

DESCRIPTION
CUTTING APPARATUS AND METHOD FOR MANUFACTURING CUT
PRODUCTS

5 Technical Field

[0001] The present invention relates to a cutting apparatus and a method for manufacturing cut products.

Background Art

10 [0002] JP 2008-112961A (Patent Literature 1) discloses a method for manufacturing semiconductor devices. In this manufacturing method, grooves are formed in a lead frame as a result of a half-cut being applied using a dicing saw. Subsequently, a plating layer is formed over the grooves, and the lead frame is cut along the grooves using a narrow dicing saw. Diced semiconductor devices are thus obtained (see Patent Literature
15 1).

Citation List

Patent Literature

[0003] Patent Literature 1: JP 2008-112961A

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Summary of Invention

Technical Problem

[0004] There are cases in which an object to be cut, such as a lead frame, is warped. If a half-cut is applied to an object to be cut in a warped state, a groove formed in the object
25 would have non-uniform depth. Patent Literature 1 does not disclose a means for solving such a problem.

[0005] The present invention has been made in order to solve such a problem, and an

object thereof is to provide a cutting apparatus and a method for manufacturing cut products with which a non-uniformity in the depth of a groove formed in an object to be cut as a result of a half-cut can be reduced.

5 Solution to Problem

[0006] A cutting apparatus according to an aspect of the present invention is configured to apply a half-cut to a resin-molded object to be cut in the thickness direction of the object to be cut. This cutting apparatus includes a cutting mechanism. The cutting mechanism includes a blade for cutting the object to be cut. The blade includes a first
10 side surface and a second side surface. The cutting apparatus further includes first and second pressing mechanisms. The first pressing mechanism is provided at a position facing the first side surface. The second pressing mechanism is provided at a position facing the second side surface. The first and second pressing mechanisms are each configured to press the object to be cut downward from above. When the half-cut is
15 applied, the relative positional relationship between each of the first and second pressing mechanisms and the object to be cut changes in a similar manner to the relative positional relationship between the cutting mechanism and the object to be cut.

[0007] A method for manufacturing cut products according to another aspect of the present invention is a method for manufacturing cut products using the above-described
20 cutting apparatus. This method for manufacturing cut products includes: preparing the cutting apparatus, to which the blade having a first thickness is attached; applying a half-cut to the object to be cut; replacing the blade with a blade having a second thickness that is thinner than the first thickness; and cutting the object to be cut along the half-cut position.

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Advantageous Effects of Invention

[0008] The present invention can provide a cutting apparatus and a method for

manufacturing cut products with which a non-uniformity in the depth of a groove formed in an object to be cut as a result of a half-cut can be reduced.

Brief Description of Drawings

5 [0009] FIG. 1 is a diagram schematically illustrating a part of a plane of a cutting apparatus according to embodiment 1.

FIG. 2 is a perspective view schematically illustrating a semiconductor package.

FIG. 3 is a diagram for explaining a method for forming a step portion.

10 FIG. 4 is a schematic diagram illustrating a part of the cutting apparatus from sideways.

FIG. 5 is a schematic diagram illustrating the relationship between a pressing mechanism and a blade from sideways.

FIG. 6 is a plan view schematically illustrating the pressing mechanism.

15 FIG. 7 is a schematic diagram illustrating the relationship between the pressing mechanism and the blade from the front.

FIG. 8 is a schematic diagram for explaining the positional relationship between the blade and a roller when a half-cut is applied to a package substrate.

FIG. 9 is a schematic diagram illustrating a part of a comparative cutting apparatus from sideways.

20 FIG. 10 is a diagram for explaining the effectiveness of the pressing mechanism 60 in the cutting apparatus.

FIG. 11 is a schematic diagram illustrating, from sideways, the relationship between the pressing mechanism and the blade in a state in which the diameter of the blade has decreased.

25 FIG. 12 is a schematic diagram for explaining a movement of the pressing mechanism.

FIG. 13 is a schematic diagram illustrating a part of a cutting apparatus according

to embodiment 2 from sideways.

FIG. 14 is a schematic diagram illustrating, from sideways, the relationship between a pressing mechanism and a blade in embodiment 2.

FIG. 15 is a plan view schematically illustrating the pressing mechanism in
5 embodiment 2.

FIG. 16 is a schematic diagram illustrating, from the front, the relationship between the pressing mechanism and the blade in embodiment 2.

