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APPARATUS AND METHOD FOR DICING SEMICONDUCTOR WAFERS

RELATED APPLICATIONS

The present invention is related to the subject matter of U.S. Application Serial No. 07/804,135 filed in the name of James W. Loomis on December 6, 1991 for "Frangible Semi-Conductor Wafer Dicing Method Which Employs Scribing and Breaking", a continuation-in-part of the above application, Application Serial No. 08/109,760 filed August 20, 1993 with the same title and a divisional application Serial No. 08/110,178 filed August 20, 1993.

FIELD OF THE INVENTION

The present invention relates to an apparatus and method for dicing semiconductor wafers and other frangible materials and more particularly to an apparatus for and method of dicing wafers by scribing and breaking a large wafer while preventing adjacent diced wafers from damaging one another during dicing and the pick and place operation.

BACKGROUND OF THE INVENTION

Dicing a semiconductor wafer while it is adhered to a flexible film is a desirable production technique because the dice maintain their original x-y coordinate positions after dicing. If their positional relationship is maintained, test information derived from testing every die, while they are integral, can be related to them after dicing.

When the dicing process is accomplished by sawing, the saw cut removes enough material between the dice to isolate each die from one another to prevent adjacent dice from hitting one another when the dice are removed from the adhesive film. This removal technique is commonly called "pick and place". Since saw dicing is the prevalent method, dicing on adhesive film and using pick and place techniques is almost mandatory in the semiconductor industry.

A recent semiconductor technology is employing a semiconductor material, gallium arsenide, which is difficult to saw into dice. It is more efficiently scribed and broken into dice. However, in the scribe and break process no material is removed to create physical isolation of the dice from one another. This lack of physical isolation can, and does, cause the dice to damage each other during scribing and breaking of adjacent rows. Also pick and place cannot be accomplished. Thus the wafer must grow when it is transformed from one piece into 200 to 30,000 pieces depending on surface area of the dice. Compounding the problem even further, the break process necessitates bending the dice relative to one another. To make a scribe and break process which holds the wafer and resultant dice on adhesive film requires a method of gradually stretching the film as the wafer is segmented.

Semiconductor wafers are shaped like a round disk. As a result, most film holding systems are circular and a further result is all stretching mechanisms create radial stretch.

Radial stretch creates a problem with the scribe and break process because the wafer is segmented bilaterally (x and y), not radially. The order of events for dicing with scribe and break is to segment the wafer into strips and segment the strips into dice. To prevent damage, that is, prevent the strips from touching and the dice from touching, a method for holding and placing bilateral tension on the film is necessary.

OBJECTS OF THE INVENTION

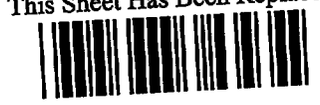
It is an object of the present invention to stretch a diced wafer mounted on an elastic base in the x-y mode; that is, bilaterally during dicing.

It is another object of the present invention to provide a method of and apparatus for applying an x-y stretch to a stretchable material on which a diced semiconductor wafer is mounted.

Yet another object of the present invention is to mount a stretchable material on which is to be disposed a semiconductor wafer on a frame that exerts a bilateral force on the stretchable material.

Still another object of the present invention is to provide a method for applying an x-y force to a semiconductor wafer that has been diced by the scribe and

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break method whereby to provide sufficient spacing between the diced chips to permit the dice to be removed by the pick and place technique.

BRIEF DESCRIPTION OF THE PRESENT INVENTION

To accomplish bilateral expansion, a square frame is created, which is used to hold tape shaped like a Swiss Cross. In the alternative the frame may be in the shape of a Swiss Cross. The frame is constructed with hollow square tubing on all sides of the square with right angle corner rods/tubes inside adjacent side tubes in a telescopic fashion. In the center of each side tube is a symmetrically expanding spring arrangement which pushes on and insures equal movement of the ends of the corner pieces. The key word is symmetric movement of the spring system. When the frame is compressed and the Swiss Cross tape is attached to the sides, it exerts, upon release, a bilateral tensile load on the tape that attempts to expand the tape in a symmetrical fashion in both x and y directions independently. The frame and tape are held in a film application fixture which brings the film, frame and wafer together.

