

DESCRIPTION

TITLE OF INVENTION: SUCTION PLATE, CUTTING DEVICE, AND METHOD FOR MANUFACTURING ELECTRONIC COMPONENT

5 Technical Field

[0001] The present invention relates to technology for a suction plate, a cutting device, and a method for manufacturing an electronic component.

Related Art

[0002] Patent Document 1 discloses a cutting device capable of performing half cut and full cut on an object to be cut disposed on a table using a blade. The cutting device described in Patent Document 1 can correct the position of the blade in the height direction based on the wear amount of the blade. By correcting the position of the blade in the height direction in this manner, variation in the depth of half-cut grooves formed in the object to be cut can be suppressed.

Citation List

15 Patent Documents

[0003] Patent Document 1: Japanese Patent Application Laid-Open (JP-A) No. 2022-151243.

SUMMARY OF INVENTION

Technical Problem

20 **[0004]** Here, since high dimensional accuracy is generally required for half-cut grooves, technology capable of forming half-cut grooves with higher accuracy is required.

[0005] The present invention has been made in view of the above circumstances, and a problem to be solved is to provide a suction plate, a cutting device, and a method for manufacturing an electronic component capable of forming half-cut grooves with high accuracy.

25 Solution to Problem

[0006] The problem to be solved by the present invention is as described above, and in order to solve this problem, a suction plate according to the present invention is a suction plate for holding an object to be cut having a substrate and a resin layer, the suction plate includes: a base member comprising a base part disposed on a base provided with a suction mechanism and a projection part formed to project upward from the base part and formed with a suction surface capable of sucking the resin layer; and a frame-like member disposed so as to surround a periphery of the projection part and including a mounting surface capable of mounting the substrate formed so as to be positioned above the suction surface. At least one of the base member and the frame-like member is formed with a discharge passage capable of discharging a foreign substance in a specified space defined by the projection part and the frame-like member to outside the specified space.

[0007] Further, the cutting device according to the present invention includes the suction plate and the base provided with the suction mechanism.

[0008] Further, the method for manufacturing an electronic component according to the present invention includes: a half cut process in which a half cut is performed on the object to be cut using the cutting device described above; and a full cut process in which a full cut is performed on the object to be cut that has been subjected to half cut in the half cut process, using the cutting device.

Effects of Invention

[0009] According to the present invention, a half-cut groove may be formed with high accuracy.

BRIEF DESCRIPTION OF THE DRAWINGS

[0010]

[FIG. 1] (a) is a bottom view showing a package substrate. (b) is a side view showing the package substrate.

[FIG. 2] is a perspective view showing a semiconductor package in which a step part is

formed.

[FIG. 3] is a plan view schematically showing a configuration of the cutting device.

[FIG. 4] is a side view schematically showing a configuration of the cutting device.

[FIG. 5] is a block diagram showing an electrical connection relationship of the cutting device.

5 [FIG. 6] is a side cross-sectional view showing a configuration of the table.

[FIG. 7] (a) is a plan view schematically showing a half-cut groove formed in the package substrate. (b) is a side view schematically showing the half-cut groove formed in the package substrate.

[FIG. 8] is a flowchart showing a procedure of the half cut.

10 [FIG. 9] is an exploded perspective view showing the suction plate.

[FIG. 10] is a plan view showing the suction plate.

[FIG. 11] is a plan view showing the base part.

[FIG. 12] (a) is a diagram schematically showing a cross-section taken along line X1-X1 in FIG. 10. (b) is a diagram schematically showing a cross-section taken along line X2-X2 in FIG.

15 10.

[FIG. 13] is a perspective view showing a path through which foreign substances are discharged in the suction plate.

[FIG. 14] is a bottom view showing the base part.

[FIG. 15] (a) is a plan view showing the suction plate in which a chamfer part is formed. (b)

20 is a plan view showing the suction plate according to a first modification example.

[FIG. 16] is a plan view showing the suction plate according to a second modification example.

DESCRIPTION OF EMBODIMENTS

[0011] In the following description, description is provided according to directions indicated by arrows in the drawings. Further, the drawings used in the following description schematically depict shapes, numbers, and the like, with appropriate omissions or exaggerations for convenience.

5 **[0012]** <Configuration of Package Substrate 70>

In the following, first, the package substrate 70 is described as an example of an object to be cut that is a target of cutting by the cutting device 1.

[0013] The package substrate 70 shown in FIG. 1 is, for example, a wettable flank QFN (Quad Flat Non-leaded) package substrate. The package substrate 70 includes a substrate 71 formed of
10 metal such as a copper plate, and a rectangular resin layer 72 that seals one surface of the substrate 71 with resin. As the substrate 71, a lead frame, a printed wiring board, or the like may be used. In this embodiment, as an example, a lead frame is used as the substrate 71. In the following, among two surfaces of the substrate 71, the surface on which the resin layer 72 is formed is referred to as a first surface, and the surface opposite to the first surface is referred to as a second surface.

[0014] On the first surface of the substrate 71, semiconductor chip mounting parts (die pads)
15 (not shown) are arranged in a matrix. Electronic elements 73 such as semiconductor chips, resistor elements, and capacitor elements are fixed to the die pads. The substrate 71 is formed of metal such as copper (Cu) or 42 alloy (Fe-Ni) and has conductivity. A lead-free metal plating layer or a lead-free solder plating layer (not shown) may be formed in advance on the surface of
20 the substrate 71. At the periphery of each die pad, a plurality of leads that are terminals for connection to the outside are arranged. These plurality of leads are respectively connected to tie bars, which are metal frames arranged in a lattice pattern on the substrate 71. A plurality of electrodes (not shown) provided on each electronic element 73 are electrically connected to respective leads arranged at the periphery of the die pad via bonding wires made of gold wire or
25 copper wire.

[0015] The substrate 71 of this embodiment includes a rectangular application field 71a and a non-application field 71b surrounding the periphery of the application field 71a. The non-application field 71b is a region including the outer edge of the substrate 71, is not used as a product, and is removed later. On the other hand, the application field 71a is a region used as a product and is a region including the die pads, leads, and tie bars of the lead frame described above. The resin layer 72 is formed in a rectangular shape so as to cover the application field 71a of the substrate 71 and a part of the non-application field 71b outside the application field 71a. That is, the electronic elements 73 and bonding wires arranged in the application field 71a are sealed by the resin layer 72. By forming the resin layer 72, a step corresponding to the thickness of the resin layer 72 is formed between the first surface of the substrate 71 and the end surface of the resin layer 72 (the lower surface in FIG. 1(b)).