FIG. 17 is a diagram that schematically illustrates, from sideways, the relationship between the pressing mechanism and the blade in a state in which the
10 diameter of the blade has decreased in embodiment 2.

Description of Embodiments

[0010] In the following, embodiments (each of which is also referred to as “present embodiment” in the following) pertaining to one aspect of the present invention will be
15 described in detail with reference to the drawings. Note that the same reference symbols are provided to the same or equivalent portions in the drawings, and description thereof will not be repeated. Furthermore, for the ease of understanding, the drawings are schematic drawings in which objects are simplified or exaggerated, as appropriate. Furthermore, the directions indicated by the arrows in the drawings are the same between
20 drawings.

[1. Embodiment 1]

<1-1. Overview>

[0011] FIG. 1 is a diagram schematically illustrating a part of a plane of a cutting
25 apparatus 10 according to present embodiment 1. As illustrated in FIG. 1, the cutting apparatus 10 includes a cutting table 30 and a cutting mechanism 40.

[0012] The cutting table 30 holds a package substrate 20 to be cut. The cutting table 30

includes a holding member 31, a rotating mechanism 32, and a moving mechanism 33. The holding member 31 holds the package substrate 20 by sucking the package substrate 20 from below. The rotating mechanism 32 can rotate the holding member 31 in the θ direction in the drawing. The moving mechanism 33 can move the holding member 31
5 along the Y axis in the drawing. Note that, in the package substrate 20, lead frames or substrates on which semiconductor chips are mounted are encapsulated in a resin. Note that the package substrate 20 used to manufacture the later-described semiconductor package 50, which is described with reference to FIG. 2, is that in which lead frames described as one example are used.

10 [0013] The cutting mechanism 40 includes a blade 41. The cutting mechanism 40 dices the package substrate 20 into a plurality of semiconductor packages by cutting the package substrate 20 using the blade 41. The cutting mechanism 40 can move along the X and Y axes in the drawing. Note that the cutting apparatus 10 may have a twin-spindle configuration including two cutting mechanism 40 or a single-spindle configuration
15 including one cutting mechanism 40.

[0014] Furthermore, the cutting mechanism 40 is configured to form grooves in the package substrate 20 by removing parts of the package substrate 20 using the blade 41. That is, the cutting mechanism 40 can apply a half-cut to the package substrate 20 in the thickness direction of the package substrate 20. The term “cut” included in the name
20 (cutting apparatus) of the cutting apparatus 10 encompasses the concept of separating an object being cut into a plurality of parts and the concept of removing parts of an object being cut.

[0015] The cutting apparatus 10 has the function of applying a half-cut to the package substrate 20 so that a wettable Quad Flat No-leaded (QFN) package such as the
25 semiconductor package 50, which is one example of a cut product, can be manufactured, for example. The semiconductor package 50 and a method for manufacturing the semiconductor package 50 will be described next.

[0016] FIG. 2 is a perspective view schematically illustrating the semiconductor package 50. As illustrated in FIG. 2, in the semiconductor package 50, a step portion 51 is formed at a boundary portion between the top surface (surface on which terminals 52 are formed) and the side surfaces in the drawing. When the semiconductor package 50 is surface-mounted, solder fills the step portion 51. Thus, a three-dimensional solder connection structure can be realized in regard to the semiconductor package 50. Furthermore, because the solder fills the step portion 51, solder fillets can be easily observed from the side surfaces of the semiconductor package 50 in an appearance inspection performed after mounting.

[0017] FIG. 3 is a diagram for explaining a method for forming the step portion 51. With reference to FIG. 3, in order to form the step portion 51, first, a groove G1 is formed on the package substrate 20 using a blade 41 having a first thickness. Then, the package substrate 20 is diced by cutting the package substrate 20 at a position P1 using a blade 41 having a second thickness (thinner than the first thickness). Thus, a plurality of semiconductor packages 50 in which the step portion 51 is formed are manufactured.

[0018] As described above, the semiconductor package 50 has various advantages. The step portion 51 formed in the semiconductor package 50 can be realized by applying a half-cut. The cutting apparatus 10 has the function of applying a half-cut to the package substrate 20 in order to manufacture the semiconductor package 50, for example.