The tape and wafer are held in tension by the frame. The tape behaves elastically to the tensile strain except in the area where the wafer is adhered. In this area, reinforcement by the wafer prevents tape elongation. However, when the scribe/break operation takes place, the tape, as the wafer is segmented, is

permitted to expand, causing a spacing between the segmented parts. This happens in the x direction as the wafer is segmented into strips and then in the y direction as the strips are segmented into dice.

The frame is mounted on the scribe and break machine of the aforesaid prior applications by a U-shaped member secured to a platform of the machine. The base of the U-shaped member includes a mechanism for rotating the region of the member holding the frame through ±5° to properly align the wafer with the scribe and break mechanism.

Because of the shape of the tape and the way the frame bilaterally and symmetrically applies a tensile load on the tape, the dicing process proceeds without the dice impinging on each other and causing damage.

The final operation after dicing is exaggerated expansion of the spacing between the dice bilaterally by a tape frame expansion fixture. After expansion, the dice are easily accessed from the tape by a pick and place machine. To accommodate existing holding frames in existing pick and place machines, the tape frame expansion fixture allows transfer of the frame to a hoop set or conventional saw frame.

The essentials of the method then consist of mounting a Swiss Cross on a frame that applies an equal (symmetrical) x-y expansion force to the wafer, mounting the wafer on the Swiss Cross, dicing the wafer on a

scribe and break machine such as disclosed in the Related Applications, the entire disclosures of which are incorporated herein by reference. The aforesaid frame is then mounted on a mechanism for further expansion with heating of the elastic material to the extent necessary to permit sufficient expansion to separate the individual die to permit them to be removed from the elastic material by the pick and place technique.

Although the present invention is described as applied to the production of semiconductor chips for which the invention was specifically developed, it must be understood that the apparatus and method are equally applicable to the dicing of any wafer-like materials by the scribe and break process as opposed to dicing by sawing .

The above and other features, objects and advantages of the present invention, together with the best means contemplated by the inventor thereof for carrying out the invention will become more apparent from reading the following description of a preferred embodiment and perusing the associated drawings in which:

BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1 is a top view of a square wafer frame holder on which the elastic member is mounted;

Figure 2 is a top view of a mechanism for insuring symmetrical expansion of the film;

Figure 3 of the accompanying drawings illustrates the elastic film in the shape of a Swiss Cross with adhesive on the ends and adhesive on the side opposite for adhering a wafer that is to be mounted on the frame of Figure 1;

Figure 4 of the accompanying drawings illustrates the film application fixture employed to position the wafer frame holder and Swiss Cross relative to one another;

Figure 5 illustrates the film application fixture with the frame of Figure 1 applied thereto;

Figure 6 illustrates an eccentric mechanism located on the underside of the fixture for insuring proper location of the wafer frame holder;

Figure 7 illustrates the frame 2 as applied to the scribing and breaking machine of the aforesaid application;

Figure 8 is a view in side elevation illustrating the wafer frame holder applied to the scribe and break machine;

Figure 9 is a top view partially in section of the top of the mechanism for holding and rotating the wafer frame holder;

Figure 10 is a top view of a wafer frame holder expander;

Figure 11 is a view of a second eccentric for use with the frame expander of Figure 11; and

Figure 12 illustrates another structure for holding the wafer frame holder on the scribing and breaking machine.

DETAILED DESCRIPTION OF THE PRESENT INVENTION

Referring now to Figure 1 of the accompanying drawings, there is illustrated a wafer frame holder 2 (hereinafter "frame 2") for use in the present invention. The frame 2 has four hollow side members or tubes 1, 4, 6 and 8, preferably rectangular in cross section. Also provided are four corner members 10, 12, 14 and 16 slidably telescoped in tubes 1 and 4, 4 and 6, 6 and 8 and 8 and 1, respectively. Each tube has disposed therein a mechanism to insure that the corner members at each end of a tube 1, 4, 6 and 8 expand equally; otherwise true x expansion or y expansion may not occur. If one corner member moves more than the other either at the two ends of the same side member or at the ends of different parallel side members skewing of the film and thus the scribes will result.