[0016] It is noted that as the substrate 71 constituting the package substrate 70, in addition to the examples described above, a semiconductor substrate, a metal substrate, a ceramic substrate, a glass substrate, a resin substrate, or the like may be used. In the case where the substrate is not made of metal and does not have conductivity, a portion of the substrate that contacts the frame-like member 150 of the suction plate 100 described later (an outer peripheral part described later) may be configured to have conductivity. Further, wiring may or may not be applied to the substrate 71 constituting the package substrate 70.

[0017] By applying half cut and full cut to the package substrate 70 shown in FIG. 1, a semiconductor package (electronic component) 80 as shown in FIG. 2 is manufactured. It is noted that specific method for applying half cut and full cut to the package substrate 70 will be described later.

[0018] In the semiconductor package 80 shown in FIG. 2, a step part 81 is formed at a boundary portion between the upper surface (the surface on which the terminals 82 are formed) and the side surface. In the case where the semiconductor package 80 is surface-mounted, solder enters the

step part 81. Thereby, regarding the semiconductor package 80, a fillet-shaped solder connection structure may be realized, and the connection may be ensured. Further, since the solder enters the step part 81 and forms a fillet shape, in an appearance inspection after mounting, the connection state of the solder may be easily observed from the side surface of the semiconductor package 80.

5 Thus, various advantages exist in the semiconductor package 80. A method for forming the step part 81 will be described later.

[0019] <Configuration of Cutting Device>

Next, the configuration of the cutting device 1 will be described using FIG. 3 to FIG. 5.

[0020] The cutting device 1 manufactures a plurality of semiconductor packages 80, which
10 are cut products, by cutting the package substrate 70. It is noted that in this embodiment, "cutting" includes separating an object to be cut into a plurality of individualized cut products and removing a part of the object to be cut. Hereinafter, cutting that separates the object to be cut into a plurality of individualized cut products is referred to as full cut, and cutting that removes a part of the object to be cut in a thickness direction without separating the object to be cut is referred
15 to as half cut. The cutting device 1 mainly includes a cutting unit 10, a holding unit 20, a detection unit 30, a control unit 40, and the like.

[0021] <Configuration of Cutting Unit 10>

The cutting unit 10 shown in FIG. 3 and FIG. 4 is for cutting the package substrate 70. The cutting unit 10 mainly includes a blade 11, a spindle part 12, and the like. It is noted that the
20 cutting device 1 may have a twin spindle configuration including a pair of spindle parts 12, or may have a single spindle configuration including only one spindle part 12.

[0022] The blade 11 is an annular blade. The blade 11 is detachably attached to a tip end part of the spindle part 12. The blade 11 may rotate around the X-axis.

[0023] The spindle part 12 supports the blade 11 and rotates the blade 11. The spindle part 12
25 is arranged to extend in the X-axis direction. The spindle part 12 may move along the X-axis

and the Z-axis in FIG. 3 and FIG. 4 by a moving mechanism (not shown). The movement of the spindle part 12 (operation of the moving mechanism) is controlled by a control unit 40 described later. Hereinafter, the Z-axis direction in FIG. 3 and FIG. 4 may also be referred to as a height direction of the spindle part 12 and the blade 11.

5 **[0024]** The blade 11 attached to the spindle part 12 may perform half cut and full cut on the package substrate 70 by receiving rotation from the spindle part 12 and rotating at high speed. Hereinafter, a blade for half cut is referred to as a first blade 11A, a blade for full cut is referred to as a second blade 11B, and the first blade 11A and the second blade 11B are collectively referred to as the blade 11. The first blade 11A has a first thickness, and the second blade 11B has a
10 second thickness smaller than the first thickness. In other words, the thickness of the second blade 11B is thinner than the thickness of the first blade 11A. In this embodiment, either the first blade 11A or the second blade 11B is attached to the spindle part 12, and cutting is performed.

[0025] The first blade 11A is formed of a material having electrical conductivity. The first blade 11A is electrically connected to the spindle part 12 in a state of being attached to the spindle
15 part 12. The spindle part 12 is electrically connected to a detection circuit 32 described later.

[0026] In the case of performing half cut on the package substrate 70, the package substrate 70 is cut by the first blade 11A moving relative to a table 50 described later. Specifically, the package substrate 70 is partially removed in a thickness direction. By performing half cut along a longitudinal direction and a lateral direction on the package substrate 70, a half-cut groove G1
20 extending in the longitudinal direction of the package substrate 70 and a half-cut groove G2 extending in the lateral direction of the package substrate 70 are formed (see FIG. 7(a)). On the other hand, in the case of performing full cut on the package substrate 70, the package substrate 70 is cut along a groove pattern by the second blade 11B moving relative to the table 50. As a result, portions of the half-cut grooves G1 and G2 are separated, and the package substrate 70 is
25 singulated into a plurality of separated semiconductor packages 80 (see FIG. 2).

[0027] <Configuration of Holding Unit 20>

The holding unit 20 shown in FIG. 3 and FIG. 4 holds the package substrate 70. The holding unit 20 mainly includes a table 50, a moving mechanism 60, and the like. It is noted that the cutting device 1 may have a twin cut table configuration including two holding units 20, may include one holding unit 20, or may include three or more holding units 20.

[0028] The table 50 shown in FIG. 6 mainly includes a base 51, a suction plate 100, a suction mechanism 52, and the like.

[0029] The base 51 is a component to which the suction plate 100 is fixed. The base 51 includes a first portion 51a that contacts a lower surface of the suction plate 100, and a second portion 51c that is fixed to a lower surface of the first portion 51a via an insulation layer 51b. The first portion 51a and the second portion 51c are formed of a material having electrical conductivity, such as stainless steel.

[0030] The first portion 51a is formed with an air passage 51d that is connected to a recessed part 161 of the suction plate 100 described later. The air passage 51d is formed to penetrate from an upper surface to a lower surface of the first portion 51a. The second portion 51c is formed with a through hole 51e so as to be connected to the air passage 51d of the first portion 51a. A pipe 52a of a suction mechanism 52 described later is disposed in the through hole 51e.

