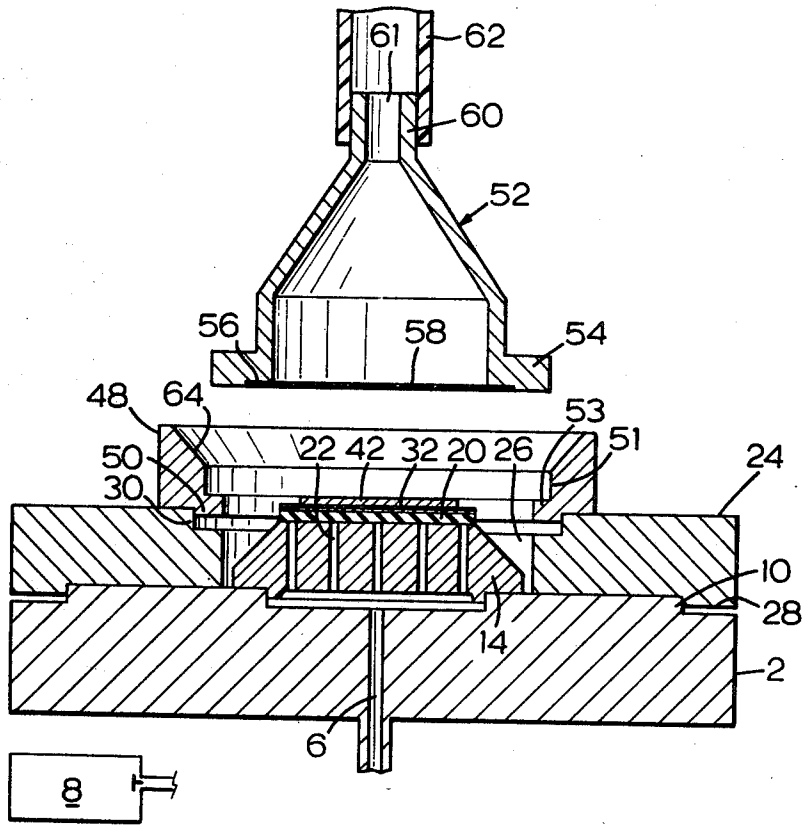
[52] **U.S. Cl.** **225/1,** 225/2, 225/93, 225/96.5
[51] **Int. Cl.** **B26f 3/00**
[50] **Field of Search** ..... 275/1, 2, 93, 96, 96.5; 15/(INQ); 269/(INQ); 29/413

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ABSTRACT: A scribed semiconductor slice is placed scribed side down on a perforated cleaving stage. The slice, covered with a protective plastic film, is held in place by vacuum applied through the stage, while a cleaving bar is stepped across the slice top to dice the slice. A vacuum holder then picks up the dice and moves them into a cover so that the holder and cover together form a cleaning chamber. Cleaning gas is passed through the chamber to clean the dice, and the holder then transports them back to another vacuum holder which in turn transports them to a storage container where they are deposited scribed side up.