Referring to Figure 2 of the accompanying drawings, the mechanism for accomplishing the above results is illustrated. A plate 3 is inserted into and secured in the center of each side member. The plate carries two pulleys 5 and 7 with a belt 9 disposed around the pulleys. Two opposed L-shaped members 11 and 13 have thick base legs 15 disposed at right angles to the length of the side member and pressing against, for example, the ends of the corner members 12 and 14. Disposed between the two pulleys is a spring 18 located between two blocks 17 and 19. The block 17 is secured to the belt 9 and leg 21 of the L-shaped member 11 while block 19 is secured to the parallel leg of belt 9 and leg 23 of L-shaped member 13. Thus upon separation of a strip of a wafer from adjacent material of the wafer, the spring 18 separates the L-shaped members by equal movement of each so that the x-y alignment of the strips and chips is maintained.

As indicated, the frame 2 is in the form of a rectangle, preferably a square. Also it is seen that an expanding force is developed by the springs, such as springs 18, in each side member when the frame is compressed to a size smaller than would prevail otherwise.

Referring to Figure 3 of the accompanying drawings there is illustrated a Swiss Cross 26 of an elastic material such as polyethylene or plasticized PVC employed with the frame 2 of Figure 1. The film is 5 to

10 microns thick. An adhesive is applied to strips 28, 30, 32 and 34 adjacent and parallel to the ends of each of the arms 36, 38, 40 and 42, respectively, of the Cross 26. Before use the adhesive strips are covered by a removable non-adhesive tape. The opposite surface, the wafer adhesion side, of the elastic material is sticky across its entire surface and is normally covered by non-adhesive tape. The sticky material is available from Nitto and Furukawa companies in Japan and Ultron in the U.S. Some of these materials are ultraviolet curable so that when the entire dicing operation is over the material may be rendered less sticky to facilitate removal of the chips from the elastic material or film. Such a material is available from the Furukawa Electric Company in Tokyo as its special polyolefin film UC128M. The sticky material is characteristically one to two microns thick.

Referring now to Figure 4 of the accompanying drawings, there is illustrated a film application fixture 44 employed to bring the frame, Swiss Cross and wafer together. The frame 44 has mounted on a generally square platform 46 four studs 47, 49, 51 and 53 and slide members 48, 50, 52 and 54. Each stud is located at a different corner of the Cross to be applied and positioned at 45° relative to the adjacent sides of the platform. Each stud is located to exactly define the position of a different one of the junctions of the arms

36, 38, 40 and 42. Each stud is located in line with a different one of slides 48, 50, 52 and 54, each slide being mounted on the platform 46. Mounted on each slide is a different block 60 having a 90° angle 62 formed in its end of a size to engage a corner member, for instance, corner member 10, of the frame 2 of Figure 1.

After the Swiss Cross 26 has been located on platform 46, with its wafer adhesion side down and adhesive strips up, the frame 2 is placed on the platform 46 over and spaced above the Swiss Cross. Referring to Figure 5, the blocks 60 are caused to slide inwardly in slots such as slot 84 (see Figure 6) and engage the corner members of the frame and thus compress and accurately position the frame 2 relative to the Swiss Cross. The non-adhesive tape is then removed from the adhesive strips and the frame is pressed down onto the adhesive strips. The ends of the Swiss Cross are then folded up around the sides of the frame 2 so that the adhesive strips contact the side members of the frame along the bottom, sides and a little of their tops so that the Swiss Cross is now secured to the frame 2.

The blocks 60 are caused to slide by a simple eccentric mechanism on the bottom of the platform 46. Referring to Figure 6 a circular plate 66 is rotatably secured to the center of the platform 46. A handle 69 is secured to the plate 66 to rotate it. Four arms 68, 70, 72 and 73 are secured at pivots 76, 78, 80 and 82 to

plate 66 and lie along 45° lines relative to the square platform 46. The arms 68, 70, 72 and 73 have studs that extend each through a different slot 84 to engage the blocks 60. Upon rotation of the handle 69 in the clockwise direction, the arms all assume the position of the dashed line position of arm 72, pulling the blocks along their respective slots and into engagement with their respective corner members to compress the frame.