[0031] The suction plate 100 mainly includes a base member 110, a frame-like member 150, and the like.

[0032] The base member 110 includes a plate-shaped part 111 formed in a rectangular plate shape, a projection part 112 projecting upward from the plate-shaped part 111, and the like. It is noted that the plate-shaped part 111 is one embodiment of the base part according to the present invention. A thickness of the plate-shaped part 111 in the up-down direction is formed thicker than a thickness of the projection part 112 in the up-down direction. An upper surface of the projection part 112 constitutes a suction surface 112a capable of sucking the resin layer 72 of the

package substrate 70. As shown in an enlarged view of FIG. 6, a thin film-like resin film 113 is provided on the suction surface 112a. For convenience of description, illustration of the resin film 113 is omitted in other drawings. Further, the resin film 113 does not necessarily need to be provided, and may be omitted or replaced with another member (e.g., a flexible plate-like member or the like).

[0033] A recessed part 114 is formed on a bottom surface of the base member 110. The recessed part 114 is formed in substantially the same shape as the suction surface 112a in a bottom view. Further, a plurality of suction holes 115 are formed in the base member 110. The suction holes 115 are formed to penetrate the base member 110 in the up-down direction. More specifically, upper ends of the suction holes 115 are opened at the suction surface 112a, and lower ends of the suction holes 115 are opened at the recessed part 114. It is noted that the resin film 113 is formed with through holes (not shown) at positions corresponding to the suction holes 115.

[0034] By forming the recessed part 114, an entire length of the suction holes 115 may be shortened. This enables improvement of suction force via the suction holes 115. A plurality of columnar parts 116 extending in the up-down direction are formed in the recessed part 114. It is noted that the configuration of the columnar parts 116 will be described later.

[0035] The frame-like member 150 is formed to surround the periphery of the projection part 112 from a lateral side. Specifically, the frame-like member 150 is formed with an opening part 151 corresponding to the projection part 112. The frame-like member 150 is mounted on the base member 110 in a state where the projection part 112 is inserted inside the opening part 151 of the frame-like member 150. In this state, an upper surface of the frame-like member 150 is positioned above the suction surface 112a of the projection part 112. The upper surface of the frame-like member 150 constitutes a mounting surface 152 on which the substrate 71 of the package substrate 70 may be mounted.

[0036] In this way, by arranging the frame-like member 150 to surround the periphery of the projection part 112, a recessed part 161 is formed by the projection part 112 and the frame-like member 150. Further, the recessed part 161 defines an arrangement space 162 in which the resin layer 72 of the package substrate 70 is arranged. It is noted that the arrangement space 162 is one embodiment of the specified space according to the present invention.

[0037] The shape of the recessed part 161 in plan view is formed in substantially the same shape as, or slightly larger than, the shape (rectangular shape) of the resin layer 72 of the package substrate 70. Further, a depth of the recessed part 161 (arrangement space 162) is formed to be substantially the same as, or slightly larger than, a thickness of the resin layer 72. It is noted that the depth of the recessed part 161 means a depth from the mounting surface 152 of the frame-like member 150 to the suction surface 112a (more specifically, an upper surface of the resin film 113 provided on the suction surface 112a). By configuring the recessed part 161 in this way, the resin layer 72 may be accommodated in the recessed part 161 in the case of mounting the package substrate 70 on the frame-like member 150.

[0038] In the case of the resin layer 72 being accommodated in the recessed part 161, the non-application field 71b (hereinafter also referred to as "outer peripheral part") (see FIG. 1) of the substrate 71 contacts an upper surface of the mounting surface 152 of the frame-like member 150 located outside the recessed part 161. Since the frame-like member 150 and the base member 110 are formed of a conductive material such as stainless steel, in the case of the outer peripheral part of the package substrate 70 being arranged on the frame-like member 150, the frame-like member 150 and the base member 110 become electrically connected to the package substrate 70.

[0039] It is noted that the suction plate 100 is formed with a discharge passage for discharging foreign substances from the recessed part 161 (arrangement space 162). A specific configuration related to the discharge passage will be described later.

[0040] The suction mechanism 52 sucks the package substrate 70 onto the table 50 by performing suction through the suction holes 115. The suction mechanism 52 mainly includes a pipe 52a, a pump 52b, and the like.

[0041] The pipe 52a is at least partially arranged in the through hole 51e of the second portion 51c and is connected to a lower end of the air passage 51d. The pump 52b is connected to the pipe 52a. By driving the pump 52b, air is sucked from the plurality of suction holes 115 through the through hole 51e and the recessed part 114. As a result, the resin layer 72 is sucked to the suction surface 112a, and the package substrate 70 is held by the suction plate 100. Even in the case of the thickness of the resin layer 72 being thinner than expected and the resin layer 72 not contacting the upper surface of the suction surface 112a in the case of arranging the package substrate 70 on the suction plate 100, by sucking the air in the recessed part 161 closed by the package substrate 70, the inside of the recessed part 161 becomes negative pressure, the substrate 71 is sucked downward, and the resin layer 72 contacts and is held by the suction surface 112a.

[0042] The moving mechanism 60 shown in FIG. 3 and FIG. 4 is for moving the table 50. The moving mechanism 60 supports the table 50 from below. The moving mechanism 60 may rotate the table 50 in the θ direction in FIG. 3 (i.e., on a horizontal plane). Further, the moving mechanism 60 may move along the Y-axis in FIG. 3. The operation of the holding unit 20 is controlled by the control unit 40 described later.

[0043] <Configuration of Detection Unit 30>

The detection unit 30 shown in FIG. 3 and FIG. 4 is for detecting positions of the spindle part 12 and the first blade 11A in a height direction (Z-axis direction). The detection unit 30 mainly includes a CCS (Contact Cutter Setup) block 31, a detection circuit 32, a detection device 33, and the like.

[0044] The CCS block 31 is attached to a side of the table 50 and may move together with the table 50. The CCS block 31 has conductivity and is electrically connected to the suction plate

100. Thus, in the case of the package substrate 70 being arranged on the suction plate 100, the package substrate 70 and the CCS block 31 are electrically connected.

