PATENT SPECIFICATION (11) 1243346

1243346

DRAWINGS ATTACHED

(21) Application No. 56793/68 (22) Filed 29 Nov. 1968

(45) Complete Specification published 18 Aug. 1971

(51) International Classification H 01 l 7/64

(52) Index at acceptance

H1K 217 357 36Y 54Y 601 60Y
B2A 27
B5E 8

(72) Inventor KENNETH HOBBS

(54) IMPROVEMENTS IN AND RELATING TO METHODS OF SEPARATING INTO PIECES PLATES OF MATERIAL

(71) We, ASSOCIATED SEMICONDUCTOR MANUFACTURERS LIMITED, of Abacus House, 33, Gutter Lane, London, E.C.2., a British Company, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement: —

THIS INVENTION relates to methods of separating into pieces a plate of material in which the plate is secured on one major surface of a foil of synthetic resin and divided into pieces, particularly, but not exclusively, to methods of separating semiconductor wafers into semiconductor wafer parts. The latter methods are used in the manufacture of semiconductor devices, for example transistors and integrated circuits. The invention further relates to apparatus in the form of chucks suitable for use in such methods, and to pieces of a plate of material when separated using such methods.

In Japanese Patent No. 7182 of 1966 there is proposed a method of severing a semiconductor wafer, in which the wafer is attached to a foil of synthetic resin and is divided into parts by severing along grooves formed in the surface of the wafer. Thereafter the foil is extended in all directions so that the severed wafer parts attached to the foil are spaced apart. However, proper extension of the foil while maintaining the orientation of the severed wafer parts is problematic. The said Japanese Patent supplies no specific teaching on how such proper extension can be achieved, neither does it suggest any apparatus suitable for carrying out this delicate operation.

In British Patent Application No. 32166/68 (Serial No. 1,233,083) there is described an apparatus which is suitable for carrying out such a method. This apparatus comprises a chamber having an opening which defines a ledge for supporting the periphery of a foil on the inner part of which severed but unspaced semiconductor wafer parts are held, means for sealing the periphery of said foil on said ledge in air-tight manner, means for applying a subatmospheric pressure within the chamber so sealed by the foil, heating means situated externally of the chamber for irradiating the foil, and a platform situated within the chamber for receiving the inner part of the foil bearing wafer parts which are mutually separated on extension of said part of the foil into the chamber by irradiation of the foil and application of said sub-atmospheric pressure.

Such methods when carried out using such apparatus as is described in the said British Patent Application have substantial advantage over the previously known method described therein, but they tend to produce several further difficulties and disadvantages.

The extension of the foil results from sucking the foil into the sub-atmospheric pressure chamber in a manner similar to that of a bubble. Local weaknesses in the foil may lead to a non-uniform extension of the foil and in severe cases may cause punctures. Because the foil is moving in three dimensions, such punctures are likely to scatter the wafer parts throughout the chamber. To reduce the effect of these local weaknesses, the surface area of the foil undergoing extension may be reduced, but this would necessitate a reduction in wafer size which is technologically undesirable for semiconductor devices. An alternative to reducing surface area is to use a comparatively thick foil, for example of 0.12 mm. thickness of material available commercially under the Trade mark "Genotherm 100". Such thickness is however approximately equal to the thickness of a semiconductor wafer, and this raises problems, for instance when fracturing the semiconductor wafer into component wafer parts by the bending moment roller method to be described hereinafter.

When the foil is sucked into the chamber, it is desirous to deposit the portion of the foil having the wafer parts secured thereto

on a platform situated within the chamber. Occasionally this does not occur, the said portion of the foil missing the platform with the result that the wafer parts usually are irrecoverable. In addition, it is desirous for the platform surface on which the foil and wafer parts are deposited to be a flat plane; such a surface facilitates the ready removal of the wafer parts. During the extension of the foil, the major foil surfaces are curved so that wafer parts originally arranged in straight rows on the unextended foil are deposited in curved rows on the extended foil on the chamber platform. Such curved rows of wafer parts are less convenient for removal than corresponding rows.

Heating of the foil when using the known apparatus is usually commenced prior to the evacuation of the chamber. Such a procedure produces a slight sagging of the foil by thermal expansion prior to the major extension by sucking. This slight sagging can cause side contact between wafer parts which may result in damage to the side of the wafer parts. Furthermore such contact may weaken the electrostatic attraction by which the wafer parts are normally attached to the foil, hence detaching one or more of the wafer parts.