[0019] When a half-cut is applied to the package substrate 20, it is important that a groove with a depth as uniform as possible be formed on the package substrate 20. In the cutting apparatus 10, measures are taken to suppress a non-uniformity in the depth of a groove formed by a half-cut. In the following, the configuration, etc., of the cutting apparatus 10 will be described in detail.

<1-2. Configuration of Cutting Apparatus>

[0020] FIG. 4 is a schematic diagram illustrating a part of the cutting apparatus 10 from

sideways. As illustrated in FIG. 4, the cutting apparatus 10 includes the cutting table 30, the cutting mechanism 40, a pressing mechanism 60, and a discharging mechanism 70.

[0021] The pressing mechanism 60 and the discharging mechanism 70 are each attached to the cutting mechanism 40. The pressing mechanism 60 is attached to the rear of the cutting mechanism 40, and the discharging mechanism 70 is attached to the front of the cutting mechanism 40. Note that the “front” of the cutting mechanism 40 is the direction from which the cutting table 30 enters upon moving to a position below the blade 41. The blade 41 is sandwiched by the pressing mechanism 60 and the discharging mechanism 70 in the Y axis direction. The pressing mechanism 60 is provided on the opposite side of the blade 41 from the discharging mechanism 70. Thus, both the pressing mechanism 60 and the discharging mechanism 70 can be attached to the cutting mechanism 40.

[0022] The pressing mechanism 60 is configured to press the package substrate 20, which is placed on the cutting table 30, downward from above. The configuration of the pressing mechanism 60 and the reason why the pressing mechanism 60 is provided will be described in detail later.

[0023] The discharging mechanism 70 includes three nozzles (for example, first, second, and third nozzles) that are each configured to discharge a machining fluid. The first nozzle discharges the machining fluid toward the blade 41. The second nozzle discharges the machining fluid toward the point of contact (cutting portion) between the blade 41 and the package substrate 20. The third nozzle discharges the machining fluid toward unnecessary chip portions that are formed while the package substrate 20 is cut. Note that the discharging mechanism 70 does not necessarily have to include three nozzles. For example, the discharging mechanism 70 may be formed from one or two nozzles, or may be formed from four or more nozzles. For example, the discharging mechanism 70 discharges a machining fluid that is supplied from a water storage tank or a water supply system. When the machining fluid is sprayed onto the rotating blade 41

by the discharging mechanism 70, a large amount of the machining fluid comes into contact with the blade 41, and the blade 41 is cooled more effectively. Furthermore, when the machining fluid is sprayed onto the cutting portion, a large amount of the machining fluid is supplied to the machining point, and heat generated during cutting can be suppressed and the package substrate 20 can be appropriately cut. In addition, as a result of the machining fluid being sprayed onto the chip portions, chip portions remaining on the cutting table 30 can be removed.

[0024] FIG. 5 is a schematic diagram illustrating the relationship between the pressing mechanism 60 and the blade 41 from sideways. FIG. 6 is a plan view schematically illustrating the pressing mechanism 60. FIG. 7 is a schematic diagram illustrating the relationship between the pressing mechanism 60 and the blade 41 from the front.

[0025] With reference to FIGS. 5, 6, and 7, the pressing mechanism 60 includes a first pressing mechanism 61 and a second pressing mechanism 62. The first pressing mechanism 61 is provided at a position close to one side surface of the blade 41, and the second pressing mechanism 62 is provided at a position close to the other side surface of the blade 41. While the package substrate 20 is being cut using the blade 41, the blade 41 is positioned in a region between the first pressing mechanism 61 and the second pressing mechanism 62. In other words, while the package substrate 20 is being cut using the blade 41, a part of the first pressing mechanism 61 faces one side surface of the blade 41, and a part of the second pressing mechanism 62 faces the other side surface of the blade 41 in a side view.

[0026] The first pressing mechanism 61 and the second pressing mechanism 62 are each configured to press the package substrate 20 (FIG. 1) downward from above. The first pressing mechanism 61 and the second pressing mechanism 62 each include a plate spring 610, a pressing unit 620, base members 630 and 640, and screws 624, 625, 631, 633, and 634.

[0027] For example, base members 630, 640, and 650 are each made from a metal. The

base member 650 is a plate-shaped member that extends in the height direction, and is attached to the rear end portion of the cutting mechanism 40. Holes H1 and H2 are formed in each of the two side surfaces of the base member 650. Each of the holes H1 and H2 is a vertically long hole. The base member 650 is fixed to the cutting mechanism 40 by screws being passed through the holes H1 and H2. The height-direction position of the pressing mechanism 60 can be changed by changing the height-direction positions in the holes H1 and H2 where screwing is performed.