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SHEET 1 OF 2

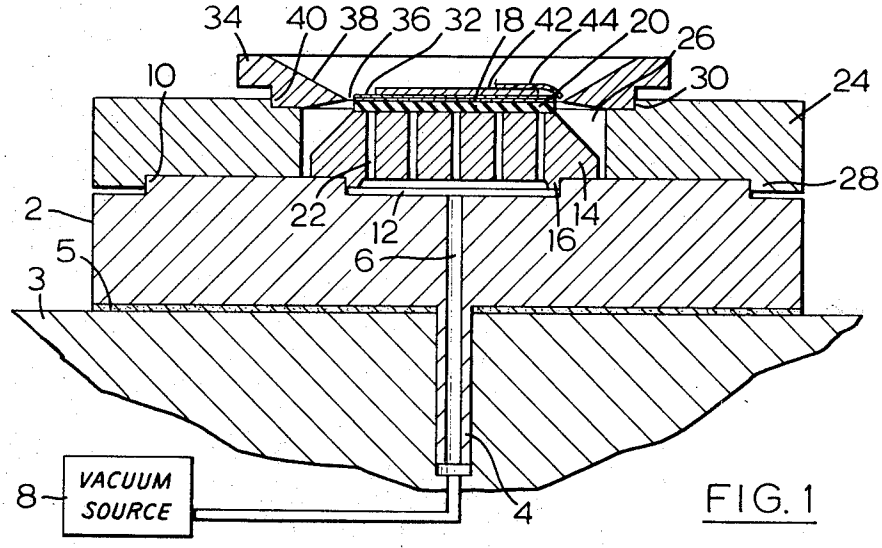


FIG. 1

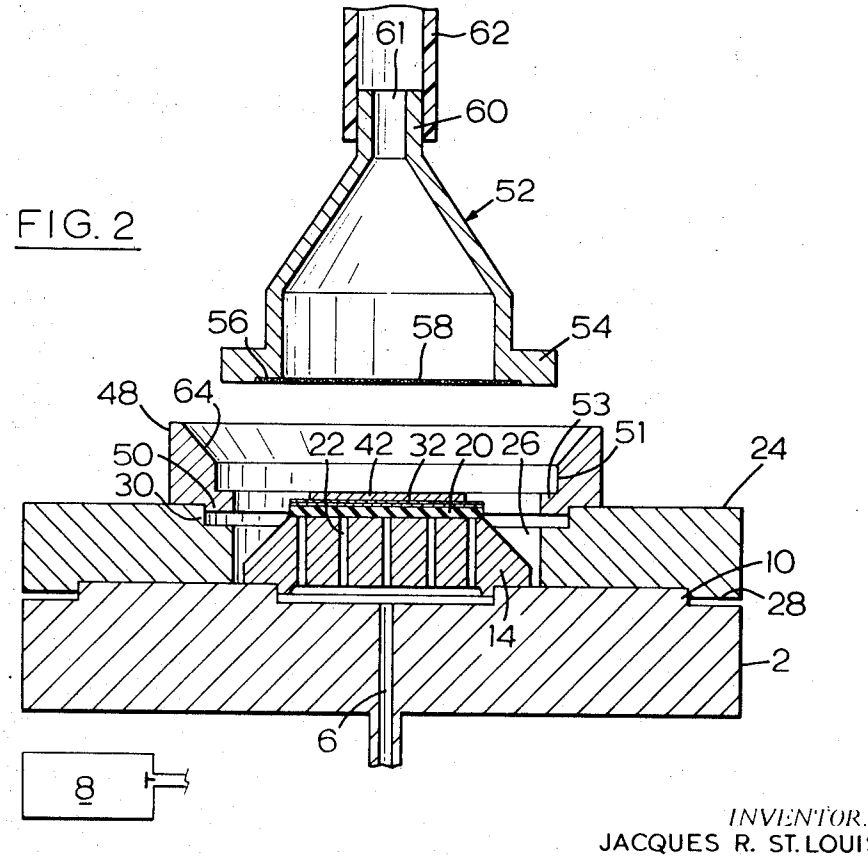


FIG. 2

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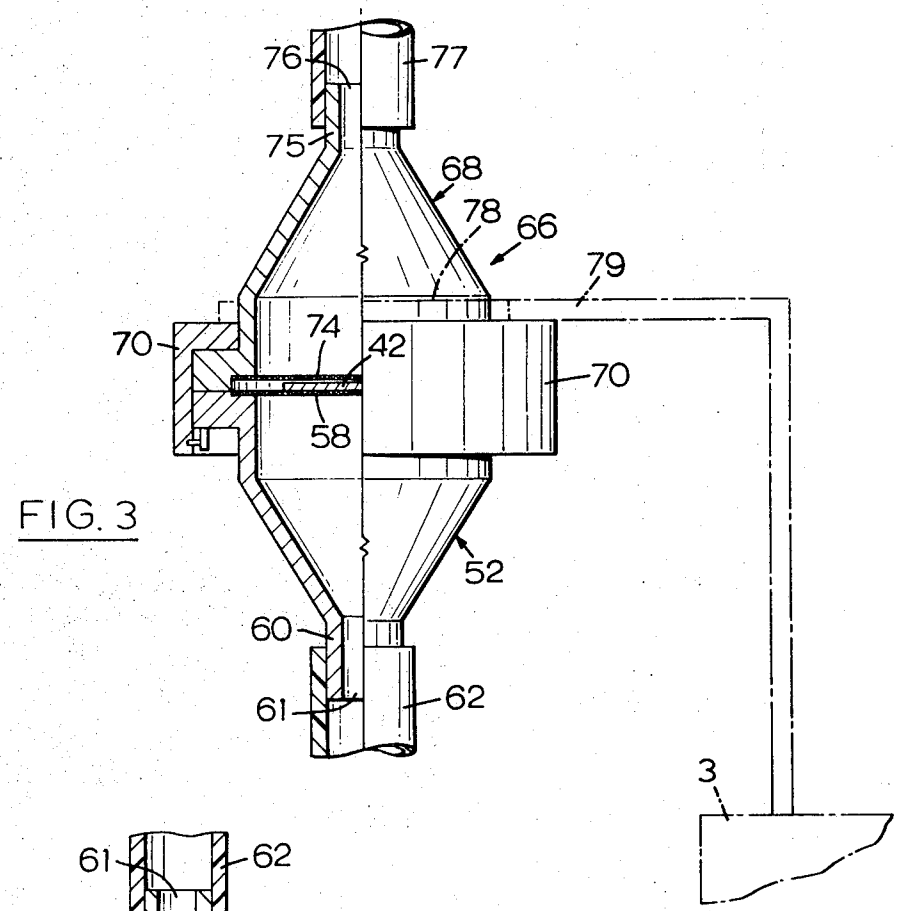


FIG. 3

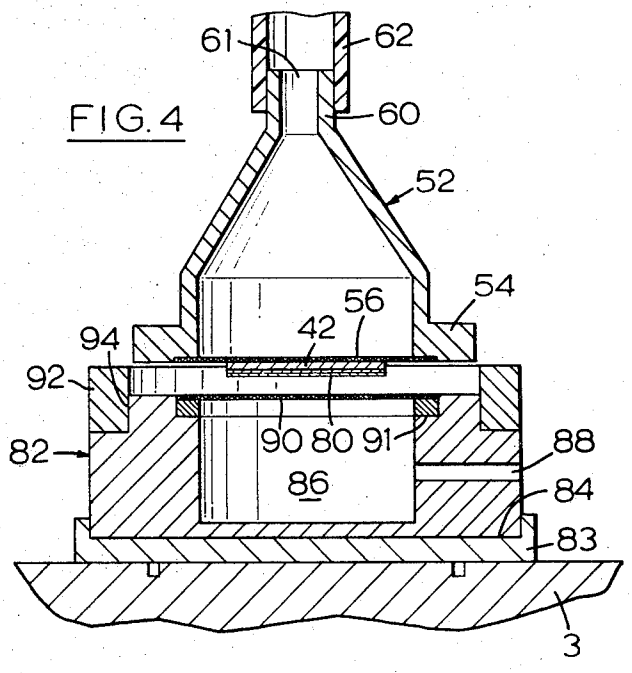


FIG. 4

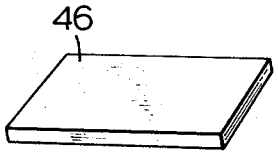


FIG. 5

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METHOD FOR DICING AND CLEANING SEMICONDUCTOR SLICES

This invention relates to a method and apparatus for dividing thin wafers of semiconductor material into individual units commonly referred to as "dice" (such a process is commonly referred to as "dicing") and for cleaning the resultant dice.

A number of processes for dicing semiconductors are commercially available. In a typical process a slice is scribed along a plurality of predetermined orthogonal lines and then placed between two thin flexible sheets e.g. of cellophane. The slice is fixed between the sheets with some form of adhesive, e.g. bee's wax, and is then broken along the scribing lines by passing the sheets, together with the slice inside, through a pair of rollers having different resiliencies. The sheets retain the dice in their position relative to each other so that there is no inversion or lateral movement of one dice relative to another.