The heating means for irradiating the foil is situated externally of the chamber so that the heating of the oil is effected by irradiating the same major surface of the foil as that on which are situated the wafer parts. It is also usual for the major surfaces of the semiconductor wafer to be highly polished, and this results in their being highly reflective to radiation. The most important portion of the foil for stretching, and hence heating, is the portion on which the wafer parts are situated Consequently substantial irradiation and comparatively high temperature are required to heat adequately this portion of the foil, and this may result in the wafer parts adhering to the foil. This may complicate either the mutual spacing of the wafer parts on extension of the foil, or their subsequent removal from the foil.

According to a first aspect of the invention, in a method of separating into pieces a plate of material, the plate is held on a central portion of one major surface of a foil of synthetic resin and divided into pieces, the foil is mounted on a chuck with peripheral portions of the foil secured to self-centring, symmetrically arranged jaws of the chuck and with the portion of the foil on which the said pieces are held lying in a substantially flat plane, and the jaws of the chuck are urged apart and move radially outward to extend omnidirectionally in said substantially flat plane the portion of the foil on which the said pieces are held so that the said pieces are spaced apart.

Such extension of the foil using such a chuck eliminates or reduces several of the hereinbefore-mentioned disadvantages. The said jaws are urged apart and move radially outward to extend omnidirectionally in said substantially flat plane the portion of the said foil on which the said pieces are held. Thus, the major surface sof the foil are not deliberately curved during extension, so that an originally straight row of the said pieces on the unextended foil remains substantially straight on the extended foil; this facilitates removal of the said pieces from the foil. The foil is not moving in three dimensions during the extension, so that effects of a puncture in the foil need not be severe. The difficulty of a portion of the foil moving in three dimensions being wholly deposited on a certain fixed platform is removed. The effect of local weaknesess in the foil is reduced compared with the three dimensional strain imposed by the previously described method and apparatus. This permits the use of a thinner foil and/or one with a larger surface area.

Since the method is particularly advantageous for semiconductor technology, the plate may be a semiconductor wafer and the said pieces may be semiconductor wafer parts of a semiconductor device. This enables the method to be used for separating wafers having a relatively larger diameter. Wafers of large diameter are more economic when it is considered that more wafer parts and hence semiconductor devices can be manufactured from one wafer, and the number of processing steps is the same as that used for a smaller wafer. In addition the arrangement of the spaced wafer parts in substantially straight rows greatly facilitates a more automatic removal of these small pieces, for example by a pick-up needle connected to a vacuum line. The thickness of the foil may be less than that of the semiconductor wafer. Such a smaller foil thickness is advantageous when dividing the wafer into parts by fracturing using the bending moment roller method to be described hereinafter. The foil may be of electrically insulating material, the wafer parts being held thereon by electrostatic attraction. In this connection, reference is invited to the said British Patent Serial No. 1,223,083. Advantageously, a non-pre-stretched foil is used which has a suitable electrostatic charge, to which the said pieces adhere during extension, whilst they can be removed readily from the foil after extension, for example by a hollow needle connected to a vacuum line. Thus, it is not necessary to use self-adhering foils and consequently the surface of the wafer secured to the foil is not contaminated. Such electrostatic attraction is advantageous in semiconductor device manufacture, since even small quantities of impurities can adversely effect the characteristics and lifetime of semiconductor devices comprising such wafer parts. As a result, wafer parts separated by such a method in accordance with this first aspect of the in-

vention may not need any subsequent cleaning.

The foil may be of thermo-plastic material and be extended by a tensioning force applied to the peripheral portions of the foil via the said jaws and by a simultaneous heating of the portion of the foil on which the said pieces are held, the application of the tensioning force commencing prior to the application of heat. Such a method overcomes the disadvantage of sagging of the foil resulting from prior heating. In this case the heating may be effected by thermal irradiation of the opposite major surface of the foil. Such a method requires less irradiation and a lower temperature than the case in which the foil is irradiated on the same major surface as that on which are held the said pieces. This enables, for example, the overall temperature of the foil to be reduced by 50°C for a "Genotherm 100" foil; at such a temperature the semiconductor pieces are not likely to adhere permanently to the foil. After extension by applying said tensioning force and heating, the foil may be cooled and substantially retain its extended form, and at least the portion of the extended foil having the said pieces held thereon may be severed from the remainder of said foil. In this case the material of the foil may be material available commercially under the Trade Mark "Genotherm 100".