[0028] The base member 640 is a member extending toward the front from the lower end portion of the base member 650, and is attached to the base member 650. The base member 630 is a bar-shaped member that is attached to the upper surface of the base member 640, and extends toward the front from the base member 640. A screw hole is formed in each of the base members 630 and 640, and the base members 630 and 640 are screwed to each other using the screws 633 and 634. The hole H3 formed in each of the base members 630 and 640 has a shape that is long in the front-rear direction, and the front-rear-direction positions of rollers 622 can be adjusted by adjusting the positions in the hole H3 where screwing is performed.

[0029] The plate spring 610 extending obliquely downward is attached to the lower surface of the base member 630. For example, the plate spring 610 is made from a metal. A screw hole is formed in the plate spring 610, and the base member 630 and the plate spring 610 are screwed to each other using a screw 632. The screw 631 passes through a screw hole in the base member 630, and presses the plate spring 610 from above. The position of the plate spring 610 that is pressed by the screw 631 is located further toward the front than the position of the plate spring 610 that is screwed to the base member 630 using the screw 632 is. The bending of the plate spring 610 is adjusted by adjusting the height-direction position of the screw 631. Thus, the elastic force of the plate spring 610 is adjusted.

[0030] The pressing unit 620 is attached to the tip portion of the plate spring 610. The

pressing unit 620 includes a base member 621, a roller 622, a rotating shaft 623, and the screws 624 and 625. For example, the base member 621 is made from a metal or a resin. Screw holes are formed in the base member 621, and the base member 621 and the plate spring 610 are screwed to each other using the screws 624 and 625. In a plan view, a recess is formed in the tip portion of the base member 621, and the roller 622 is located in the recess. The roller 622 is attached to the base member 621 via the rotating shaft 623, and is rotatable relative to the base member 621. The rotating shaft 623 extends in the X-axis direction (the thickness direction of the blade 41). For example, the roller 622 is made from rubber or a resin. The roller 622 is one example of the “pressing member” according to the present invention. By using an elastic roller 622 made from a material such as rubber or a resin, the formation of pressing marks on the package substrate 20 by the roller 622 can be suppressed. Furthermore, the crushing of burrs produced during a half-cut can be suppressed.

[0031] In a state in which the package substrate 20 is not present below the roller 622, the lower end of the roller 622 is located below a virtual plane Z1 indicating the lower-end position of the blade 41. Thus, because the lower end of the roller 622 moves to a position higher than the lower end of the blade 41 while the package substrate 20 is being cut, the roller 622 presses down the package substrate 20 due to the elastic force of the plate spring 610.

[0032] FIG. 8 is a schematic diagram for explaining the positional relationship between the blade 41 and the roller 622 when a half-cut is applied to the package substrate 20. As illustrated in FIG. 8, when a half-cut is applied to the package substrate 20, the blade 41 scrapes off a part of the package substrate 20. Thus, in the height direction, the blade 41 advances to below the upper surface of the package substrate 20. On the other hand, when a half-cut is formed, the roller 622 presses down the upper surface of the package substrate 20. Thus, the lower end of the roller 622 moves to a position that is higher than the lower end of the blade 41.

[0033] Furthermore, the position (position P6) of the rotation center of the roller 622 in the Y-axis direction is located further toward the front than the position (position P5) of the rotation center of the blade 41 in the Y-axis direction is. This is because the position (position P7) where the blade 41 starts to cut into the package substrate 20 is positioned further toward the front than the position (position P5) of the rotation center of the blade 41 in the Y-axis direction is. According to the cutting apparatus 10, because the position of the rotation center of the roller 622 is located further toward the front than the position of the rotation center of the blade 41 is, the package substrate 20 can be pressed using the roller 622 at a position that is closer to the position where cutting is started. Next, the reason why the pressing mechanism 60 is provided in the cutting apparatus 10 will be described.