Next, the dice must be cleaned either by washing them in a cleaning liquid, or by blowing a gas past them. The washing process usually disturbs the position of the dice so that some of the dice are moved or inverted. This is undesirable since usually one side of each dice (usually the scribed side) has a circuit deposited thereon, and the circuits must all remain in the same orientation for subsequent connection of leads and encapsulation. Since the dice are quite small (they are usually squares about eight-thousandths of an inch in thickness and having sides ranging between thirty- and seventy-thousandths of an inch), reorientation of inverted dice is a difficult process. A number of processes are therefore used to ensure that each dice is right side up when it reaches the user. A typical process includes the use of an optical pickup device which detects and rejects those dice which are wrong side up when they pass through the pickup device. Rejected dice later return to the feed for a further attempt at passing the optical pickup device. Such processes involve extra steps, create extra opportunity for malfunctions, and are relatively expensive. In addition, they do not generally employ sufficient precautions to prevent damage caused by collisions between wafer corners and delicate wafer surfaces during washing and other handling.

Therefore, it is an object of this invention to provide a simple and efficient process and apparatus for taking a scribed slice, cleaving it, and cleaning the dice, without moving one dice relative to another dice.

Briefly, the process of this invention consists of placing a slice (usually scribed side down) on a preferred cleaving stage and holding it in this position by application of a vacuum below the stage while a bar is stepped over the disc to cleave the disc into dice. A vacuum operated holder then picks up the dice and moves them into a cover so that the holder and cover together form a cleaning chamber. The dice are then cleaned while they rest in their relative positions, and the holder then transports them back to a selected receptacle. The selected receptacle may if desired be a vacuum operated holder which is then used to transfer the dice to a storage container where they are scribed side (i.e. circuit side) up.

The process and apparatus will be better understood with reference to the following description and drawings wherein:

FIG. 1 is a sectional view through a part of the apparatus for holding the slice in position preparatory to dicing;

FIG. 2 is a sectional view through a part of the apparatus for holding and lifting the diced slice;

FIG. 3 is a half sectional view of a cleaning chamber;

FIG. 4 is a sectional view of a part of the apparatus for handling the cleaned dice; and

FIG. 5 is a schematic view of a cleaving bar.

The figures 1 to 4 represent a sequence of steps in the process of cleaving and cleaning the disc according to one embodiment of the invention.

As shown in FIG. 1, a cleaving stage support 2 is rotatably supported on a table 3 by means of a bushing 4 which projects into a correspondingly shaped hole in the table. A felt disc 5 between the cleaning stage support 2 and table 3 permits each rotation of the support 2, for easy access in any direction to a slice to be cleaved.

The support 2 includes an orifice 6 connected to a vacuum source diagrammatically indicated at 8. The top face of support 2 contains an annular projection 10 defining a central cylindrical recess 12, and a cleaving stage 14 is located in the recess 12 by a cylindrical protrusion 16 on the lower face of the cleaving stage. The upper face 18 of the cleaving stage 14 may consist of a layer 20 of hard rubber material bonded to the stage 14. The stage 14 is perforated with a series of holes 22 so that vacuum applied to the orifice 6 is transmitted to the upper face 18 of the stage.

Encircling the cleaving stage 14 is an annular locating ring 24. The ring 24 has a central cylindrical opening 26 to accommodate the cleaving stage 14, and has on its bottom surface an annular flange 28 which locates the ring 24 on the upper surface of the cleaving stage support 2. The top surface of the locating ring 24 also has a cylindrical recess 30 concentric with and extending to the opening 26 in the ring.

At the start of the dicing operation, a series of soft paper discs 32 soaked in freon are placed on the upper face 18 of the cleaving stage. The discs 32 preferably have an aggregate thickness of six-thousandths to eight-thousandths of an inch and cover the complete upper face 18 of the cleaving stage.

