

Description

Title of Invention

CUTTING METHOD, METHOD FOR PRODUCING CUT PRODUCT, and
CUTTING APPARATUS

5

Technical Field

[0001]

This disclosure relates to a cutting method, a method for producing a cut product,
and a cutting apparatus.

10

Background Art

[0002]

Substrates with semiconductor chips or the like mounted thereon are typically
sealed up in resin and then cut by a cutting apparatus to be singulated for use as electronic
parts. Methods have been known for cutting substrates sealed up in resin (see, for example,
Patent Literature 1).

15

[0003]

Patent Literature 1 discloses a method for cutting a substrate ("wafer" in Patent
Literature 1) to which a protective film ("adhesive film" in Patent Literature 1) is bonded.

20

The method for cutting a substrate includes a film pasting step for attaching a protective
film to the back surface of the substrate, a film cutting step for cutting at least the
protective film on the back surface of the substrate, a modified layer forming step for
emitting a laser beam to the inside of the substrate to form a modified layer, and a dividing
step for dividing the substrate with use of a breaking roller. The film cutting step involves
supplying cutting water onto the protective film on the back surface of the substrate while
cutting the protective film with use of a blade.

25

Citation List

Patent Literature

30

[0004]

Patent Literature 1: JP 2022-054894 A

Summary of Invention

Technical Problem

35

[0005]

Cutting a material typically causes viscous fracture (or ductile fracture) to be

dominant at high temperatures and brittle fracture to be dominant at low temperatures. With viscous fracture dominant, cutting a material draws out the material. The cut material remains drawn out, with the portion drawn out being a fin. With brittle fracture dominant, cutting a material draws out the material only temporarily. The cut material returns to its original state, typically with no fin. Cutting a protective film through the film cutting step included in the cutting method disclosed in Patent Literature 1 may, if the cutting water cools the protective film insufficiently, let viscous fracture be dominant when cutting the protective film and consequently leave a fin on the cut protective film.

[0006]

The above circumstances have led to a demand for a cutting method, a method for producing a cut product, and a cutting apparatus each of which unlikely leaves a fin on a protective film.

Solution to Problem

[0007]

A cutting method as an embodiment of this disclosure is a method for cutting an object, the object including: a substrate with an element mounted thereon; and a protective film bonded to the substrate to protect the element, the method including: supplying a fluid from a fluid discharger onto the protective film to cool the protective film; subsequently cutting the protective film; and subsequently cutting the substrate while supplying cutting water onto the object, the cutting water having a temperature higher than a temperature of the fluid.

[0008]

A method according to this disclosure for producing a cut product includes: cutting an object by the above cutting method.

[0009]

A cutting apparatus as an embodiment of this disclosure is a cutting apparatus usable for the above cutting method, the cutting apparatus including: a first cutting mechanism usable during the cutting of the protective film; and a second cutting mechanism usable during the cutting of the substrate.

Advantageous Effects

[0010]

Embodiments of this disclosure provide a cutting method, a method for producing a cut product, and a cutting apparatus each of which unlikely leaves a fin on a protective film.

Brief Description of Drawings

[0011]

Fig. 1 is a perspective view of a substrate and a protective film, illustrating how the protective film is bonded to the substrate.

Fig. 2 is a front view of a cutting apparatus.

5 Fig. 3 is a plan view of a cutting apparatus.

Fig. 4A is a plan view of a cutting apparatus, illustrating how a first cutting mechanism cuts a protective film.

Fig. 4B is a front view of a cutting apparatus, illustrating how a first cutting mechanism cuts a protective film.

10 Fig. 4C is a left side view of a cutting apparatus, illustrating how a first cutting mechanism cuts a protective film.

Fig. 5 is a perspective view of a substrate after a first cutting mechanism cuts a protective film.

15 Fig. 6A is a plan view of a cutting apparatus, illustrating how a second cutting mechanism cuts a substrate.

Fig. 6B is a front view of a cutting apparatus, illustrating how a second cutting mechanism cuts a substrate.

Fig. 6C is a left side view of a cutting apparatus, illustrating how a second cutting mechanism cuts a substrate.

20 Fig. 7 is a perspective view of an electronic part to which a segment of a protective film is bonded.

Fig. 8 is a diagram schematically illustrating a step for forming a shield layer on an electronic part.

25 Fig. 9 is a diagram schematically illustrating an electronic part with a segment of a protective film removed.

Fig. 10 is a partially enlarged cross-sectional view of an object including an alternative substrate and a protective film bonded thereto.

Fig. 11 is a front view of a first cutting device including an alternative nozzle attached thereto.

30

Description of Embodiments

[0012]

35 The description below deals with a cutting method, a method for producing a cut product, and a cutting apparatus as embodiments of this disclosure with reference to drawings. This disclosure is, however, not limited to the embodiments below, and may be altered variously as long as such alteration falls within the scope of this disclosure.

[0013]

Substrates with elements such as semiconductor chips mounted thereon are sealed up in resin and then cut to be singulated for use as electronic parts. Substrates sealed up in resin are cut with use of a dedicated cutting apparatus.