[0045] The detection circuit 32 is a circuit configured to conduct electricity through the first blade 11A and the CCS block 31 in response to the first blade 11A contacting an upper surface of the CCS block 31. The detection circuit 32 is electrically connected to the CCS block 31 and the spindle part 12. The detection device 33 is incorporated in the detection circuit 32. Further, since the suction plate 100 has conductivity and is in contact with the CCS block 31 (see FIG. 6), the detection circuit 32 also conducts electricity in the case of the first blade 11A contacting a conductive portion of the package substrate 70.

[0046] The detection circuit 32 is configured to apply a constant voltage between the CCS block 31 and the spindle part 12 by a power source not shown. The detection device 33 detects a change in presence or absence of energization in the detection circuit 32. More specifically, the detection device 33 detects contact between the first blade 11A (more precisely, an outer edge of the first blade 11A) and the CCS block 31, and contact between the first blade 11A and the package substrate 70, and notifies the control unit 40 described later.

[0047] <Configuration of Control Unit 40>

The control unit 40 shown in FIG. 3 to FIG. 5 is electrically connected to the cutting unit 10, the holding unit 20, and the detection unit 30, and controls operations of the units 10 to 30. The control unit 40 may be configured integrally with the units 10 to 30, or may be configured separately from the units 10 to 30. As shown in FIG. 5, the control unit 40 mainly includes a control part 41, a display part 42, an input part 43, a memory part 44, and the like.

[0048] The control part 41 includes a CPU, a RAM, a ROM, and the like. The ROM stores an operation program 41a for controlling operations of the units 10 to 30. The CPU reads out and executes the operation program 41a from the ROM. The RAM is appropriately used for

arithmetic processing of the CPU. It is noted that the operation program 41a may be stored in the memory part 44 instead of the ROM.

[0049] The display part 42 is configured to, for example, display various types of information to a user, and is configured to display a user interface screen for receiving input of cutting parameters and detection parameters described later from the user. The display part 42 may be realized in any form such as a liquid crystal display element, a liquid crystal display, an organic EL display, a touch panel display, and the like.

[0050] The input part 43 is configured to, for example, input various fixed values and input various parameters for cutting. The input part 43 may be realized in any form such as a keyboard, push-type buttons, a touch panel display, and the like. In the case of the input part 43 being realized by a touch panel display, the input part 43 may also serve as the display part 42.

[0051] The parameters for cutting are not particularly limited, but include, for example, cutting parameters that specify positions at which the package substrate 70 is to be cut. Since the package substrate 70 is normally cut according to a grid-like cutting pattern, cutting lines in vertical and horizontal directions are determined by determining the cutting parameters.

[0052] <Calculation of half-cut height>

Next, calculation of the half-cut height by the control part 41 will be described. The half-cut height is a position of a lowermost end of the first blade 11A when performing a half cut on the package substrate 70. The control part 41 controls a position of the spindle part 12 in a height direction and brings the first blade 11A closer toward an upper surface of the CCS block 31. The control part 41 recognizes a coordinate in the height direction of the spindle part 12 as a reference Z coordinate (hereinafter referred to as reference coordinate) when contact between the new first blade 11A without wear and the CCS block 31 is detected. Thereby, a height position of the spindle part 12 and further a height position of the first blade 11A are detected with reference to the upper surface of the CCS block 31. Furthermore, the control part 41 controls the position of

the spindle part 12 in the height direction so as to bring the first blade 11A closer toward the upper surface of the package substrate 70. It is noted that the height position of the spindle part 12 controlled by the control part 41 is specifically, for example, a position of a rotation axis of the spindle part 12 in a Z-axis direction, and the control part 41 may determine the position of the spindle part 12 in the Z-axis direction by converting a rotation direction and a number of rotations of a motor that moves the spindle part 12 along a ball screw into a movement distance of a Z-axis coordinate.

[0053] As an example, the half-cut height may be calculated as follows. First, a distance (fixed value B) from the upper surface of the CCS block 31 to the upper surface of the suction plate 100 and a thickness (fixed value C) of the package substrate 70 are added to the reference coordinate (A), and a cutting depth (fixed value D) of the half cut and a correction amount (measured value E) generated by wear of the first blade 11A at the start of the half cut are subtracted to calculate a coordinate in the height direction ($A+B+C-D-E$). Then, the position of the spindle part 12 in the height direction is controlled so that a lowermost end portion of the first blade 11A is arranged at the calculated coordinate (hereinafter referred to as machining basic coordinate). It is noted that the fixed values are input to and stored in the cutting device 1 in advance. The correction amount (measured value) generated by wear of the first blade 11A at the start of the half cut may be calculated from the coordinate in the height direction when the first blade 11A contacts the CCS block 31 and the above-mentioned reference coordinate (for wear of the first blade 11A and correction of the position of the first blade 11A in the height direction generated by the wear, see Japanese Patent Application Laid-Open Publication No. 2022-151243).

[0054] Furthermore, the position of the spindle part 12 in the height direction is controlled in consideration of the actual thickness of the package substrate 70. Specifically, the control part 41 brings the first blade 11A into contact with the package substrate 70. From the coordinate (F) in the height direction at this time, a difference between the actual thickness of the package

substrate 70 and the thickness (fixed value C) of the package substrate 70 is calculated as an offset amount (A+B+C-F) of the height of the package substrate 70. Then, in consideration of this offset amount, the machining basic coordinate is corrected, and the position of the spindle part 12 in the height direction is controlled so that the lowermost end portion of the first blade 11A is arranged.

[0055] Furthermore, correction for wear of the first blade 11A generated by performing the half cut is performed, for example, at a timing when a half-cut length or a half-cut time exceeds a set value. That is, when the half-cut length or the half-cut time exceeds the set value (the timing may be after completion of the half cut of one cutting line or may be during the half cut), the first blade 11A is brought into contact with the CCS block 31, and a coordinate in the height direction at this time is obtained. Then, from this and the above-mentioned reference coordinate, a correction amount generated by wear of the first blade 11A is calculated (see Japanese Patent Application Laid-Open Publication No. 2022-151243), and the position of the spindle part 12 in the height direction is corrected.