Referring again to Figure 5, the frame 2 and with the Swiss Cross 26 applied is released from the film application fixture 48 by rotating handle 69 counterclockwise. Then the assembly 2 and 26 are removed. The non-adhesive tape covering the wafer adhesive side of the Swiss Cross is a) removed entirely; or b) the center portion is only removed; or c) only the outer portion is removed. Most often the entire non-adhesive cover is removed. A wafer 64 is oriented so the scribe grids (not illustrated) are parallel to sides of frame 2 and adhered to the center of the Swiss Cross in a fashion which avoids air entrapment between the film and wafer. The assembled frame 2, Swiss Cross 26 and wafer 64 are now placed in the scoring and breaking machine of the aforesaid patent application modified only as necessary to support the frame 2.

Referring now specifically to Figures 7 and 8 of the accompanying drawings, the scribing and breaking machine 89 of Application Serial No. 08/109,760 is

illustrated (to extent necessary to understand the present invention) as modified hereby.

The machine 89 has an index slide 90 for indexing the frame 2/film 26/wafer 64 assembly from left to right as viewed in Figure 8. A block 92 is secured by conventional means, preferably screws, to the slide 90 and a plate 94 forming a part of a U-shaped member 96 is cantilevered therefrom.

Referring now to Figure 9, a body 98 is secured to the U-shaped member 96 and has magnets 100 and 102 flush with surface 104 at the back of a slot 105 defined in the face of the member 98 facing the scribing and breaking elements of the mechanism. The magnets are employed to hold the frame 2 during the dicing operation. Studs or dowel pins 106 stick out from the surface 104 to permit proper positioning of the frame 2 in the recess 106. To remove the frame 2 from the body 98, there is provided a lever 110 which when rotated causes a leg 112 of the lever to protrude from the wall and push the frame 2 off of the magnets and cause it to be released.

The body 98 has a bottom lip 114 extending out further than the upper surface of the slot to provide additional support to the frame 2.

It should be noted that the U-shaped member has two legs, only one of which, leg 118, is illustrated. The legs of the U-shaped member 96 extend under the frame 2 to a point beyond the scribing and breaking region of

the machine with the frame supported at the ends of the arms by thin blocks such as block 120.

When slicing is completed along, for instance the x axis, the frame is removed from the frame holder and rotated 90°. Slicing may again be performed along the x axis so that the individual chips are now formed and have been separated by the stretch provided along both axes of the wafer by the Swiss Cross and frame 2.

A frame expansion device 122 is illustrated in Figure 10. The device comprises a square platform 124 having four identical translatable fixtures 126 each arranged parallel to its adjacent edge of the platform and having an upstanding lip 128. The fixtures 126 are slidable each in a different one of slots 130. In practice a hot disc 132 is placed in the center of the platform 124, the frame/film/wafer assembly is placed over the platform with each one of its side members placed outside of a lip 128. Lever 134 is now rotated and this causes the members 126 to move toward their adjacent edges, the heat transferred by the hot disc 132 to the film on which the chips are mounted softens the film allowing it to expand in the x and y directions. Thus the chips are separated from one another sufficiently to allow them to be removed from the film without damaging adjacent chips.

The movement of the fixtures 126 may be by the eccentric illustrated in Figure 6 or by the eccentric

illustrated in Figure 11. In Figure 11 slots 131 are curved and have bolts 136, with one mounted in each slot. Upon rotation of the handle as indicated, the bolts 136 which are threaded into the underside of fixtures 126 are moved toward the outer edges of the platform and the film is expanded.

Referring now to Figure 12 of the accompanying drawings, the member 98 is modified as illustrated in Figure 12. Instead of using magnets to hold the frame 2, a ball and detent arrangement is used. Specifically, the body 98 has been modified as body 98' to provide a spring biased ball 138 in the two sides of the recess 106. The frame corner members 10 and 16 have recesses formed in their sides, only one being illustrated by number 140. Thus the frame may be snapped into place and held rigidly.

The method of the present invention is as follows:

1) Place tape film 26 in film application fixture 44, and remove adhesive covers on ends of the Swiss Cross. The wafer adhesion side with its protective cover is facing down.

2) Place frame 2 expanded in the fixture 44 expanded.