5 [0014]

Substrates are sealed up in resin as a result of placing substrates on a molding die (not illustrated in the drawings) of a resin molding apparatus and supplying liquid, molten resin into the molding die. The molten resin may be a thermoplastic resin or a thermosetting resin. A thermosetting resin has a viscosity that decreases when heated. Continuing to heat a thermosetting resin polymerizes and cures the thermosetting resin into a cured resin. A thermosetting resin is desirable in resin-sealing substrates with elements such as semiconductor chips mounted thereon. The resin in which the substrates are sealed up protects the elements mounted on the substrates.

[0015]

15 [Configuration of Object]

The cutting apparatus as the present embodiment is designed to cut an object 60 illustrated in Fig. 1. The object 60 includes a substrate 63 with two or more elements 61 mounted thereon and sealed up in resin. The object 60 also includes a resin package 65 facing the elements 61 and a protective film 67 bonded to the substrate 63. The elements 61 are, for example, integrated circuits (that is, semiconductor chips). The protective film 67 includes on a back face an adhesive layer (not illustrated in the drawings) made of an adhesive or the like to be bonded to the substrate 63. The elements 61 each include electrodes 61a opposite to the resin package 65 across the substrate 63 and exposed. The protective film 67 covers the substrate 63 to protect the electrodes 61a. The object 60 for the present embodiment includes a single substrate 63 and two or more elements 61 mounted thereon and each including two or more electrodes 61a. Fig. 1 illustrates an example including a single substrate 63, twenty-one elements 61 mounted thereon, and four electrodes 61a included in each element 61. Fig. 1 shows broken lines to indicate portions of the object 60 at which portions the cutting apparatus cuts (described later).

30 [0016]

[Overall Configuration of Cutting Apparatus]

The description below deals with a cutting apparatus 1 for cutting a resin-sealed substrate for singulation. Figs. 2 and 3 are a front view and a plan view, respectively, of the cutting apparatus 1 as the present embodiment. The cutting apparatus 1 includes a body 10, a table panning mechanism 20, a first cutting mechanism 30, a second cutting mechanism 40, and a control section 3 for controlling each of the above. The cutting

apparatus 1 as the present embodiment allows the user to fix an object 60 to the table panning mechanism 20, uses the first cutting mechanism 30 to move the table panning mechanism 20 linearly to cut the protective film 67 of the object 60, and then uses the second cutting mechanism 40 to cut the substrate and the resin package of the object 60 for singulation. The cutting apparatus 1 operates as described below on the basis of operation instructions from the control section 3 unless otherwise specified. The description below basically omits to deal with operation instructions from the control section 3 and deals as necessary with operation instructions from the control section 3.

[0017]

The cutting apparatus 1 as the present embodiment allows the user to switch between the first and second cutting mechanisms 30 and 40 to use one of the first and second cutting mechanisms 30 and 40 in combination with the body 10 and the table panning mechanism 20. The first and second cutting mechanisms 30 and 40 are basically identical to each other in configuration except for such matters as the position of a blade and the shape of a nozzle. Figs. 2 and 3 each show a schematic shape to indicate both the first and second cutting mechanisms 30 and 40.

[0018]

[Configuration of Body]

The body 10 includes a frame 12, sinks 13, a collection box 14, bellows covers 16, and a shutter 18. The body 10 includes two sinks 13 disposed on respective opposite sides of the table panning mechanism 20 (that is, relative to the vertical direction in Fig. 3), extending along the direction in which the table panning mechanism 20 moves, and welded or otherwise attached to the frame 12. The sinks 13 convey to the collection box 14 remnants 69 resulting from the first and second cutting mechanisms 30 and 40 cutting an object 60. The sinks 13 are below the first and second cutting mechanisms 30 and 40 in the gravitational direction and inclined relative to the horizontal direction (which is perpendicular to the vertical direction). The cutting apparatus 1 as the present embodiment includes sinks 13 inclined at an angle of approximately 5 degrees relative to the horizontal direction. The cutting apparatus 1 includes a water supply section (not illustrated in the drawings) above the sinks 13 for causing water to flow over the sinks 13. As the first and second cutting mechanisms 30 and 40 cut an object 60, and the resulting remnants 69 fall onto the sinks 13, the water flowing over the sinks 13 convey the remnants 69 downstream (that is, toward the lower left in Fig. 2). The description below uses the term "downstream" to refer to the left side in Figs. 2 and 3 and the term "upstream" to refer to the right side in Figs. 2 and 3. The sinks 13 may be inclined at an angle of larger or smaller than 5 degrees as long as the sinks 13 allow remnants 69 to be

conveyed downstream smoothly.

[0019]

The collection box 14 is disposed at the downstream end of the sinks 13, continuous with the sinks 13, and welded or otherwise attached to the frame 12. As the sinks 13 allow remnants 69 to be conveyed downstream, the collection box 14 collects the remnants 69 falling therein. The collection box 14 collects remnants 69 having been conveyed over each of the sinks 13, which are on the respective opposite sides of the table panning mechanism 20. The sinks 13 and the collection box 14 may be integral with the frame 12 instead of being welded or otherwise attached to the frame 12. The body 10 may include two collection boxes 14 in correspondence with the respective sinks 13.