[0056] <Singulation of Package Substrate 70>

Next, a method for cutting the package substrate 70 to form the semiconductor package 80 will be described with reference to FIG. 7. First, the first blade 11A having a first thickness is attached to the spindle part 12. Using this first blade 11A, the package substrate 70 is half-cut along the cutting line to form a groove pattern including a plurality of half-cut grooves G1 and G2 as shown in FIG. 7(a). Each time formation of one half-cut groove G1 or G2 is completed, for example, determination of a cutting distance described later may be performed. It is noted that the outermost portion of the package substrate 70 cut by the first blade 11A is a boundary line (dashed line shown in FIG. 7(a)) between the application field 71a and the non-application field 71b. The non-application field 71b is a region that does not include a semiconductor chip or the like after

full cutting and does not become the semiconductor package 80. This boundary line cut by the first blade 11A is above the resin layer 72 and is within the recessed part 161 in plan view.

[0057] FIG. 7(b) is a schematic side view of the vicinity of the half-cut grooves G1 and G2 of the package substrate 70. After formation of the groove pattern, the second blade 11B having a second thickness smaller than the first thickness is attached to the spindle part 12, and the package substrate 70 is fully cut at position P1 by the second blade 11B to singulate the package substrate 70. The position P1 is preferably at the center of the half-cut grooves G1 and G2. As a result, a plurality of semiconductor packages 80 having the step part 81 as shown in FIG. 2 are manufactured. It is noted that the cross-sectional shape of the half-cut grooves G1 and G2 is not limited to the shape shown in FIG. 7(b).

[0058] When forming a groove pattern on the package substrate 70 by half cutting, it is important that half-cut grooves G1 and G2 having a depth as uniform as possible are formed on the package substrate 70, and high accuracy is required. Thus, in this embodiment, control of the half cut is performed as follows. Hereinafter, a process of performing the half cut of the package substrate 70 (half cut process) will be described with reference to FIG. 6 and the flowchart shown in FIG. 8.

[0059] <Half Cut of Package Substrate 70>

First, the package substrate 70 is positioned and arranged in alignment with the recessed part 161 of the holding unit 20, and air is sucked from the suction holes 115 of the base member 110 to hold the package substrate 70 on the suction plate 100 (step S1). As a result, the non-application field 71b of the substrate 71 of the package substrate 70 contacts the upper surface of the suction plate 100 (the mounting surface 152 of the frame-like member 150), so that the package substrate 70 and the suction plate 100 become electrically conductive.

[0060] Next, the spindle part 12 and the moving mechanism 60 are operated to perform positioning (alignment) between the first blade 11A and the package substrate 70 (step S2).

Subsequently, the spindle part 12 is moved to bring the first blade 11A into contact with the CCS block 31, and the height position of the first blade 11A at this time is stored in the memory part 44. As a result, as described above, the correction amount generated by wear of the first blade 11A is calculated and stored in the memory part 44 (step S3).

5 **[0061]** Subsequently, if the height of the upper surface of the package substrate 70 has not been measured (NO in step S4), the spindle part 12 is moved to bring the first blade 11A into contact with the second surface of the substrate 71 of the package substrate 70. More specifically, the first blade 11A is brought into contact with a portion of the non-application field 71b of the second surface of the substrate 71 of the package substrate 70, where the resin layer 72 is formed on the
10 first surface side below. Since the outer peripheral part of the package substrate 70 is in contact with the suction plate 100, current flows through the first blade 11A and the substrate 71, and energization is detected by the detection device 33. As a result, the height position of the first blade 11A is calculated (step S5) and stored in the memory part 44. Based on this, the above-described offset amount is calculated and stored in the memory part 44. On the other hand, if the
15 height of the upper surface of the package substrate 70 has been measured (YES in step S4), calculation of the half-cut height (step S6) is performed as follows.

[0062] That is, the half-cut height by the first blade 11A is calculated from the correction amount and offset amount calculated as described above and the machining basic coordinate (step S6). Based on this, the height position of the lowermost end portion of the first blade 11A is adjusted
20 to a position lowered by the cutting depth of the half cut from the height position where the first blade 11A contacted the package substrate 70.

[0063] Thereafter, the spindle part 12 is moved to perform a half cut on the package substrate 70 along the above-described cutting line (step S7). At this time, the cutting edge at the lower end of the first blade 11A is held at the above-described half-cut height and the half cut is
25 performed. In this process, when the half cut on one cutting line is completed, if the cutting

distance by the first blade 11A exceeds a set value (YES in step S8), it is determined that wear has occurred in the first blade 11A, and the above-described correction amount is calculated (step S3). On the other hand, if the cutting distance does not exceed the set value (NO in step S8), it is determined whether half cuts have been applied to all cutting lines on the package substrate (step S9). It is noted that in step S8, instead of the cutting distance by the first blade 11A, it may be determined whether the cutting time by the first blade 11A has exceeded a set value.

[0064] In step S9, if half cuts have not been applied to all cutting lines (NO in step S9), a half cut is performed on another cutting line (step S7). If half cuts have been applied to all cutting lines (YES in step S9), the package substrate 70 is cleaned, dried, removed from the suction plate 100, and carried out (step S10). Subsequently, the table 50 is cleaned using cleaning water and dried (step S11). It is noted that when cleaning the table 50, foreign substances (e.g., cutting waste, etc.) in the recessed part 161 of the suction plate 100 are discharged to the outside through a discharge passage described later. This may suppress foreign substances from being caught between the suction surface 112a of the suction plate 100 and the package substrate 70, and enables performing a half cut with high accuracy.

[0065] Thereafter, if the half cuts of all package substrates 70 are completed (YES in step S12), the operation of the cutting device 1 is terminated, and if package substrates 70 to be half-cut remain (NO in step S12), a new package substrate 70 is held on the suction plate 100 (step S1), and the half cut is continued.

[0066] Thereafter, the cutting device 1 may further perform a process of performing a full cut (full cut process). In this case, blade replacement is performed, and the second blade 11B is attached to the spindle part 12 in place of the first blade 11A. Then, a full cut is performed by the second blade 11B after replacement. The second blade 11B cuts and separates the package substrate 70 in the thickness direction according to the formed groove pattern. As a result, semiconductor packages 80, which are a plurality of singulated electronic components, are

obtained. The semiconductor packages 80 after completion of the full cut may be sent to other units included in the cutting device 1.