After the discs 32 are emplaced, a slice centering fixture 34 is placed over the locating ring 24. The fixture 34 is an annular ring having a central cylindrical opening 36 one-sixteenth to one-eighth of an inch larger than the upper face 18 of the cleaving stage. The opening 36 is defined by a sloping wall 38 to each placement of the slice onto the cleaving stage 14. The fixture 34 also has a cylindrical protrusion 40 from its lower surface of the same diameter as the recess 30 in the upper surface of the locating ring 24, to locate the fixture 34 in the locating ring.

After the slice centering fixture 34 is emplaced, a scribed slice 42 is selected. (The slice will usually be scribed on one face with a first series of parallel lines and with a second series of parallel lines at right angles to the first series, so that when the slice is cleaved along both sets of lines, a series of square or rectangular dice will result. The scribing does not form part of the present invention.) The slice 42 is then placed scribed side (i.e. circuit side) down on the paper discs 32 using the slice centering fixture 34 as a guide. The slice 42 is normally of size such that it covers about 75 percent of the diameter of the upper face of the stage 14. The vacuum supply 8 attached to the orifice 6 is then activated so that the disc 42 is held on the cleaving stage 14 by air pressure. The slice centering fixture 34 is now removed.

The next step is to drape a sheet of thin, flexible plastic material, such as that sold under the trade mark Mylar, over the slice 42. This material, a portion of which is shown at 44 in FIG. 1, drapes over the sides of the slice 42 and is used to retain the dice in place during cleaving. The vacuum is then broken and reapplied to ensure that there are no wrinkles in the sheet 44. A cleaving bar 46 (FIG. 5) is then used to cleave the slice. The bar 46 is a rectangular prism having sharp clean edges. One edge of the cleaving bar is aligned with a leading edge of the slice. The cleaving is performed by gliding the bar 46 lightly sideways across the slice, pausing over a scribe line, tilting the bar slightly, and pressing down with even pressure until a click is heard, indicating that the slice has broken at the scribe line in question. The bar 46 is then stepped lightly across the slice to a position which the operator judges to be over the next scribe line, pressed down again until a click is heard, and then is moved to the next scribe line. After the slice has been broken along all the scribe lines in one direction, the support 2 and cleaving stage 14 are rotated in unison through 90°, and the slice is then cleaved along all of the orthogonal lines.

The bar 46 is preferably about 50° longer than the outer diameter of the locating ring 24, and during cleaving it should be reasonably flat with only its center in contact with the thin sheet 44. The thickness of the locating ring 24 relative to that of the cleaving stage 14 should be such that the slice 42 with the Mylar 44 draped over it will protrude slightly above the top surface of the locating ring 24, so that the edge of the bar

46 will contact the Mylar, as the bar is drawn across the slice. The paper discs 32 act as a cushion, permitting the slice to flex and thus to fracture along the scribe lines when the bar 46 is pressed down. The thin rubber coating on the cleaving stage 14 provides an added cushion but can be omitted if desired.

After the cleaving is completed, the Mylar sheet 44 is peeled off the diced slice, using tweezers or other suitable tool, while the stage is still under vacuum.

FIG. 2 illustrates the parts necessary to perform the next step in the process. A holder guiding fixture 48 is placed on the locating ring 24. The holder guiding fixture 48 has a cylindrical protrusion 50 extending into the cylindrical recess 30 of the ring 24. A cylindrical recess 51 on the fixture 48 terminates at its lower end in an inwardly extending radial flange 53, and at its upper end in an outwardly tapered guide wall 64.

A generally bell-shaped holder 52 has an outwardly extending radial flange 54 at its mouth for entering the cylindrical recess 51. The flange 54 contains a cylindrical recess 56 in which a micropore wire screen 58 is retained (e.g. by an adhesive). The holder 52 also has, at its opposite end, a tube 60 projecting therefrom and forming a port 61 in the end of the holder 52. The tube 60 is adapted to receive a flexible hose 62 from a vacuum supply such as that shown at 8.