After extension of the foil, the said pieces may be visually checked for damage or irregularities, the approved pieces then being removed from the foil and further processed.

The plate may be divided along two orthogonal sets of planes substantially perpendicular to the one major surface of the foil.

According to a second aspect of the invention, a chuck suitable for use in a method in accordance with the first aspect of the invention to extend a foil portion on which pieces are held so that the said pieces are spaced apart, comprises a substantially annular scroll plate which is rotatable in a casing about an axis and has groove portions on one major surface of the scroll plate at right angles to the axis of rotation, which groove portions are inclined with respect to radial directions of the scroll plate, a plurality of symmetrically arranged jaws which co-operate with the groove portions of the scroll plate and are guided in the radial direction, the scroll plate and jaw arrangement being such that on rotation of the scroll plate the jaws are constrained to move radially in a substantially flat plane while maintaining their axial concentricity, means for rotating the scroll plate to advance the jaws inwards towards one another, and means for applying to the scroll plate in an advanced position of the jaws a tensioning force to urge the jaws apart, the jaws being adapted to permit securing thereto of peripheral portions of the foil portion to be extended.

Throughout the present Specification including the Claims, the term "scroll plate" is used to indicate the function which the plate with the groove portions performs in the said chuck. The term is not to be understood as necessarily requiring a spiral arrangement of the said groove portions on the one major surface of the plate.

The said jaws may have an upstanding peg outside the main body of the casing for securing the foil by positioning of the peg in a corresponding aperture at peripheral portions of the foil.

The said jaws may have within the casing a ball bearing which co-operates with the groove portions of the scroll plate, and the scroll plate may have regularly distributed ball bearings in recesses in the opposite major surface of the scroll plate to obtain the bearing of the rotatable scroll plate in the casing.

The means for rotating the scroll plate may comprise a trigger which is rigidly secured to the scroll plate, and the means for applying a tensioning force to the scroll plate may comprise a toggle and spring arrangement which acts on the trigger.

The portion of each jaw which is adapted to hold a peripheral portion of the foil and which is situated outside the main body of the casing may lie above and adjacent a flange portion of the casing, which flange portion projects from the body of the casing towards the axis of rotation and is adapted to act as a reflective guard to protect the jaws and peripheral foil portions against thermal irradiation during an irradiation process in the extension of the foil.

Eight symmetrically arranged jaws may be present, and the annular scroll plate may have eight grooves which are symmetrically spaced around the one major surface of the scroll plate and inclined at an angle of approximately 60° to radial directions of the scroll plate.

Embodiments of the first and second aspects of the invention will now be described, by way of example, with reference to the accompanying diagrammatic drawings, in which:—

Figure 1 is a plan view of a semiconductor wafer attached to a foil and suitable for separating into wafer parts by a method in accordance with the first aspect of the invention;

Figure 2 is a plan view of a chuck in accordance with the second aspect of the invention, the wafer and foil of Figure 1 being positioned on the chuck, and

Figure 3 is a cross-sectional view of the chuck of Figure 2 along the line III—III of Figure 2 during heating of the foil.

Figure 1 shows a semiconductor wafer 1 of 38 mm. diameter having on one major surface two perpendicular sets of diamond-scribed score lines 2 and 3 defining lines of separation between a plurality of wafer parts 4. The majority of the wafer parts 4 each

comprise a semiconductor circuit element such as a transistor or integrated circuit. The other major surface of the water 1 is held by electrostatic attraction on the one major surface of non-pre-stretched foil 5 of material available commercially under the Trade Mark "Genotherm 100". Such a material is an electrically insulating synthetic resin. The foil 5 is substantially disc-shaped and has a maximum diameter of 103 mm. and a thickness of less than 0.12 mm. The wafer 1 is secured on the foil 5 prior to forming the sets of score lines 2 and 3.

The wafer 1 is divided into the wafer parts 4 by a bending moment roller method. The one major surface of the wafer 1 is disposed on a resilient support. With the wafer 1 so supported, a roller is moved in relative motion with the wafer 1 under pressure over the opposite major surface of the wafer 1 and in contact with the opposite major surface of the foil 5. The motion of the roller is substantially perpendicular to one set of score lines 2. The roller exerts on the wafer 1 a bending moment which moves progressively along the wafer 1. Fracturing across the thickness of the wafer 1 is effected by said bending moment along each of the score lines 2 in turn. The wafer 1 is then re-orientated through 90° and in a similar way fracturing is effected along each score line 3 in turn. In this manner the wafer 1 is divided into a plurality of separate, but unspaced, wafer parts 4.