<1-3. Reason Why Pressing Mechanism Is Provided>

[0034] FIG. 9 is a schematic diagram illustrating a part of a comparative cutting apparatus 10X from sideways. As illustrated in FIG. 9, the cutting apparatus 10X does not include a pressing mechanism. For example, there are cases in which the package substrate 20 is warped. If a half-cut is applied to the package substrate 20 in a warped state, a problem occurs in which a groove has different depth depending on position. For example, a situation occurs in which the groove depth formed at position P3 is deeper than the groove depth formed at position P2, and the groove depth formed at position P4 is deeper than the groove depth formed at position P3. In the cutting apparatus 10 according to present embodiment 1, the pressing mechanism 60 is provided in order to overcome such a problem.

[0035] FIG. 10 is a diagram for explaining the effectiveness of the pressing mechanism 60 in the cutting apparatus 10 according to present embodiment 1. As illustrated in FIG. 10, in the cutting apparatus 10, a position of the package substrate 20 that is adjacent to the cutting start portion is pressed down by the rollers 622 when a half-cut is applied to

the package substrate 20. A half-cut is applied to the package substrate 20 in a state in which the warpage of the package substrate 20 is suppressed as a result of the package substrate 20 being pressed down by the rollers 622. Thus, according to the cutting apparatus 10, a non-uniformity in the depth of a groove formed by a half-cut can be suppressed because the package substrate 20 is half-cut in a state in which the warpage of the package substrate 20 is suppressed.

[0036] FIG. 11 is a schematic diagram illustrating, from sideways, the relationship between the pressing mechanism 60 and the blade 41 in a state in which the diameter of the blade 41 has decreased. As illustrated in FIG. 11, even if the diameter of the blade 41 decreases, an object to be cut can be pressed downward from above because the rollers 622 are biased downward by the elastic force of the plate spring 610.

[0037] FIG. 12 is a schematic diagram for explaining a movement of the pressing mechanism 60. As illustrated in FIG. 12, a rotating shaft J1 is provided in the part of the cutting mechanism 40 to which the pressing mechanism 60 is attached, and the part of the cutting mechanism 40 is configured to rotate. Specifically, as a result of the part of the cutting mechanism 40 rotating, the pressing mechanism 60 is retracted from a position that overlaps with the blade 41 in a side view. Consequently, the blade 41 can be replaced easily. Thus, it can be said that the cutting apparatus 10 according to present embodiment 1 includes a retracting mechanism that includes the rotating shaft J1 and that is configured to retract the pressing mechanism 60 to a position that does not overlap with the blade 41 in a side view.

<1-4. Operation of Cutting Apparatus>

[0038] For example, the semiconductor package 50 (FIG. 2) is manufactured according to the following method. In the cutting apparatus 10, a blade 41 having a first thickness is attached.

[0039] Subsequently, in the cutting apparatus 10, the cutting table 30 advances to below

the blade 41 from the front of the cutting mechanism 40. As the cutting table 30 advances, the pressing mechanism 60 presses the package substrate 20 on the cutting table 30 downward from above, and the blade 41 starts to half-cut the package substrate 20. When a half-cut is applied, the relative positional relationship between the pressing mechanism 60 and the package substrate 20 changes in a similar manner to the relative positional relationship between the cutting mechanism 40 and the package substrate 20 because the pressing mechanism 60 is attached to the cutting mechanism 40.

[0040] When half-cutting of the package substrate 20 is complete, the blade 41 is replaced in the cutting apparatus 10. The blade 41 after replacement has a second thickness (thinner than the first thickness).

[0041] Subsequently, in the cutting apparatus 10, the cutting table 30 advances to below the blade 41 from the front of the cutting mechanism 40. As the cutting table 30 advances, the pressing mechanism 60 presses the package substrate 20 on the cutting table 30 downward from above, and the blade 41 starts to cut the package substrate 20. As a result of the package substrate 20 being cut along grooves formed by a half-cut, the manufacturing of a plurality of semiconductor packages 50 is completed.

<1-5. Features>

[0042] As described above, the cutting apparatus 10 according to present embodiment 1 includes the pressing mechanism 60, and, when a half-cut is applied to the package substrate 20, the relative positional relationship between each of the first pressing mechanism 61 and the second pressing mechanism 62 and the package substrate 20 changes in a similar manner to the relative positional relationship between the cutting mechanism 40 and the package substrate 20. In the cutting apparatus 10, the package substrate 20 is pressed down by the rollers 622 when a half-cut is applied to the package substrate 20. A half-cut is applied to the package substrate 20 in a state in which the warpage of the package substrate 20 is suppressed as a result of the package substrate 20

being pressed down by the rollers 622. Thus, according to the cutting apparatus 10, a non-uniformity in the depth of a groove formed by a half-cut can be suppressed because the package substrate 20 is half-cut in a state in which the warpage of the package substrate 20 is suppressed.