3) Pull lever 69 to contract frame 2.

4) Push frame 2 into contact with film 26 and wrap ends of Cross around the four sides of frame 2.

5) Counter-rotate lever 69 to place the film under x-y tension.

6) Remove frame 2 and film 26 from fixture 44.

7) Remove center where wafer is to be placed from cover laminate on film 26 or remove entire laminate cover from adhesive on film 26. Adhesive that holds wafer is applied to the entire tape surface so one can strip off all or just a circle where wafer is to be placed.

8) Align pattern of wafer parallel to film application fixture 44 and put wafer, circuit side down, in cavity 64.

8a) Align pattern of wafer parallel to film application fixture 44 and put wafer, circuit side up, in cavity 64.

9) Reinstall frame and tape in frame without compressing.

10) Using a cotton tipped applicator or similar, iron film 26 onto back of wafer, taking care not to trap air between back of wafer and tape.

11) Remove frame 2, wafer and film 26 from film application fixture 44.

12) Peel remainder of cover laminate away if not already done.

13) The tape 26, wafer and frame 2 are now ready for installation in scribe/break machine and oriented relative to the mechanism of the machine.

14) After scribing and breaking insert frame 2, film 26, wafer assembly in the expansion fixture 122 to expand film and thus space the chips away from each other.

15) The chips may now be removed from the film.

16) As an added step the expanded film with the diced wafer may be exposed to ultraviolet light to cure the plastic before removing the chips from the film.

Once given the above disclosure, many other features, modifications and improvements will become apparent to the skilled artisan. Such features, modifications and improvements are, therefore, considered to be a part of this invention, the scope of which is to be determined by the following claims.

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WHAT IS CLAIMED IS:

1. A film for holding a thin body to be diced, comprising

a Swiss Cross of a thin elastic film of material,

a sticky substance formed on a first surface of said film,

adhesive disposed in bands across the ends of the arms of the Swiss Cross on the side opposite the surface with the sticky substance.

2. A film according to claim 1 wherein said sticky substance is curable to render it less sticky.

3. A method of preparing a wafer for and dicing a wafer comprising the steps of

securing a flexible sheet with an adhesive surface on a compressed rectangular frame that can be expanded along x and y coordinates,

securing an object to be diced into small uniform pieces on said sheet,

allowing the frame to expand,

placing the frame on a machine for scribing and breaking said object, and



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breaking the object into small uniform pieces.

4. The method according to claim 3 further comprising the steps of

further expanding the flexible sheet after breaking of the object into pieces to increase the physical separation of the pieces.

5. The method according to claim 4 wherein said film is heated prior to the step of further expanding the film.

6. The method according to claim 3 further comprising the steps of

rotating the frame about its center to align the wafer with the scribing and breaking mechanism of the machine.

7. The method of dicing a semiconductor wafer comprising the steps of

placing an elastic film in the form of a Swiss Cross on a board such as to align it with studs on the board,

aligning an expandable frame with and pressing it against the Swiss Cross,

securing the Swiss Cross to the frame,

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actuate an eccentric on the board to expand the frame,

remove the frame from the board,

place on and adhere a wafer to be diced to the Swiss Cross,

place the frame film wafer assembly in a scribe and dice machine,

scribe and dice the wafer.

8. The method according to claim 7 further comprising the step of

further expanding the frame film diced wafer assembly to increase separation of the diced elements.

9. A support for a body to have an operation performed thereon comprising

a first member for holding a body to be operated upon,

a support member having a fixture for holding the first member,

a machine for operating upon said body and having a center,

said first member being rotatable about the center of the body.

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10. A support according to claim 9 further comprising

magnets for holding said first member in said fixture.

11. A support according to claim 9 further comprising

a ball and detent structure for holding said first member in said fixture.

12. Apparatus for providing separation between a plurality of thin members that have been separated from one another, comprising

a symmetrically telescopic expandable frame of four hollow side members, four corner members telescoped into the ends of the hollow side members and four matched springs disposed in the hollow side members to exert outward forces on the corner members to provide an expanding force on the frame,

means for compressing said frame, and

an elastic material secured to the four side members of the compressed frame.

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