[0067] It is noted that the cutting device 1 may also be provided with a pressing mechanism for pressing the package substrate 70 to be cut (particularly, half-cut). By pressing the package substrate 70 with the pressing mechanism and performing a half cut in a state where warping or lifting of the package substrate 70 is eliminated, or by bringing the first blade 11A into contact to measure the height of the upper surface of the package substrate 70, a half-cut groove may be formed with higher accuracy. It is noted that as the pressing mechanism, for example, a mechanism described in Japanese Patent Application Laid-Open Publication No. 2022-79910 may be used.

[0068] <Configuration of Suction Plate 100>

The configuration of the suction plate 100 will be described in more detail below.

[0069] In the suction plate 100 shown in FIG. 9 to FIG. 12, a discharge passage is formed for discharging foreign substances (e.g., cutting waste, etc.) in the recessed part 161 (arrangement space 162). Specifically, the discharge passage is mainly configured by the step part 121, the chamfer part 122, the first groove part 123, the second groove part 124, and the like formed in the base member 110.

[0070] The step part 121 is formed along the outer peripheral edge part of the upper end part (suction surface 112a) of the projection part 112. The step part 121 is formed over the entire circumference of the projection part 112. As a result, the step part 121 is formed so as to surround the periphery of the suction surface 112a. The step part 121 is formed so as to be slightly lower than the central portion (suction surface 112a) of the projection part 112. It is noted that the step part 121 is one embodiment of the third passage according to the present invention.

[0071] The chamfer part 122 is formed so as to cut out the four corners of the projection part 112 formed in a rectangular shape in plan view. The chamfer part 122 is formed from the upper

end to the lower end of the projection part 112. By forming the chamfer part 122, a gap extending vertically is formed between the projection part 112 and the inner surface (opening part 151) of the frame-like member 150. The upper end part of the chamfer part 122 is connected to the step part 121. It is noted that the chamfer part 122 is one embodiment of the first passage according to the present invention.

[0072] The first groove part 123 shown in FIG. 9 and FIG. 11 is formed along the short side of the projection part 112 formed in a rectangular shape in plan view. The first groove part 123 is formed by recessing a portion along a pair of short sides of the projection part 112 on the upper surface of the plate-shaped part 111. As a result, the first groove part 123 is formed so as to extend in a direction parallel to the short side of the package substrate 70 held by the suction plate 100.

[0073] The second groove part 124 shown in FIG. 9, FIG. 10, and FIG. 11 is formed along the long side of the projection part 112 formed in a rectangular shape in plan view. The second groove part 124 is formed by recessing a portion along a pair of long sides of the projection part 112 on the upper surface of the plate-shaped part 111. As a result, the second groove part 124 is formed so as to extend in a direction parallel to the long side of the package substrate 70 held by the suction plate 100. Further, two end parts in the longitudinal direction of the second groove part 124 are formed so as to extend to the end part of the plate-shaped part 111. As a result, two end parts of the second groove part 124 are formed so as to open to the side surface of the plate-shaped part 111. It is noted that the second groove part 124 is one embodiment of the second passage according to the present invention.

[0074] The middle part of the second groove part 124 is connected to the first groove part 123 near the corner part of the projection part 112. Further, at this portion, the first groove part 123 and the second groove part 124 are connected to the chamfer part 122. In this manner, the step

part 121, the chamfer part 122, the first groove part 123, and the second groove part 124 are connected to each other.

[0075] In the case where the frame-like member 150 is attached to the base member 110 in which the step part 121 and the like are formed in this manner, the side surface of the projection part 112 and the inner surface (opening part 151) of the frame-like member 150 are fitted to each other, whereby the frame-like member 150 may be positioned relative to the base member 110.

[0076] In a state where the frame-like member 150 is attached to the base member 110, as shown in FIG. 12 and FIG. 13, the recessed part 161 (arrangement space 162) is connected to the outside of the suction plate 100 via the discharge passage (the step part 121, the chamfer part 122, the first groove part 123, and the second groove part 124). Thus, in the case where the table 50 (suction plate 100) is cleaned in step S11 of FIG. 8, foreign substances in the recessed part 161 are discharged to the outside via the discharge passage together with the cleaning water (e.g., discharged along the dotted arrow in FIG. 12(b)). This may suppress foreign substances from being caught between the suction surface 112a of the suction plate 100 and the package substrate 70, and enables performing a half cut with high accuracy.

[0077] Further, as shown in FIG. 12(a) and FIG. 14, a plurality of columnar parts 116 extending in the up-down direction are formed in the recessed part 114. The columnar part 116 is formed, for example, in a prismatic shape. The columnar part 116 is formed so as to extend downward from the upper surface of the recessed part 114. The length of the columnar part 116 in the up-down direction is formed to be substantially the same as the depth of the recessed part 114. The columnar part 116 is formed at a position that does not overlap with the suction hole 115. The lower end of the columnar part 116 contacts the upper surface of the base 51 (see FIG. 6). The base member 110 in which the recessed part 114 is formed may be supported by the columnar part 116. As a result, deformation of the base member 110 may be suppressed in the case where air

is sucked by the suction mechanism 52 and the inside of the recessed part 114 becomes negative pressure.

[0078] It is noted that the shape, number, and the like of the columnar parts 116 are not particularly limited. For example, the columnar part 116 may be formed in a shape other than a prism (such as a cylindrical shape). Further, the arrangement and number of the columnar parts 116 may be arbitrarily changed.

[0079] Further, the discharge passage may be formed to be appropriately inclined so as to promote the discharge of foreign substances via the discharge passage. For example, the second groove part 124 shown in FIG. 11 may be formed so as to descend from the left-right center of the plate-shaped part 111 toward the left and right end parts. As a result, foreign substances flowing through the second groove part 124 together with the cleaning water may be promoted to be discharged to the outside. Further, not limited to the second groove part 124, other parts (e.g., the step part 121, the first groove part 123, and the like) may be inclined.

[0080] Although the embodiments of the present invention have been described above, the present invention is not limited to the above embodiments, and appropriate modifications are possible within the scope of the technical idea of the invention described in the claims.

[0081] For example, in the above embodiment, as shown in FIG. 15(a), an example is shown in which the recessed part 161 (arrangement space 162) and the first groove part 123 and the second groove part 124 formed in the lower part of the projection part 112 are connected by forming the chamfer part 122 at the corner part of the projection part 112, but the present invention is not limited thereto.