[0020]

The bellows covers 16 are made of a material such as resin or rubber, and are disposed between the sinks 13. While the table panning mechanism 20 includes a movable table base 21, the bellows covers 16 are located in respective opposite directions in which the table base 21 moves, that is, upstream and downstream from the table base 21. The description below uses the term "first bellows cover 16a" to refer to the upstream bellows cover 16, the term "second bellows cover 16b" to refer to the downstream bellows cover 16, and the term "bellows covers 16" to collectively refer to the first and second bellows covers 16a and 16b.

[0021]

The bellows covers 16 are vertically above a later-described ball screw 23 of the table panning mechanism 20 (that is, vertically above in Fig. 2), and cover the entire ball screw 23 to prevent the ball screw 23 from being wetted by cutting water for use when the second cutting mechanism 40 cuts an object 60. The first and second bellows covers 16a and 16b each have a first end fixed to the table base 21 and a second end fixed to the frame 12. The bellows covers 16 are so positioned as to expand and contract as the table base 21 moves. Specifically, a downstream movement (that is, to the left in Figs. 2 and 3) of the table base 21 expands the first bellows cover 16a and contracts the second bellows cover 16b, whereas an upstream movement thereof (that is, to the right in Figs. 2 and 3) contracts the first bellows cover 16a and expands the second bellows cover 16b. The bellows covers 16, each of which has a first end fixed to the table base 21 and a second end fixed to the frame 12, constantly cover the entire ball screw 23 even when expanded or contracted.

[0022]

The shutter 18 is above the second bellows cover 16b and covers the entire second bellows cover 16b to prevent the second bellows cover 16b from being damaged

by remnants 69 cut off by the first and second cutting mechanisms 30 and 40 and falling. The shutter 18 includes two or more elongated, thin plates 18a made of metal and overlapping with one another by an amount variable in response to the expansion and contraction of the second bellows cover 16b. The shutter 18 has a first end fixed to the table base 21 and a second end fixed to the frame 12 and protruding vertically above the collection box 14. Each thin plate 18a is above the thin plate 18a adjacent downstream. As the first and second cutting mechanisms 30 and 40 cut an object 60, and the resulting remnants 69 fall onto the shutter 18, the shutter 18 pushes the remnants 69 downstream when contracted such that the thin plates 18a overlap by a larger amount to finally drop the remnants 69 into the collection box 14.

[0023]

[Configuration of Panning Mechanism]

The table panning mechanism 20 includes a table base 21, a shaft 22, a ball screw 23, a nut 24, a slider 25, a driving source 26, and a cutting table 28 attached to the upper face of the table base 21. The shaft 22 is attached to the lower face of the table base 21 and extends vertically downward from the table base 21. The shaft 22 extends downward past the sinks 13 and has a lower end connected to the nut 24, which is coupled to the ball screw 23. The slider 25 is around the shaft 22. The table base 21 is fixed to the slider 25 as well. The slider 25 is supported by a rail (not illustrated in the drawings) on the frame 12. The table base 21, the shaft 22, the nut 24, and the slider 25 are integrally movable upstream and downstream along the rail. The table panning mechanism 20 operates under control of the control section 3.

[0024]

The driving source 26 is in the form of a rotary actuator such as a motor for driving the ball screw 23 for rotation about an axis in the normal and reverse directions. The rotation does not rotate the nut 24, as the nut 24 is connected to the shaft 22; the rotation instead moves the nut 24 (which is coupled to the ball screw 23) upstream or downstream. The movement of the nut 24 moves the table base 21, the shaft 22, and the slider 25 (which are integral with the nut 24) upstream or downstream along the rail.

[0025]

[Configurations of First and Second Cutting Mechanisms]

The first cutting mechanism 30 includes a first blade 32, a first nozzle 34 (which is an example fluid discharger), and a first fluid supply section 36. The first blade 32 is in the form of a disc rotatable by a drive section (not illustrated in the drawings) under control of the control section 3 to cut the protective film 67. The first nozzle 34 serves to blow low-temperature air (which is an example fluid) to a surface of the protective film

67 to cool the protective film 67 for the first blade 32 to cut the protective film 67. Cooling the protective film 67 allows brittle fracture to be dominant when the first blade 32 cuts the protective film 67, thereby reducing fins resulting from the cutting operation.

[0026]

5 The first fluid supply section 36 cools air to be blown to the protective film 67 and supplies the cooled air to the first nozzle 34. Specifically, the first fluid supply section 36 cools air to below 0 degrees. The description below may use the term "low-temperature air" to refer to air that the first fluid supply section 36 has cooled to below 0 degrees. The low-temperature air has a temperature of -20 degrees, for example. The first fluid supply
10 section 36 may be configured to cool air indirectly by, for instance, absorbing heat from air by means of expansion and contraction of a cooling medium. The first nozzle 34 blows low-temperature air with use of a pump or the like in a publicly known manner. This is not described in detail here. The first fluid supply section 36 supplies low-temperature air (that is, air that the first fluid supply section 36 has cooled to below 0 degrees) to the first
15 nozzle 34, which then blows the low-temperature air to the protective film 67. The first nozzle 34 should desirably be configured to blow to the protective film 67 low-temperature air with a temperature of below 0 degrees even on the surface of the protective film 67; however, the low-temperature air may have a temperature of not less than 0 degrees on the surface. The first fluid supply section 36 may be configured to cool
20 air directly by means of expansion and contraction of a cooling medium or indirectly with use of liquid nitrogen.