The wafer parts 4 held on the major surface of the foil 5 are spaced apart from one another by extending the foil 5 omnidirectionally in a substantially flat plane using the chuck shown in Figures 2 and 3.

The substantially disc-shaped foil 5 has eight toothed portions 6 symmetrically spaced around its circumference. Each toothed portion 6 contains an aperture 7 suitable for securing the foil to eight jaws 8 of the chuck. In Figure 2 and Figure 3 the foil 5 with the wafer parts 4 held thereon is shown mounted on the chuck. Each jaw 8 of the chuck is secured to a peripheral toothed portion 6 of the foil by the positioning of a peg portion 9 of the jaw in the aperture 7 of the toothed portion 6 of the foil 5.

In the plan view of Figure 2 part of an upper portion of the casing 13 of the chuck is shown removed in order to show the interior of the chuck.

The chuck comprises a scroll plate 11 which is of an annular configuration and has eight grooved portions 12 symmetrically spaced on one major plane surface thereof. The grooved portions 12 are inclined at an angle of approximately 60° to radial directions of the scroll plate 11 and extended outwardly in a clockwise direction. Each jaw 8 has a portion with a ball bearing 10 on the underside thereof which engages with one of the grooved portions 12 of the scroll plate 11. The scroll plate 11 is rotatable in a casing 13 about its annular axis on four ball-bearings 14 symmetrically spaced in recesses on the opposite plane surface of the scroll plate 11. The ball-bearings 10 of the jaws 8 are so arranged with respect to the grooved portions 12 of the scroll plate 11 that, when the scroll plate 11 is axially rotated, the jaws 8 are advanced and withdrawn along radial directions of the annular scroll plate 11, substantially maintaining their axial concentricity.

The chuck is carried and held by means of handles 15 and 16 situated at opposite sides along a diameter of the chuck. A trigger 20 is situated adjacent the handle 15 and passes through a recess 21 in the outer circumference of the casing 13. The recess 21 extends a distance along the outer circumference of the casing 13 so that the trigger 20 is capable of rotational movement through a small angle. Interior of the casing 13, the trigger 20 is attached rigidly to the scroll plate 11, so that by rotating the trigger 20 an operator holding the chuck can rotate the scroll plate 11 and hence advance or withdraw the jaws 8.

Between the handle 15 and the trigger 20 is a toggle and spring arrangement 17, 18 and 19. The spring 19 is connected between the knee of the toggles 17 and 18 and the outer circumference of the casing 13 so as to apply a substantially uniform tensioning force to the trigger 20. The ball-bearings 10 of the jaws 8, the grooved portions 12 of the scroll plate 11, the triger 20 attached to the scroll plate 11, and the toggle and spring arrangement 17, 18 and 19 are such that, when by rotation of the scroll plate 11 the jaws 8 are advanced beyond a certain distance along radial directions, a tensioning force is applied to the scroll plate 11 and transmitted to the jaws 8.

The scroll plate 11 can be rotated so that the eight jaws 8 are fully advanced together forming a closed annular ring and touching an inner circular rim 24 of the casing 13. In this position, the jaws 8 have been advanced beyond this certain distance and the scroll plate 11 is tensioned by the spring and toggle arrangement 17, 18 and 19. The mutual spacing of the peg portions 9 of the jaws 8 now corresponds to the mutual spacing of the apertures 7 of the foil 5. Consequently it is with the jaws 8 in this position that the foil 5 with the wafer parts 4 held thereon is mounted on the chuck as shown in Figures 2 and 3, and held in a substantially flat plane. In this way, with the scroll plate 11 pre-tensioned, a tensioning force in said plane is applied to peripheral portions of the foil 5. It is this tensioning force that is subsequently used to extend the foil 5 substantially linearly in a substantially flat plane.

The approximate major dimensions of the chuck are as follows: The exterior diameter

of the casing is 200 mm., and the diameter of the inner circular rim 24 of the casing 13 is 77.5 mm. The outer and the inner diameters of the annular scroll plate 11 are 190 mm. and 133 mm. respectively. The length of the jaws 8 is 60 mm., the bearings 10 being situated 34 mm. from the inner edge of the jaws 8.