[0082] As an example, FIG. 15(b) shows a suction plate 100A (base member 110A) according to a first modification example. In the base member 110A according to the first modification example, the step part 121 near the corner part of the projection part 112 is left, and a cutout part 125 is formed in the middle part of one side of the projection part 112 having a rectangular shape

in plan view. In such a configuration, the recessed part 161 (arrangement space 162) and the first groove part 123 and the second groove part 124 formed in the lower part of the projection part 112 are connected via the cutout part 125. Further, in this configuration, the side surface of the step part 121 left at the corner part of the projection part 112 and the inner surface (opening part 151) of the frame-like member 150 are fitted to each other, whereby positioning of the frame-like member 150 with respect to the base member 110A may be performed.

[0083] As described above, the configuration of the discharge passage for discharging foreign substances from the recessed part 161 (arrangement space 162) is not particularly limited, and the configuration (shape, position, number, and the like of the passage) may be arbitrarily changed as long as foreign substances can be discharged from the recessed part 161.

[0084] For example, in the above embodiment, an example is shown in which the step part 121 is formed on the outer peripheral edge part of the projection part 112, but the step part 121 (groove part) may be appropriately formed also in a part other than the outer peripheral edge part of the projection part 112 (e.g., near the center). Further, the step part 121 does not necessarily need to be formed on the projection part 112, and the chamfer part 122 and the recessed part 161 may be directly connected.

[0085] Further, in the above embodiment, an example is shown in which the end part of the second groove part 124 is formed so as to open to the side surface of the base member 110 (plate-shaped part 111), and foreign substances are discharged to the outside from this opening, but the present invention is not limited thereto. For example, instead of the second groove part 124, the first groove part 123 may be formed so as to open to the side surface of the base member 110, or both the first groove part 123 and the second groove part 124 may be formed so as to open to the side surface of the base member 110.

[0086] Further, in the above embodiment, an example is shown in which the first groove part 123 and the second groove part 124 extending parallel to each side of the projection part 112

having a rectangular shape in plan view are formed, but the shape and extending direction of the groove part are not limited thereto, and the groove part may be formed in any shape and direction.

[0087] Further, in the above embodiment, an example is shown in which foreign substances are discharged to the outside (side of the base member 110) via the second groove part 124 opening to the side surface of the base member 110 (plate-shaped part 111), but the present invention is not limited thereto. For example, it is also possible to form a collection part capable of collecting foreign substances in the discharge passage, and to collect foreign substances discharged from the recessed part 161 (arrangement space 162).

[0088] Further, in the above embodiment, the suction plate 100 (see FIG. 10 and the like) formed in a rectangular shape is exemplified on the assumption that the rectangular package substrate 70 is cut, but the present invention is not limited thereto, and the shape of the suction plate 100 may be arbitrarily changed according to the shape of the object to be cut (such as the package substrate 70).

[0089] As an example, FIG. 16 shows a suction plate 100B (base member 110B) according to a second modification example. In the base member 110B according to the second modification example, the projection part 112 is formed in a square shape in plan view. Although not shown, the frame-like member 150 is also formed with an opening part 151 having a shape corresponding to the projection part 112 (square shape in plan view). Accordingly, the suction plate 100B may hold the square-shaped package substrate 70. The suction plate 100B having such a shape is suitable for sucking a relatively large package substrate 70.

[0090] It is noted that in the base member 110B according to the second modification example shown in FIG. 16, similarly to the base member 110A according to the first modification example (see FIG. 15(b)), the step part 121 is left at the corner part of the projection part 112, and the cutout part 125 is formed on each side of the projection part 112. Further, in the base member 110B according to the second modification example, a plurality of third groove parts 126 parallel to the

second groove part 124 are formed so as to connect to the middle part of the first groove part 123. The end part of the third groove part 126 is formed so as to open to the side surface of the base member 110B. In this way, by increasing the groove parts opening to the side surface of the base member 110B, discharge of foreign substances may be efficiently promoted.

5 **[0091]** In this way, the shape of the suction plate 100B (base member 110B) may be arbitrarily changed as long as it is a shape capable of sucking and holding the object to be cut (such as the package substrate 70).

10 **[0092]** Further, in the above embodiment, the discharge passage (the step part 121, the chamfer part 122, the first groove part 123, the second groove part 124, and the like) is formed by applying appropriate processing to the base member 110, but the discharge passage does not necessarily need to be formed in the base member 110. For example, the discharge passage may be formed by forming appropriate groove parts or the like in the frame-like member 150 instead of the base member 110, or by forming appropriate groove parts or the like in both the base member 110 and the frame-like member 150.

15 **[0093]** Further, the cutting device 1 according to the above embodiment may include units other than those described above. For example, the cutting device 1 may include a substrate supply unit that supplies the package substrate 70, an inspection unit that inspects the package substrate 70 and/or the semiconductor package 80, a cleaning unit that cleans and/or dries the cut semiconductor package 80, a transport unit that transports the cut semiconductor package 80 to a storage part, and the like.

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[0094] <Appendix>

The suction plate 100 according to a first aspect of the disclosure is a suction plate 100 for holding a package substrate 70 (object to be cut) having a substrate 71 and a resin layer 72, including:

a base member 110 including a plate-shaped part 111 (base part) disposed on a base 51 provided with a suction mechanism 52 and a projection part 112 formed to project upward from the plate-shaped part 111 and formed with a suction surface 112a capable of sucking the resin layer 72; and a frame-like member 150 disposed so as to surround a periphery of the projection part 112 and including a mounting surface 152 capable of mounting the substrate 71 formed so as to be positioned above the suction surface 112a.

At least one of the base member 110 and the frame-like member 150 is formed with a discharge passage (a step part 121, a chamfer part 122, a first groove part 123, and/or a second groove part 124) capable of discharging a foreign substance in an arrangement space 162 (specified space) defined by the projection part 112 and the frame-like member 150 to outside the arrangement space 162.

According to the suction plate 100 of the first aspect of the disclosure, a half-cut groove may be formed with high precision. Specifically, since foreign substances in the arrangement space 162 may be discharged to the outside, foreign substances may be suppressed from being caught between the suction surface 112a and the package substrate 70.