The holder 52 is guided into the fixture 48 by the tapered guide wall 64 until the micropore screen 58 rests close to (e.g. within one-thousandth of an inch of) the upper face of the diced slice 42. A vacuum is applied to the port 61 through the hose 62, and the vacuum supply to the orifice 6 of the cleaving stage support is broken. The slice 42 and paper 32 are now held against the micropore screen 58 and can be lifted with the holder 52. The holder 52 is removed from the fixture 48, inverted, and brought into the position shown in FIG. 3, after removing the paper 32 from the face of the diced slice 42.

FIG. 3 illustrates the diced slice 42 in a cleaning chamber 66 which consists of a cover 68 similar to the holder 52 clamped by a locking ring 70 to the holder 52. The pressure by which the cover 68 and holder 52 are clamped together is made sufficient to provide an adequate seal between them. The cover 68 includes a micropore screen 74 (of similar type to the screen 58 of the holder 52). The cover 68 further includes a tube 75 at its top, forming a port 76, with a flexible hose 77 extending therefrom.

It should be noted that the screen 74, which is attached to the cover 68, does not touch the scribed upper face of the diced slice 42, but instead is spaced therefrom by two- or three-thousandths of an inch. The spacing is so that the screen 74 will not damage the delicate circuits on the upper face of the slice 42.

In order to retain the cleaning chamber 66 in the position shown in FIG. 3, a clamp ring 78 and holder 79 (shown in dotted lines in FIG. 3) are typically provided to secure the cover 68 to a fixed support such as the table 3.

Just before the holder 52 is brought into contact with the cover 68, the vacuum applied through tube 60 is broken. This is to prevent a collision between holder 52 and cover 68 caused by the suction of the vacuum. Even a very low impact collision can cause wafer upset. Thus, for a brief instant, the diced slice rests on the screen 58 by gravity. After the cover 68 and holder 52 are locked together by locking ring 70, tube 62 is opened to the atmosphere by a solenoid valve, not shown, and another valve, not shown, is opened to introduce clean air or nitrogen at fairly high pressure into the tube 77. The clean air or nitrogen serves to clean the diced slice 42. The screen 58 has pores of sufficient diameter to allow dust and small particles left from the cleaving operation to pass through. Because the clean air moves in the same direction as the airflow induced by the vacuum, and is diffused by screen 74, it does not tend to lift the dice off the screen 58 and disturb their position. The clean air is passed through the chamber 66 for a period of 2 to 3 minutes to ensure complete cleaning of the diced slice 42.

After the cleaning is complete, the air or nitrogen flow is terminated, locking ring 70 is unlocked, and holder 52 is lowered about one-half inch. Vacuum is then reapplied through port 61; the holder 52 is lowered another 2 or 3 inches, and two or three dry paper discs 80 (of diameter about 25 percent greater than the normal slice diameter) are draped over the exposed diced surface of the slice 42. The holder 52 is then inverted and brought into the position shown in FIG. 4. The paper discs 80 remain in contact with the scribed face at this time because of the vacuum.

In FIG. 4 the cleaved slice 42 and dry paper discs 80 are shown as approaching a transfer chuck 82. The transfer chuck 82 is a cylindrical body resting in a flanged ring 83 secured to the surface of the table 3, to prevent the transfer chuck from tilting or sliding laterally. The transfer chuck 82 includes a central cylindrical chamber 86 having an orifice 88 through which a vacuum can be applied. A screen 90 is seated in a cylindrical recess 91 and covers the chamber 86, and a removable annular spacer ring 92 is seated on the chuck 82 in an annular recess 94 to guide the holder 52 onto the chuck 82.