The chuck having mounted thereon the unextended tensioned foil 5 with the wafer parts 4 held on the one major surface thereof is transferred to a heating apparatus (not shown). The opposite major surface of the foil 5 rests on the outer rim of a hollow base member.

The tensioned foil 5 is irradiated by switching on a heating lamp situated in the hollow base member. In this way, the major surface of the foil 5 opposite that on which are held the wafer parts 4 is directly heated by thermal radiation 25. The under portion of the casing 13 adjacent the inner rim 24 acts as a reflective guard so protecting the jaws 8.

The heating is continued for several seconds until the temperature of the foil 5 of "Genotherm 100" is such that it becomes extensionable. The scroll plate 11 of the chuck is pretensioned and was formerly maintained in such a tensioned state by the rigidity of the foil 5 held in the jaws 8 engaging with the scroll plate 11. When the foil becomes extensionable, the scroll plate 11 is free to rotate so that the chuck is triggered.

The trigger 20 moves away from the handle 15 in the direction shown in Figure 2 by the arrow 22, the scroll plate 11 to which the trigger 20 is attached rotates about its annular axis in an anti-clockwise direction 22. Since the jaws 8 are constrained to move in radial directions, the bearings 10, attached to the jaws 8 and engaging with the channel portions 12 of the scroll plate 11, slide along the channel portions 12 when the scroll plate 11 is rotated. As a result, the jaws 8 are withdrawn along radial directions 23, and the foil 5 is consequently extended radially in a substantially flate plane. The spring 19 also pre-tensions the foil 5 via the scroll plate 11 and the jaws 8, and this reduces to a minimum any slack or sagging in the foil 5 during extension.

Each jaw 8 of the chuck moves a distance of approximately 15 mm., so that the diameter of the foil 5 is increased during this extension from approximately 103 mm. to approximately 133 mm. The diameter of the portion of the one major surface of the 5 on which the wafer parts 4 are held increases from approximately 38 mm. to approximately 50 mm., so spacing apart the wafer parts 4, for instance by a distance of approximately 200 microns.

The extended foil 5 still mounted on the chuck is transferred from the heating apparatus to a trimmer. When the foil 5 is cool, its extension is maintained so that the wafer parts 4 are permanently spaced apart. Using the trimmer a central circular portion of the extended foil 5 of approximately 76 mm. diameter and having thereon the spaced wafer parts 4 is severed from the remainder of the extended foil 5. This circular foil portion is attached to a rigid carrier disc, and the wafer parts 4 are visually checked. Those wafer parts with damage or irregularities are externally marked by a suitable colouring agent. The approved semiconductor wafer parts are then removed from the foil portion by means of a pick-up head or a hollow needle having a sub-atmospheric connection, and are further processed at an area remote from the foil. Since the wafer parts 4 are spaced apart by a distance, for instance, of 200 microns, an approved wafer part can be detached from the foil without disturbing adjacent wafer parts.

The position and orientation of individual wafer parts 4 with respect to each other on the extended foil 5 is substantially the same as in the original semiconductor wafer 1. Consequently the approved wafer parts can be removed with a known orientation. In addition, since there is no curvature in a row of spaced wafer parts 4 on the extended foil 5, it is possible to process at high speed the foil 5 with wafer parts 4. The angular positions of only a few wafer parts on the extended foil 5 need be orientated with respect to the pick-up head. It is then possible, after such orientation, to move the foil portion in two orthogonal directions with respect to the pick-up head in order to remove the approved wafer parts.

WHAT WE CLAIM IS:—

1. A method of separating into pieces a plate of material, in which the plate is held on a central portion of one major surface of a foil of synthetic resin and divided into pieces, the foil is mounted on a chuck with peripheral portions of the foil secured to self-centring, symmetrically arranged jaws of the chuck and with the portion of the foil on which the said pieces are held lying in a substantially flat plane, and the jaws of the chuck are urged apart and move radially outward to extend omnidirectionally in said substantially flat plane the portion of the foil on which the said pieces are held so that the said pieces are spaced apart.

2. A method as claimed in Claim 1, wherein the plate is a semiconductor wafer and the said pieces are semiconductor wafer parts of a semiconductor device.