[0027]

 The second cutting mechanism 40 includes a second blade 42, a second nozzle 44, and a second fluid supply section 46. The second blade 42 is in the form of a disc
25 rotatable by a drive section (not illustrated in the drawings) under control of the control section 3 to cut the substrate and the resin package at the same time. The second blade 42 has a thickness (or width) smaller than that of the first blade 32. The second nozzle 44 serves to supply cutting water onto a surface of the substrate and the resin package to cool the substrate and the resin package for the second blade 42 to cut the substrate and the
30 resin package. Cooling the substrate and the resin package reduces frictional heat between (i) the substrate and the resin package and (ii) the second blade 42 to prevent the substrate and the resin package from being deformed or degraded.

[0028]

 The second fluid supply section 46 cools cutting water to be supplied onto the
35 substrate and the resin package and supplies the cooled cutting water to the second nozzle 44. Specifically, the second fluid supply section 46 holds cutting water with a temperature

of, for example, 10 degrees to 25 degrees, which is higher than the temperature of the low-temperature air. The second fluid supply section 46 may be configured to not cool cutting water. The second fluid supply section 46 cools cutting water and presses cutting water to be supplied to the second nozzle 44 in a publicly known manner. This is not described in detail here. The second fluid supply section 46 optionally cools cutting water and supplies the cutting water to the second nozzle 44, which then supplies the cutting water onto the substrate and the resin package.

[0029]

[Cooling Step]

The description below deals with how the first cutting mechanism 30 of the cutting apparatus 1 cuts the protective film 67 of an object 60, with reference to Figs. 4A to 4C. Figs. 4A to 4C omit elements such as the body 10, and the table base 21 and the ball screw 23 of the table panning mechanism 20.

[0030]

The object 60 is fixed to the cutting table 28 by air suction (not illustrated in the drawings) or with use of fixing adhesive tape (not illustrated in the drawings), for example. The first blade 32 and the first nozzle 34 of the first cutting mechanism 30 are downstream from the object 60 before the first blade 32 cuts the protective film 67 (that is, before the cutting table 28 moves downstream). The first blade 32 cuts portions of the object 60 which portions correspond to boundaries along which the object 60 may be cut into mutually adjacent electronic parts.

[0031]

The first cutting mechanism 30 for the present embodiment includes a first nozzle 34 divided partway into five first blower openings 34a apart from one another and arranged linearly along the direction in which the first blade 32 cuts the protective film 67.

[0032]

Before the control section 3 drives the table panning mechanism, the first fluid supply section 36 cools air to below 0 degrees and blows the low-temperature air from the first blower openings 34a simultaneously to a surface of the protective film 67 linearly. This cools at least that portion of the protective film 67 which the first blade 32 cuts and a portion around the above portion (cooling step).

[0033]

If the low-temperature air is colder than the cutting water, the cooling step may allow brittle fracture to be dominant when the first blade 32 cuts the protective film 67. If the cooling step allows brittle fracture to be dominant when the first blade 32 cuts the

protective film 67, the low-temperature air does not necessarily have a temperature of below 0 degrees. Cooling the cutting water to below 0 degrees will solidify the cutting water; the cutting water cannot have a temperature of below 0 degrees. If the user needs a temperature of below 0 degrees for brittle fracture to be dominant when the first blade 32 cuts the protective film 67, the first fluid supply section 36 should preferably be configured to use low-temperature air with such a temperature.

[0034]

[Film Cutting Step]

After the first fluid supply section 36 blows low-temperature air to the protective film 67 for a predetermined time period, or after a publicly known temperature detector detects that the protective film 67 has a temperature lower than a predetermined temperature, the control section 3 drives the table panning mechanism to bring the object 60 closer to the first blade 32 and starts rotating the first blade 32. The first blade 32 rotates clockwise as viewed in the direction in Fig. 4B. Cutting the protective film 67 with use of the first blade 32 rotating as above throws remnants 69 to the left of the object 60, that is, toward the second bellows cover 16b, which is covered by the shutter 18 (see Fig. 2 as well).

[0035]

Next, the control section 3 drives the driving source 26 of the table panning mechanism 20 to rotate the ball screw 23 and move the table base 21 to the left in Figs. 4A and 4B. This also moves the cutting table 28 and the object 60 thereon to the left, causing the edge of the first blade 32 to cut the protective film 67 as illustrated in Fig. 4C (film cutting step).