[0095] In the suction plate 100 of the second aspect according to the first aspect, the discharge passage includes a chamfer part 122 (first passage) formed between the projection part 112 and the frame-like member 150 and connected to the arrangement space 162.

According to the suction plate 100 of the second aspect of the disclosure, foreign substances in the arrangement space 162 may be discharged to the outside via the chamfer part 122.

[0096] In the suction plate 100 of the third aspect according to the second aspect, the discharge passage includes a second groove part 124 (second passage) connecting the chamfer part 122 and a side surface of the plate-shaped part 111.

According to the suction plate 100 of the third aspect of the disclosure, foreign substances discharged from the arrangement space 162 may be discharged to the outside of the base member 110.

[0097] In the suction plate 100 of the fourth aspect according to the third aspect,

5 the package substrate 70 is formed in a rectangular shape, and
the second groove part 124 is formed so as to extend in a direction parallel to at least one side (long side) of the package substrate 70 sucked by the suction surface 112a.

According to the suction plate 100 of the third aspect of the disclosure, by forming the second groove part 124 in a direction corresponding to the shape of the package substrate 70, the suction
10 plate 100 may be formed relatively compactly. Particularly in the above embodiment, since the second groove part 124 opening to the side surface of the base member 110 is formed only in a direction (one direction) parallel to the long side of the package substrate 70, a decrease in rigidity of the base member 110 may be suppressed.

It is noted that "parallel" includes not only a strict meaning but also a substantial meaning. Thus,
15 even in the case where the side of the package substrate 70 and the second groove part 124 are not completely parallel, for example, when they are within a range of error due to the arrangement of the package substrate 70, they are parallel.

[0098] In the suction plate 100 of the fifth aspect according to any one of the second to fourth aspects,

20 the discharge passage includes a step part 121 (third passage) formed at a periphery of the suction surface 112a and connected to the chamfer part 122.

According to the suction plate 100 of the fifth aspect of the disclosure, foreign substances may be guided to the chamfer part 122 via the step part 121, and discharge of the foreign substances may be effectively promoted.

25 **[0099]** In the suction plate 100 of the sixth aspect according to any one of the first to fifth aspects,

a thickness of the plate-shaped part 111 in an up-down direction is formed thicker than a thickness of the projection part 112 in an up-down direction.

According to the suction plate 100 of the sixth aspect of the disclosure, by forming the thickness of the plate-shaped part 111 in the up-down direction to be relatively thick, flatness of the suction surface 112a may be easily secured.

[0100] In the suction plate 100 of the seventh aspect according to any one of the first to sixth aspects,

a recessed part 114 connected to a suction hole 115 formed in the suction surface 112a is formed on a bottom surface of the base member 110, and

at least one columnar part 116 capable of contacting the base 51 is formed inside the recessed part 114.

According to the suction plate 100 of the seventh aspect of the disclosure, deformation of the base member 110 may be suppressed by negative pressure generated with the package substrate 70.

[0101] Further, the cutting device 1 of the eighth aspect of the disclosure includes:

the suction plate 100 according to any one of the first to seventh aspects, and
the base 51 provided with the suction mechanism 52,

According to the cutting device 1 of the eighth aspect of the disclosure, a half-cut groove may be formed with high accuracy.

[0102] Further, the method for manufacturing an electronic component of the ninth aspect of the disclosure includes:

a half cut process in which a half cut is performed on the package substrate 70 using the cutting device 1 of the eighth aspect; and

a full cut process in which a full cut is performed on the package substrate 70 that has been subjected to half cut in the half cut process, using the cutting device 1,

According to the cutting device 1 of the ninth aspect of the disclosure, a half-cut groove may be formed with high accuracy.

Reference Signs List

[0103]

5	1	Cutting device
	51	Base
	52	Suction mechanism
	70	Package substrate
	71	Substrate
10	72	Resin layer
	100	Suction plate
	110	Base member
	111	Plate-shaped part
	112	Projection part
15	112a	Suction surface
	114	Recessed part
	115	Suction hole
	116	Columnar part
	121	Step part
20	122	Chamfer part
	123	First groove part
	124	Second groove part
	150	Frame-like member
	152	Mounting surface
25	162	Arrangement space

CLAIMS

[Claim 1]

A suction plate for holding an object to be cut having a substrate and a resin layer, the suction plate comprising:

5 a base member comprising a base part disposed on a base provided with a suction mechanism and a projection part formed to project upward from the base part and formed with a suction surface capable of sucking the resin layer; and

 a frame-like member disposed so as to surround a periphery of the projection part and comprising a mounting surface capable of mounting the substrate formed so as to be positioned
10 above the suction surface,

 wherein at least one of the base member and the frame-like member is formed with a discharge passage capable of discharging a foreign substance in a specified space defined by the projection part and the frame-like member to outside the specified space.

[Claim 2]

15 The suction plate according to claim 1, wherein the discharge passage comprises a first passage formed between the projection part and the frame-like member and connected to the specified space.

[Claim 3]

 The suction plate according to claim 2, wherein the discharge passage comprises a second
20 passage connecting the first passage and a side surface of the base part.

[Claim 4]

 The suction plate according to claim 3, wherein the object to be cut is formed in a rectangular shape, and

 the second passage is formed so as to extend in a direction parallel to at least one side of the
25 object to be cut sucked by the suction surface.

[Claim 5]

The suction plate according to any one of claims 2 to 4, wherein the discharge passage comprises a third passage formed at a periphery of the suction surface and connected to the first passage.

5 [Claim 6]

The suction plate according to any one of claims 1 to 5, wherein a thickness of the base part in an up-down direction is formed thicker than a thickness of the projection part in an up-down direction.

[Claim 7]

10 The suction plate according to any one of claims 1 to 6, wherein a recessed part connected to a suction hole formed in the suction surface is formed on a bottom surface of the base member, and

at least one columnar part capable of contacting the base is formed inside the recessed part.

[Claim 8]

15 A cutting device comprising:

the suction plate according to any one of claims 1 to 7; and

the base provided with the suction mechanism.

[Claim 9]

A method for manufacturing an electronic component, comprising:

20 a half cut process in which a half cut is performed on the object to be cut using the cutting device according to claim 8; and

a full cut process in which a full cut is performed on the object to be cut that has been subjected to half cut in the half cut process, using the cutting device.

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