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[2. Embodiment 2]

[0043] The cutting apparatus 10 according to above-described embodiment 1 includes the pressing mechanism 60. A cutting apparatus 80 according to present embodiment 2 and the cutting apparatus 10 according to above-described embodiment 1 mainly differ in terms of the structure of the pressing mechanism. In the following, description will be provided focusing on portions that are different from above-described embodiment 1.

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<2-1. Configuration of Cutting Apparatus>

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[0044] FIG. 13 is a schematic diagram illustrating a part of the cutting apparatus 80 according to present embodiment 2 from sideways. As illustrated in FIG. 13, the cutting apparatus 80 includes the cutting table 30, the cutting mechanism 40, a pressing mechanism 90, and the discharging mechanism 70.

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[0045] The pressing mechanism 90 and the discharging mechanism 70 are each attached to the cutting mechanism 40. The pressing mechanism 90 is attached to the rear of the cutting mechanism 40, and the discharging mechanism 70 is attached to the front of the cutting mechanism 40. The blade 41 is sandwiched by the pressing mechanism 90 and the discharging mechanism 70 in the Y axis direction. The pressing mechanism 90 is provided on the opposite side of the blade 41 from the discharging mechanism 70. Thus, both the pressing mechanism 90 and the discharging mechanism 70 are attachable to the cutting mechanism 40. The pressing mechanism 90 is configured to press the package substrate 20, which is placed on the cutting table 30, downward from above.

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[0046] FIG. 14 is a schematic diagram illustrating the relationship between the pressing

mechanism 90 and the blade 41 from sideways. FIG. 15 is a plan view schematically illustrating the pressing mechanism 90. FIG. 16 is a schematic diagram illustrating the relationship between the pressing mechanism 90 and the blade 41 from the front.

[0047] With reference to FIGS. 14, 15, and 16, the pressing mechanism 90 includes a first pressing mechanism 91 and a second pressing mechanism 92. The first pressing mechanism 91 is provided at a position close to one side surface of the blade 41, and the second pressing mechanism 92 is provided at a position close to the other side surface of the blade 41. While the package substrate 20 is being cut using the blade 41, the blade 41 is positioned in a region between the first pressing mechanism 91 and the second pressing mechanism 92. In other words, while the package substrate 20 is being cut using the blade 41, a part of the first pressing mechanism 91 faces one side surface of the blade 41, and a part of the second pressing mechanism 92 faces the other side surface of the blade 41 in a side view.

[0048] The first pressing mechanism 91 and the second pressing mechanism 92 are each configured to press the package substrate 20 downward from above. The first pressing mechanism 91 includes a base member 940, and pressing units 950 and 960. The second pressing mechanism 92 includes a base member 910, and pressing units 920 and 930.

[0049] For example, base members 910, 940, and 970 are each made from a metal. The member formed by the base members 910, 940, and 970 is a substantially L-shaped member, and is attached to the rear end portion of the cutting mechanism 40. Holes H4 and H5 are formed in each of the two side surfaces of the member. Each of the holes H4 and H5 is a vertically long hole. The member is fixed to the cutting mechanism 40 by screws being passed through the holes H4 and H5. The height-direction position of the pressing mechanism 90 can be changed by changing the height-direction positions in the holes H4 and H5 where screwing is performed. Furthermore, on each of the base members 910 and 940, support shafts 926 extending in the X-axis direction (the thickness direction of the blade 41) are formed.

[0050] The pressing units 920, 930, 950, and 960 each include a rotating member 921, a roller 922, rotating shafts 923 and 925, and a torsion spring 924. The rotating shafts 923 and 925 each extend in the X-axis direction. The rotating member 921 is a plate-shaped member made from a metal, for example, and is rotatably attached to the base member 910 or 940. The base member 910 or 940 and the rotating member 921 are attached to one another via the rotating shaft 925. The torsion spring 924 is attached around the rotating shaft 925.