[0036]

The first fluid supply section 36 continues to blow low-temperature air to a surface of the protective film 67 while the first blade 32 is cutting the protective film 67. The first fluid supply section 36, in other words, blows low-temperature air to two or more portions of the protective film 67 simultaneously while the table panning mechanism 20 is moving the object 60. This keeps at a low temperature that portion of the protective film 67 which the first blade 32 cuts, and allows brittle fracture to be dominant when the first blade 32 cuts the protective film 67, thereby reducing fins on the cut surface. Figs. 4A and 4B each illustrate an example in which the first fluid supply section 36 blows low-temperature air to five portions of the protective film 67 simultaneously. The first fluid supply section 36 may be configured to cool air to a temperature lower than that of the cutting water. The first fluid supply section 36 uses low-temperature air if the cutting water does not cool the protective film 67 to such a

temperature as to allow brittle fracture to be dominant when the first blade 32 cuts the protective film 67.

[0037]

After the first blade 32 cuts the protective film 67 in a direction, the control section 3 rotates the ball screw 23 in the reverse direction to move the table base 21 to the right together with the object 60 until the first blade 32 and the object 60 return to be positioned relative to each other as illustrated in Figs. 4A and 4B. The cutting apparatus 1 includes a moving mechanism (not illustrated in the drawings), which moves the first blade 32 upward or downward in Fig. 4A (or to the left or right in Fig. 4C) so that the first blade 32 faces a portion of the object 60 which portion the first blade 32 cuts subsequently. The first blade 32 then cuts the portion. The cutting apparatus 1 repeats the above procedure.

[0038]

The cutting apparatus 1 as the present embodiment includes a handling means (not illustrated in the drawings). After performing the above cutting operation twice, the cutting apparatus 1 causes the handling means to turn the object 60 by 90 degrees relative to the cutting table 28 and then cuts the object 60 similarly six times. The cutting apparatus 1 thereby cuts only the protective film 67 of the object 60 and divides the protective film 67 into two or more segments bonded to the substrate 63 as illustrated in Fig. 5, which illustrates an example in which the cutting apparatus 1 has cut the protective film 67 into twenty-one segments.

[0039]

[Substrate Cutting Step]

The description below deals with how the second cutting mechanism 40 of the cutting apparatus 1 cuts the substrate 63 and the resin package 65 of the object 60, with reference to Figs. 6A to 6C. When the film cutting step ends, the user replaces the first cutting mechanism 30 with the second cutting mechanism 40. The second blade 42 and the second nozzle 44 of the second cutting mechanism 40 are downstream from the object 60 before the second blade 42 cuts the substrate 63 and the resin package 65 (that is, before the cutting table 28 moves downstream). The second blade 42 cuts portions of the object 60 which portions correspond to boundaries along which the object 60 may be cut into mutually adjacent electronic parts, that is, at which portions the first blade 32 cut off portions of the protective film 67 for removal during the film cutting step.

[0040]

The second cutting mechanism 40 for the present embodiment includes a second nozzle 44 including a single second blower opening 44a, as opposed to the first nozzle

34. The second blower opening 44a is so positioned as to jet cutting water toward an end of the object 60, that is, a part of the area of the object 60 from which area the first cutting mechanism 30 removed a portion of the protective film 67 by cutting off the portion, the part being closest to the second blade 42.

5 [0041]

Before the control section 3 drives the table panning mechanism, the second fluid supply section 46 cools cutting water and jets the cooled cutting water from the second blower opening 44a to a surface of the substrate 63. This cools at least that portion of the substrate 63 which the second blade 42 cuts and a portion around the above portion. The substrate 63 and the resin package 65 are each harder than the protective film 67 and need cutting across a larger thickness. Cutting the substrate 63 and the resin package 65 generates a larger amount of heat per unit time than cutting the protective film 67. The low-temperature air as gas is supplied to the cutting portion (for the present embodiment, the substrate 63 and the resin package 65) per unit time in a mass smaller than the cutting water as liquid. The substance supplied absorbs heat in an amount proportional to its mass. The low-temperature air thus does not allow escape of a sufficient amount of heat generated when the second blade 42 cuts the substrate 63 and the resin package 65. That is why the second cutting mechanism 40 uses cutting water when cutting the substrate 63 and the resin package 65. Supplying a large amount of cutting water onto the substrate 63 allows heat to escape efficiently.

20 [0042]

While or after the second cutting mechanism 40 jets the cutting water to the substrate 63, the control section 3 drives the table panning mechanism to bring the object 60 closer to the second blade 42 and starts rotating the second blade 42. The second blade 42 rotates clockwise as viewed in the direction in Fig. 6B. Cutting the substrate 63 and the resin package 65 with use of the second blade 42 rotating as above throws remnants 69 to the left of the object 60, that is, toward the second bellows cover 16b, which is covered by the shutter 18 (see Fig. 2 as well).

25 [0043]

Next, the control section 3 drives the driving source 26 of the table panning mechanism 20 to rotate the ball screw 23 and move the table base 21 to the left in Figs. 6A and 6B. This also moves the cutting table 28 and the object 60 thereon to the left, causing the edge of the second blade 42 to cut the substrate 63 and the resin package 65 as illustrated in Fig. 6C (substrate cutting step). The cutting table 28 has clearance grooves 28a to prevent the second blade 42 from cutting the cutting table 28 while cutting the substrate 63 and the resin package 65.