3. A method as claimed in Claim 2, wherein the thickness of the foil is less than that of the semiconductor wafer.

4. A method as claimed in Claim 2 or Claim 3, wherein the foil is of electrically insulating material, the wafer parts being held thereon by electrostatic attraction.

of the casing is 200 mm., and the diameter of the inner circular rim 24 of the casing 13 is 77.5 mm. The outer and the inner diameters of the annular scroll plate 11 are 190 mm. and 133 mm. respectively. The length of the jaws 8 is 60 mm., the bearings 10 being situated 34 mm. from the inner edge of the jaws 8.

The chuck having mounted thereon the unextended tensioned foil 5 with the wafer parts 4 held on the one major surface thereof is transferred to a heating apparatus (not shown). The opposite major surface of the foil 5 rests on the outer rim of a hollow base member.

The tensioned foil 5 is irradiated by switching on a heating lamp situated in the hollow base member. In this way, the major surface of the foil 5 opposite that on which are held the wafer parts 4 is directly heated by thermal radiation 25. The under portion of the casing 13 adjacent the inner rim 24 acts as a reflective guard so protecting the jaws 8.

The heating is continued for several seconds until the temperature of the foil 5 of "Genotherm 100" is such that it becomes extensionable. The scroll plate 11 of the chuck is pretensioned and was formerly maintained in such a tensioned state by the rigidity of the foil 5 held in the jaws 8 engaging with the scroll plate 11. When the foil becomes extensionable, the scroll plate 11 is free to rotate so that the chuck is triggered.

The trigger 20 moves away from the handle 15 in the direction shown in Figure 2 by the arrow 22, the scroll plate 11 to which the trigger 20 is attached rotates about its annular axis in an anti-clockwise direction 22. Since the jaws 8 are constrained to move in radial directions, the bearings 10, attached to the jaws 8 and engaging with the channel portions 12 of the scroll plate 11, slide along the channel portions 12 when the scroll plate 11 is rotated. As a result, the jaws 8 are withdrawn along radial directions 23, and the foil 5 is consequently extended radially in a substantially flate plane. The spring 19 also pre-tensions the foil 5 via the scroll plate 11 and the jaws 8, and this reduces to a minimum any slack or sagging in the foil 5 during extension.

Each jaw 8 of the chuck moves a distance of approximately 15 mm., so that the diameter of the foil 5 is increased during this extension from approximately 103 mm. to approximately 133 mm. The diameter of the portion of the one major surface of the 5 on which the wafer parts 4 are held increases from approximately 38 mm. to approximately 50 mm., so spacing apart the wafer parts 4, for instance by a distance of approximately 200 microns.

The extended foil 5 still mounted on the chuck is transferred from the heating apparatus to a trimmer. When the foil 5 is cool, its extension is maintained so that the wafer parts 4 are permanently spaced apart. Using the trimmer a central circular portion of the extended foil 5 of approximately 76 mm. diameter and having thereon the spaced wafer parts 4 is severed from the remainder of the extended foil 5. This circular foil portion is attached to a rigid carrier disc, and the wafer parts 4 are visually checked. Those wafer parts with damage or irregularities are externally marked by a suitable colouring agent. The approved semiconductor wafer parts are then removed from the foil portion by means of a pick-up head or a hollow needle having a sub-atmospheric connection, and are further processed at an area remote from the foil. Since the wafer parts 4 are spaced apart by a distance, for instance, of 200 microns, an approved wafer part can be detached from the foil without disturbing adjacent wafer parts.

The position and orientation of individual wafer parts 4 with respect to each other on the extended foil 5 is substantially the same as in the original semiconductor wafer 1. Consequently the approved wafer parts can be removed with a known orientation. In addition, since there is no curvature in a row of spaced wafer parts 4 on the extended foil 5, it is possible to process at high speed the foil 5 with wafer parts 4. The angular positions of only a few wafer parts on the extended foil 5 need be orientated with respect to the pick-up head. It is then possible, after such orientation, to move the foil portion in two orthogonal directions with respect to the pick-up head in order to remove the approved wafer parts.

WHAT WE CLAIM IS:—

1. A method of separating into pieces a plate of material, in which the plate is held on a central portion of one major surface of a foil of synthetic resin and divided into pieces, the foil is mounted on a chuck with peripheral portions of the foil secured to self-centring, symmetrically arranged jaws of the chuck and with the portion of the foil on which the said pieces are held lying in a substantially flat plane, and the jaws of the chuck are urged apart and move radially outward to extend omnidirectionally in said substantially flat plane the portion of the foil on which the said pieces are held so that the said pieces are spaced apart.