[0051] The roller 922 is rotatably attached to the tip portion of the rotating member 921. For example, the roller 922 is made from rubber or a resin. The rotating member 921 and the roller 922 are connected to one another via the rotating shaft 923. One end of the torsion spring 924 presses the rotating shaft 923 downward, and the other end of the torsion spring 924 presses the support shaft 926 downward. Thus, the roller 922 is biased in a rotating direction. Note that, in the thickness direction of the blade 41, the roller 922 is attached to the inner side of the rotating member 921. In other words, the distance between the roller 922 and the blade 41 is shorter than the distance between the rotating member 921 and the blade 41. Thus, when a half-cut is applied to the package substrate 20, a position that is closer to the half-cut position can be pressed using the roller 922. The rotating member 921 included in each of the pressing units 930 and 960 is one example of the “first rotating member” according to the present invention, and the roller 922 attached to the rotating member 921 is one example of the “first pressing member” according to the present invention. Furthermore, the rotating member 921 included in each of the pressing units 920 and 950 is one example of the “second rotating member” according to the present invention, and the roller 922 attached to the rotating member 921 is one example of the “second pressing member” according to the present invention.

[0052] In a state in which the package substrate 20 is not present below the roller 922, the lower end of the roller 922 is located below a virtual plane Z2 indicating the lower-end position of the blade 41. Thus, because the lower end of the roller 922 moves to a

position higher than the lower end of the blade 41 while the package substrate 20 is being cut, the roller 922 presses down the package substrate 20 due to the elastic force of the torsion spring 924.

[0053] FIG. 17 is a diagram that schematically illustrates, from sideways, the relationship between the pressing mechanism 90 and the blade 41 in a state in which the diameter of the blade 41 has decreased. As illustrated in FIG. 17, even if the diameter of the blade 41 decreases, an object to be cut can be pressed downward from above because the rollers 922 are biased downward by the elastic force of the torsion spring 924.

[0054] Note that a retracting mechanism as illustrated in FIG. 12 is also provided in the cutting apparatus 80 according to present embodiment 2.

<2-2. Features>

[0055] As described above, the cutting apparatus 80 according to present embodiment 2 includes the pressing mechanism 90, and, when a half-cut is applied to the package substrate 20, the relative positional relationship between each of the first pressing mechanism 91 and the second pressing mechanism 92 and the package substrate 20 changes in a similar manner to the relative positional relationship between the cutting mechanism 40 and the package substrate 20. In the cutting apparatus 80, the package substrate 20 is pressed down by the rollers 922 when a half-cut is applied to the package substrate 20. A half-cut is applied to the package substrate 20 in a state in which the warpage of the package substrate 20 is suppressed as a result of the package substrate 20 being pressed down by the rollers 922. Thus, according to the cutting apparatus 80, a non-uniformity in the depth of a groove formed by a half-cut can be reduced because the package substrate 20 is half-cut in a state in which the warpage of the package substrate 20 is suppressed.

[3. Other Embodiments]

[0056] The concepts of above-described embodiments 1 and 2 are not limited to embodiments 1 and 2 described above. In the following, examples of other embodiments to which the concepts of above-described embodiments 1 and 2 can be applied will be described.

5 [0057] In above-described embodiments 1 and 2, the upper surface of the holding member 31 is flat. However, the upper surface of the holding member 31 does not necessarily have to be completely flat. For example, the upper surface of the holding member 31 may be warped in accordance with the warpage of the package substrate 20. In this case, a half-cut is applied to the package substrate 20 while adjusting the height of the blade
10 41. Even in this case, the pressing mechanism effectively functions if the package substrate 20 is warped more than the upper surface of the holding member 31.

[0058] Furthermore, in above-described embodiments 1 and 2, the package substrate 20 is cut as a result of the cutting table 30 moving in the Y-axis direction. However, the cutting method is not limited to this. A configuration may be adopted such that the
15 cutting table 30 can only move in a rotational movement, and the package substrate 20 may be cut as a result of the cutting mechanism 40 being moved in the Y-axis direction. That is, it suffices that the package substrate 20 is cut by the cutting table 30 and the cutting mechanism 40 being moved relative to one another.

[0059] Also, in above-described embodiment 1, the base members 630, 640, and 650 may
20 be formed integrally, for example.

[0060] Furthermore, in above-described embodiment 2, the base members 910, 940, and 970 may be formed integrally, for example.