[0044]

The second cutting mechanism 40 continues to supply the cutting water onto the surface of the substrate 63 while the second blade 42 is cutting the substrate 63 and the resin package 65. This keeps at a low temperature those respective portions of the substrate 63 and the resin package 65 which the second blade 42 cuts, and reduces generation of frictional heat resulting from the cutting operation. While the second blower opening 44a jets cutting water onto a surface of the substrate 63, the cutting water is splashed back by the surface toward the cutting apparatus 1 and wets the cutting apparatus 1. This splash does not wet the ball screw 23, the nut 24, or the driving source 26, as they are covered by the first and second bellows covers 16a and 16b (see Fig. 2 as well). The second blade 42 has a thickness (or width) smaller than that of the first blade 32 as mentioned above. The first blade 32 cuts the protective film 67 with a first cutting width d1, whereas the second blade 42 cuts the substrate 63 and the resin package 65 with a second cutting width d2, the first cutting width d1 being larger than the second cutting width d2 (see Figs. 4C and 6C). This prevents the second blade 42 from cutting the protective film 67. The first cutting width d1 may be equal to the second cutting width d2.

[0045]

After the second blade 42 cuts the substrate 63 and the resin package 65 in a direction, the table panning mechanism 20 rotates the ball screw 23 in the reverse direction to move the table base 21 to the right together with the object 60 until the second blade 42 and the object 60 return to be positioned relative to each other as illustrated in Figs. 6A and 6B. The cutting apparatus 1 includes a moving mechanism (not illustrated in the drawings), which moves the second blade 42 upward or downward in Fig. 6A (or to the left or right in Fig. 6C) so that the second blade 42 faces a portion of the object 60 which portion the second blade 42 cuts subsequently. The second blade 42 then cuts the portion. The cutting apparatus 1 repeats the above procedure.

[0046]

The cutting apparatus 1 as the present embodiment includes a handling means (not illustrated in the drawings). After performing the above cutting operation twice, the cutting apparatus 1 causes the handling means to turn the object 60 by 90 degrees relative to the cutting table 28 and then cuts the object 60 similarly six times. The cutting apparatus 1 thereby singulates the object 60 into two or more electronic parts 60a (which is an example cut product) to each of which a segment of the protective film 67 is bonded as illustrated in Fig. 7. The cutting apparatus 1 singulates the object 60 illustrated in Fig. 5 into twenty-one electronic parts 60a, which are conveyed from the cutting table 28 by a conveying mechanism (not illustrated in the drawings).

[0047]

As mentioned above, the use of the cutting apparatus 1 unlikely leaves fins on the cut surface of the protective film 67. This allows the cutting apparatus 1 to singulate an object 60 into electronic parts 60a almost none of which has a fin. The cutting apparatus 1 singulates an object 60 into electronic parts 60a, which the conveying mechanism then sucks thereto. The conveying mechanism may fail to suck an electronic part 60a thereto appropriately if the electronic part 60a has a fin. The cutting apparatus 1 cuts an object 60 into electronic parts 60a almost none of which has a fin. This reduces the possibility of the conveying mechanism failing to convey an electronic part 60a.

[0048]

[Shield Layer Forming Step]

Next, each electronic part 60a, to which a segment of the protective film 67 is bonded, is placed in a sputtering device (not illustrated in the drawings) chamber to undergo sputtering with use of a sputtering target 50 made of an electrically conductive material. This forms a shield layer 52 on a surface of the electronic part 60a as illustrated in Fig. 8. The shield layer 52 protects the element 61 in the electronic part 60a from external noise or the like. After the shield layer 52 is formed, the electronic part 60a is taken out of the sputtering device, followed by removal of the segment of the protective film 67. This provides an electronic part 60a as a finished product as illustrated in Fig. 9. The shield layer 52 does not cover the electrodes 61a of the element 61 as the electrodes 61a were covered by the segment of the protective film 67 during the sputtering operation.

[0049]

[Alternative Embodiments]

The description below deals with embodiments alternative to the embodiment described above. For ease of understanding, the description below uses the same terms and reference signs as in the description of the above embodiment for similar elements.

[0050]

<1> The object 60 for the embodiment described above includes a substrate 63, elements 61 mounted thereon, and a protective film 67 for protecting electrodes 61a exposed on a surface of the substrate 63. This disclosure is, however, not limited to such a configuration. The object 60 may be replaced with, for example, an object 70 (see Fig. 10) including a substrate 73, a resin housing 75 disposed on the substrate 73 and having two or more depressions 75a, integrated circuits 71 (which is an example element) each mounted in a depression 75a and exposed, and a protective film 67 bonded to a surface of the resin housing 75 to protect the integrated circuits 71. The protective film 67 prevents cutting water from entering the depressions 75a and wetting the integrated

circuits 71 when the cutting apparatus 1 cuts the substrate 73 and the resin housing 75 into electronic parts. The integrated circuits 71 are, for example, micro-electromechanical systems (MEMS).