2. A method as claimed in Claim 1, wherein the plate is a semiconductor wafer and the said pieces are semiconductor wafer parts of a semiconductor device.

3. A method as claimed in Claim 2, wherein the thickness of the foil is less than that of the semiconductor wafer.

4. A method as claimed in Claim 2 or Claim 3, wherein the foil is of electrically insulating material, the wafer parts being held thereon by electrostatic attraction.

5. A method as claimed in any of the preceding Claims, in which the foil is of thermoplastic material and is extended by a tensioning force applied to the peripheral portions of the foil via the said jaws and by a simultaneous heating of the portion of the foil on which the said pieces are held, the application of the tensioning force commencing prior to the application of heat.

6. A method as claimed in Claim 5, wherein the heating is effected by thermal irradiation of the opposite major surface of the foil.

7. A method as claimed in Claim 5 or Claim 6, wherein after extension by applying said tensioning force and heating, the foil is cooled and substantially retains its extended form, and at least the portion of the extended foil having the spaced pieces held thereon is severed from the remainder of said foil.

8. A method as claimed in any of the preceding Claims, wherein after extension of the foil the said pieces are visually checked for damage or irregularities, the approved pieces then being removed from the foil and further processed.

9. A method as claimed in any of the preceding Claims, wherein the plate is divided along two orthogonal sets of planes substantially perpendicular to the one major surface of the foil.

10. A method of separating into pieces a plate of material, substantially as herein described with reference to Figures 1 to 3 of the accompanying drawings.

11. A piece of a plate of material when separated by a method claimed in any of Claims 1 to 10.

12. A chuck suitable for use in a method claimed in any of Claims 1 to 10 to extend a foil portion on which pieces are held so that the said pieces are spaced apart, comprising a substantially annular scroll plate which is rotatable in a casing about an axis and has groove portions on one major surface of the scroll plate at right angles to the axis of rotation, which groove portions are inclined with respect to radial directions of the scroll plate, a plurality of symmetrically arranged jaws which co-operate with the groove portions of the scroll plate and are guided in the radial direction, the scroll plate and jaw arrangement being such that on rotation of the scroll plate the jaws are constrained to move radially in a substantially flat plane while maintaining their axial concentricity, means for rotating the scroll plate to advance the jaws inwards towards one another, and means for applying to the scroll plate in an advanced position of the jaws as a tensioning force to urge the jaws apart, the jaws being adapted to permit securing thereto of peripheral portions of the foil portion to be extended.

13. A chuck as claimed in Claim 12, wherein the said jaws have an upstanding peg outside the main body of the casing for securing the foil by positioning of the peg in a corresponding aperture at peripheral portions of the foil.

14. A chuck as claimed in Claim 12 or Claim 13, wherein the said jaws have within the casing a ball bearing which co-operates with the groove portions of the scroll plate, and the scroll plate has regularly distributed ball bearings in recesses in the opposite major surface of the scroll plate to obtain the bearing of the rotatable scroll plate in the casing.

15. A chuck as claimed in any of Claims 12 to 14, wherein the means for rotating the scroll plate comprises a trigger which is rigidly secured to the scroll plate, and the means for applying a tensioning force to the scroll plate comprises a toggle and spring arrangement which acts on the trigger.

16. A chuck as claimed in any of Claims 12 to 15, wherein the portion of each jaw which is adapted to hold a peripheral portion of the foil and which is situated outside the main body of the casing lies above and adjacent a flange portion of the casing, which flange portion projects from the body of the casing towards the axis of rotation and is adapted to act as a reflective guard to protect the jaws and peripheral foil portions against thermal irradiation during an irradiation process in the extension of the foil.

17. A chuck as claimed in any of Claims 12 to 16, wherein eight symmetrically arranged jaws are present, and the annular scroll plate has eight grooves which are symmetrically spaced around the one major surface of the scroll plate and inclined at an angle of approximately 60° to radial directions of the scroll plate.

18. A chuck substantially as herein described with reference to Figures 2 and 3 of the accompanying drawings.

G. V. CARCASSON,
Chartered Patent Agent,
Mullard House,
Torrington Place,
London, W.C.1.
Agent for the Applicants.

Printed for Her Majesty's Stationery Office, by the Courier Press, Leamington Spa, 1971.
Published by The Patent Office, 25 Southampton Buildings, London, WC2A 1AY, from which copies may be obtained.