As mentioned, FIG. 4 shows the holder 52 as it is approaching the chuck 82 and ring 92. After the paper 80 comes into contact with the screen 90, the vacuum which had been applied to the port 61 is broken, and a vacuum is applied through the orifice 88 to the underside of the screen 90. The paper 80 and diced slice 42 are held on the screen 90 by the vacuum in the chamber 86, with the paper serving to protect the circuits on the slice 42 from contact with the screen 90. The holder 52 and ring 92 are then removed, Then the chuck 82 is inverted and entered into a container (not shown) having an inner diameter greater than that of the chuck 82. Inside the container is a flat mirrored surface or the like to receive the dice. The diced slice 42 is placed on this surface so that the paper 80 is uppermost and the vacuum applied through the orifice to the chuck 82 is broken. After removing the chuck 82, the paper 80 is removed leaving the diced slice 42. The slice is clean and is the right way up for use.

The reason for soaking the paper discs 32 in freon before placing the slice 42 on them for dicing, is to prevent the dice from sticking to the paper disc 80 after the final transfer. It was found that without the Freon static electricity would build up in the slice during the cleaving process and would cause sticking of the dice to the disc 80 even after the vacuum in the transfer chuck 82 was removed. The Freon conducts away the static electricity charge and evaporates quite quickly. Water could also be used if desired, but is more apt to dissolve water soluble marking inks which are sometimes used on the circuits present on the dice to indicate faulty circuits.

I claim:

1. The process of dicing a thin brittle slice of semiconductor material or the like having a first scribed face containing a number of scribe lines arranged in a predetermined pattern, said slice having a second face opposing said scribed face, said process comprising the steps of:

a. placing said slice on a perforated cleaving stage with said scribed face down, and holding said slide on said cleaving stage by applying a vacuum to the perforations of said stage;

b. cleaving said slice along said scribe lines to form dice;

c. applying a first vacuum holder having a screen to said second face of said dice such that said screen is in contact with said dice, breaking the vacuum applied through said cleaving stage; and applying vacuum to said holder to retain said dice therein;

d. lifting said holder with said dice and clamping said holder to a cover thereby forming a chamber in which said dice are supported, and breaking said vacuum applied to said holder;

e. passing a cleaning gas through said chamber for a predetermined time to remove particles of dust caused by cleaving said disc;

f. unclamping and removing said cover and reapplying vacuum to said holder; and

g. placing said holder on a selected receptacle, and breaking the vacuum applied to said holder to deposit said dice on said selected receptacle.

2. The process according to claim 1 wherein said step (b) includes placement of a soft paper disc on said stage, between said stage and said dice, said paper disc permitting passage of air therethrough and acting as a cushion to enable fracturing of said dice.

3. The process according to claim 2 wherein said paper disc, prior to its placement on said stage, is soaked in a liquid conductive of electrostatic charges, to prevent sticking of said dice to said disc.

4. The process according to claim 3 wherein said liquid is Freon.

5. The process according to claim 3 wherein said step (b) includes the steps of covering said slice with a thin, flexible sheet, then moving a cleaving edge across said slice and pressing said cleaving edge down over each of said scribe lines, and then removing said sheet.

6. A process according to claim 5 wherein, after said slice is covered with said thin, flexible sheet, said vacuum applied to said cleaving stage is temporarily interrupted to remove wrinkles from said sheet.

7. A process according to claim 6 wherein, before said holder is placed on said selected receptacle, a soft paper disc is placed on the scribed face of said disc in said holder and is retained in position by the vacuum applied to said holder, to protect said scribed face upon deposit of said dice in said selected receptacle.

8. A process according to claim 5 wherein, prior to said step (d), said flexible sheet is removed, and in said step (d), said holder is inverted so that said scribed face is up, said vacuum being broken just before said holder is brought into engagement with said cover, so that said dice rest on said holder by gravity, and wherein, in said step (e), the flow of said cleaning gas is diffused before it reaches said dice and is passed past said dice from said cover to said holder to avoid lifting and disturbing said dice.

9. A process according to claim 1 wherein said selected receptacle is a second vacuum holder, said process further comprising the steps of applying vacuum to said second holder to retain said dice therein, inverting said second holder and placing it against a container having a flat, polished support surface with said dice against said support surface, removing the vacuum applied to said second holder, and removing said second holder, leaving said dice on said support surface with said scribed face uppermost.