[0051]

5 <2> The first cutting mechanism 30 for the present embodiment includes a first nozzle 34 divided partway into two or more (five for the embodiment described above) first blower openings 34a apart from one another and arranged linearly along the direction in which the first blade 32 cuts the protective film 67. This disclosure is, however, not limited to such a configuration. The first nozzle 34 may include a single first blower
10 openings 34a shaped in a straight line (that is, an elongated rectangle) as illustrated in Fig. 11. The first blower opening 34a with such a shape also blows low-temperature air to the protective film 67 linearly along the direction in which the first blade 32 cuts the the protective film 67, and thereby cools the protective film 67.

[0052]

15 <3> The embodiment described above is a single cutting apparatus 1 that allows the user to switch between the first and second cutting mechanisms 30 and 40 for the film cutting step and the substrate cutting step. This disclosure is, however, not limited to such a configuration, and may involve two separate cutting apparatuses 1, one with the first cutting mechanism 30 and the other with the second cutting mechanism 40. In this case,
20 the cutting apparatus 1 with the first cutting mechanism 30 performs the film cutting step. The object 60 with the cut protective film 67 is then conveyed from the cutting apparatus 1 with the first cutting mechanism 30 to the cutting apparatus 1 with the second cutting mechanism 40, which then performs the substrate cutting step. The electronic parts 60a thus produced are conveyed from the cutting apparatus 1 with the second cutting
25 mechanism 40. Almost none of the electronic parts 60a has a fin in this case as well. This reduces the possibility of the conveying mechanism failing to convey an electronic part 60a.

[0053]

30 <4> The cutting apparatus 1 as the embodiment described above includes a first cutting mechanism 30 that includes a first blade 32 and a first nozzle 34 both fixed in position and that is configured to move an object 60, 70 when the first blade 32 cuts the protective film 67 and a second cutting mechanism 40 that includes a second blade 42 and a second nozzle 44 both fixed in position and that is configured to move the object
35 cutting apparatus 1, however, does not necessarily cut an object 60, 70 in this manner, and may be configured to, for instance, move the first blade 32 and the first nozzle 34,

and the second blade 42 and the second nozzle 44, instead of moving an object 60, 70 or while moving an object 60, 70 when cutting the object 60, 70. In other words, the cutting apparatus 1 configured as such causes relative movement of the first blade 32 and the first nozzle 34, the second blade 42 and the second nozzle 44, and an object 60, 70 to change their relative positional relationship.

[0054]

<5> The table panning mechanism 20 for the embodiment described above includes a ball screw 23 and a nut 24 to move the table base 21 linearly. This disclosure is, however, not limited to such a configuration. The table panning mechanism 20 may include a linear actuator to directly move the table base 21 linearly.

[0055]

<6> The cutting apparatus 1 as the embodiment described above blows low-temperature air to the protective film 67 to cool the protective film 67. The cutting apparatus 1 may be configured to additionally cool the cutting table 28 in a publicly known manner. Cooling the cutting table 28 also cools the resin package 65 when the cutting apparatus 1 cools the protective film 67, thereby cooling the substrate 63 on both surfaces. This prevents the substrate 63 from being warped if the cutting apparatus 1 cools the substrate 63 on one surface (that is, the protective film 67) alone.

[0056]

<7> The first fluid supply section 36 for the embodiment described above cools air with use of a cooling medium. The first fluid supply section 36 may be configured to supply liquid nitrogen (which is an example fluid) itself to the first nozzle 34. Liquid nitrogen has a boiling point of -196 degrees. The liquid nitrogen supplied to the first nozzle 34 is vaporized before being jetted from the first blower openings 34a. This cools the protective film 67 to a lower temperature.

[0057]

[Summary of Above Embodiments]

The description below summarizes the cutting method, the method for producing a cut product, and the cutting apparatus 1 each described above as an embodiment.

[0058]

(1) A cutting method is characteristically a method for cutting an object 60, 70, the object 60, 70 including: a substrate 63, 73 with an element 61 or integrated circuit 71 mounted thereon; and a protective film 67 bonded to the substrate 63, 73 to protect the element 61 or integrated circuit 71, the method including: supplying a fluid from a fluid discharger (first nozzle 34) onto the protective film 67 to cool the protective film 67; subsequently cutting the protective film 67; and subsequently cutting the substrate 63, 73

while supplying cutting water onto the substrate 63, 73, the cutting water having a temperature higher than a temperature of the fluid.

[0059]

The cutting method characteristic as above includes cooling the protective film 67 and subsequently cutting the protective film 67. This allows brittle fracture to be dominant during the cutting of the protective film 67, rendering it unlikely to leave fins on the cut surface of the protective film 67. The cutting method also includes subsequently cutting the substrate 63. This allows optimized conditions individually for the cutting of the protective film 67 and for the cutting of the substrate 63, 73 as compared to cutting the protective film 67 and the substrate 63, 73 simultaneously.

[0060]

(2) The cutting method according to item (1) above may be further arranged such that the fluid is low-temperature air cooled to below 0 degrees Celsius before being supplied onto the protective film 67.