[0061] Embodiments of the present invention have been described as examples above. In other words, the detail description and the attached drawings have been disclosed to
25 provide description by way of example. Accordingly, the constituent elements described in the detailed description and the attached drawings may include those that are not essential to solve the problem. Thus, such inessential constituent elements shall not be

immediately construed as being essential just because they are described in the detailed description and the attached drawings.

[0062] Furthermore, the above-described embodiments are mere examples of the present invention in all respects. Various improvements and modifications can be applied to the
5 above-described embodiments within the scope of the present invention. That is, upon implementing the present invention, specific configurations can be adopted, as appropriate, in accordance with the embodiments to be made.

List of Reference Numerals

10	[0063] 10, 10X, 80	Cutting apparatus
	20	Package substrate
	30	Cutting table
	31	Holding member
	32	Rotating mechanism
15	33	Moving mechanism
	40	Cutting mechanism
	41	Blade
	50	Semiconductor package
	51	Step portion
20	52	Terminal
	60, 90	Pressing mechanism
	61, 91	First pressing mechanism
	62, 92	Second pressing mechanism
	70	Discharging mechanism
25	610	Plate spring
	620, 920, 930, 950, 960	Pressing unit
	621, 630, 640, 650, 910, 940, 970	Base member

	622, 922	Roller	
	623, 923, 925, J1	Rotating shaft	
	624, 625, 631, 632, 633, 634	Screw	
	921	Rotating member	
5	924	Torsion spring	
	926	Support shaft	
	G1	Groove	
	H1, H2, H3, H4, H5	Hole	
	P1, P2, P3, P4, P5, P6, P7	Position	
10	Z1, Z2	Virtual plane	

CLAIMS

1. A cutting apparatus configured to apply a half-cut to a resin-molded object to be cut in the thickness direction of the object to be cut, comprising

5 a cutting mechanism including a blade for cutting the object to be cut,
wherein the blade includes a first side surface and a second side surface,
the cutting apparatus further comprises:

a first pressing mechanism provided at a position facing the first side surface; and

10 a second pressing mechanism provided at a position facing the second side surface,

the first and second pressing mechanisms are each configured to press the object to be cut downward from above, and

15 when the half-cut is applied, the relative positional relationship between each of the first and second pressing mechanisms and the object to be cut changes in a similar manner to the relative positional relationship between the cutting mechanism and the object to be cut.

2. The cutting apparatus according to claim 1,

20 wherein the first and second pressing mechanisms each comprise:

a first pressing member provided at a position that is closer to the front of the blade than to the rear of the blade; and

a second pressing member provided at a position that is closer to the rear of the blade than to the front of the blade, and

25 the first and second pressing members are each configured to press the object to be cut downward from above.

3. The cutting apparatus according to claim 2,

wherein the first and second pressing mechanisms each further comprise:

a first rotating member which is configured so that a force acts thereon in a rotation direction, and to which the first pressing member is attached; and

5 a second rotating member which is configured so that a force acts thereon in a rotation direction, and to which the second pressing member is attached, and

the distance between the first pressing member and the blade is shorter than the distance between the first rotating member and the blade, and

the distance between the second pressing member and the blade is shorter than
10 the distance between the second rotating member and the blade.

4. The cutting apparatus according to claim 1,

wherein the first and second pressing mechanisms each comprise a pressing member, and

15 the pressing member is configured to press the object to be cut downward from above at a position that is further toward the front than a rotation center of the blade.

5. The cutting apparatus according to any one of claims 1 to 4 further comprising

a retracting mechanism configured to retract each of the first and second pressing
20 mechanisms to a position that does not overlap with the blade in a side view.

6. The cutting apparatus according to claim 5 further comprising

a discharging mechanism that discharges a machining fluid from the front of the blade,

25 wherein the retracting mechanism is provided at a position that is on the opposite side of the blade from the discharging mechanism.

7. The cutting apparatus according to claim 2 or 3,
wherein the first and second pressing members are each formed from a roller.

8. The cutting apparatus according to claim 4,
5 wherein the pressing member is formed from a roller.

9. A method for manufacturing cut products using the cutting apparatus according
to any one of claims 1 to 8, comprising:

10 preparing the cutting apparatus, to which the blade having a first thickness is
attached;

applying a half-cut to the object to be cut;

replacing the blade with a blade having a second thickness that is thinner than
the first thickness; and

cutting the object to be cut along the half-cut position.

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