[0061]

This method involves low-temperature low-temperature air to be supplied onto the protective film 67. This allows brittle fracture to be dominant during the cutting of the protective film 67, rendering it unlikely to leave fins on the cut surface of the protective film 67.

[0062]

(3) The cutting method according to item (1) or (2) above may be further arranged such that the supplying of the fluid includes supplying the fluid simultaneously onto a plurality of portions of the protective film 67 while moving the object 60, 70 relative to the fluid discharger (first nozzle 34).

[0063]

This method includes, before cutting the protective film 67, sufficiently cooling a portion of the protective film 67 which portion is to be cut.

[0064]

(4) The cutting method according to item (1) or (2) above may be further arranged such that the supplying of the fluid includes supplying the fluid onto the protective film 67 linearly while moving the object 60, 70 relative to the fluid discharger (first nozzle 34).

[0065]

This method includes, before cutting the protective film 67, continuously cooling a portion of the protective film 67 which portion is to be cut.

[0066]

(5) The cutting method according to any one of items (1) to (4) above may be further arranged such that the cutting of the protective film 67 includes cutting the protective film 67 with a first cutting width d1, whereas the cutting of the substrate 63, 73 includes cutting the substrate 63, 73 with a second cutting width d2, the first cutting width d1 being larger than the second cutting width d2.

[0067]

This method prevents the cut surface of the protective film 67 from being cut during the cutting of the substrate 63, 73.

[0068]

(6) The cutting method according to any one of items (1) to (5) above may be further arranged such that the object 60 further includes a resin package 65 opposite to the protective film 67 across the substrate 63 and covering the substrate 63, and the method further includes, after the cutting of the substrate 63, forming a shield layer 52 on a surface of the object 60 on which surface the protective film 67 is absent.

[0069]

This method does not form a shield layer 52 on a portion of the object 60 which portion the protective film 67 covers, and prevents a shield material from adhering to the substrate 63 due to the protective film 67.

[0070]

(7) A method for producing a cut product (electronic part 60a) includes cutting an object 60 by a method according to any one of items (1) to (6) above.

[0071]

This production method unlikely leaves a fin on the cut surface of a segment of the protective film 67 on a cut product (electronic part 60a).

[0072]

(8) A cutting apparatus 1 usable for a method according to any one of items (1) to (6) above characteristically includes: a first cutting mechanism 30 usable during the cutting of the protective film 67; and a second cutting mechanism 40 usable during the cutting of the substrate 63, 73.

[0073]

The above configuration allows the first and second cutting mechanisms 30 and 40 to be optimized for cutting the protective film 67 and the substrate 63, 73, respectively, as compared to cutting the protective film 67 and the substrate 63, 73 at the same time.

Industrial Applicability

[0074]

This disclosure is applicable to a cutting method, a method for producing a cut product, and a cutting apparatus.

Reference Signs List

5	[0075]	
	1	Cutting apparatus
	30	First cutting mechanism
	34	First nozzle (fluid discharger)
	40	Second cutting mechanism
10	52	Shield layer
	60	Object
	60a	Electronic part (cut product)
	61	Element
	63	Substrate
15	65	Resin package
	67	Protective film
	70	Object
	71	Integrated circuit (element)
	73	Substrate
20	d1	First cutting width
	d2	Second cutting width

Claims

1. A method for cutting an object,
the object including:
5 a substrate with an element mounted thereon; and
a protective film bonded to the substrate to protect the element,
the method comprising:
supplying a fluid from a fluid discharger onto the protective film to cool the
protective film;
10 subsequently cutting the protective film; and
subsequently cutting the substrate while supplying cutting water onto the object,
the cutting water having a temperature higher than a temperature of the fluid.
2. The method according to claim 1, wherein
15 the fluid is low-temperature air cooled to below 0 degrees Celsius before being
supplied onto the protective film.
3. The method according to claim 1 or 2, wherein
the supplying of the fluid includes supplying the fluid simultaneously onto a
20 plurality of portions of the protective film while moving the object relative to the fluid
discharger.
4. The method according to claim 1 or 2, wherein
the supplying of the fluid includes supplying the fluid onto the protective film
25 linearly while moving the object relative to the fluid discharger.
5. The method according to any one of claims 1 to 4, wherein
the cutting of the protective film includes cutting the protective film with a first
cutting width, whereas the cutting of the substrate includes cutting the substrate with a
30 second cutting width, the first cutting width being larger than the second cutting width.
6. The method according to any one of claims 1 to 5, wherein
the object further includes a resin package opposite to the protective film across
the substrate and covering the substrate, and
35 the method further comprises, after the cutting of the substrate, forming a shield
layer on a surface of the object on which surface the protective film is absent.

7. A method for producing a cut product,
the method comprising:
cutting an object by a method according to any one of claims 1 to 6.

5

8. A cutting apparatus usable for a method according to any one of claims 1 to 6,
the cutting apparatus comprising:
a first cutting mechanism usable during the cutting of the protective film; and
a second cutting mechanism usable during the cutting of the substrate.