

FILM CUTTING APPARATUS, RELEASE FILM CUTTING METHOD,
FILM CUTTING METHOD, RESIN-MOLDING APPARATUS,
RESIN-MOLDING METHOD, AND PRODUCTION APPARATUS FOR
RESIN-MOLDED ARTICLE

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CROSS-REFERENCE TO RELATED APPLICATION

This application claims priority from Japanese Patent Application No. 2013-270429 filed on December 26, 2013. The entire subject matter of the Japanese Patent Application is incorporated herein by reference.

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BACKGROUND OF THE INVENTION

[0001] The present invention relates to a film cutting apparatus, a release film cutting method, a film cutting method, a resin-molding apparatus, a resin-molding method, and a production apparatus for a resin-molded article.

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[0002] Electronic components such as IC, semiconductor electronic components, and the like are mostly molded as resin-encapsulated electronic components to use.

[0003] In a resin-encapsulation method for one or more electronic components, for example, by supplying resin into a die cavity,

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resin-encapsulation of the electronic component(s) is performed in the die cavity. An example of the method of supplying resin into the die cavity includes the method disclosed in JP 2010-36542A. In this method, first, a plate for resin containment provided with a through-hole corresponding to the die cavity is prepared, and the undersurface of the plate is covered with a release film. Thereby, the through-hole is formed into a resin containing portion of the plate. Next, by supplying a needed amount of resin material to the resin containing portion of the plate and making the thickness of the resin material uniform, a planarized resin-distributed plate is formed. By placing this resin-distributed plate at the position of the die cavity and

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covering the cavity surface with the release film, the resin is supplied into

the die cavity from the resin containing portion.

[0004] According to the method disclosed in JP 2010-36542A, it is possible to efficiently supply resin into the die cavity and efficiently improve the reliability of the amount of the resin to be supplied into the die cavity at the
5 time of supplying the resin into the die cavity.

BRIEF SUMMARY OF THE INVENTION

[0005] In recent years, as substrates (wafers) for electronic components such as semiconductor components and the like, large circular substrates are being
10 used. Hence, for performing resin-encapsulation of one or more electronic component(s) placed on the large circular substrate, there is a need for efficient production of a large circular release film corresponding to such a substrate.

[0006] Hence, the present invention is intended to provide a film cutting
15 apparatus, a release film cutting method, a film cutting method, a resin-molding apparatus, a resin-molding method, and a production apparatus for a resin-molded article that can efficiently produce a large circular release film.

[0007] In order to achieve the aforementioned purpose, the present invention
20 provides a film cutting apparatus including: a rotating member; a rotating arm; and a cutter, wherein the rotating member is directly or indirectly connected to a first end of the rotating arm and the cutter is directly or indirectly connected to a second end of the rotating arm, a rotation axis of the rotating member penetrates through the rotating member and is
25 substantially perpendicular to a surface of the film to be cut, the cutter pierces a predetermined position of the film by moving the cutter toward the surface of the film, and the film is cut out into a circle by rotation of the rotating arm and the cutter that pierces the film in response to rotation of the rotating member around the rotation axis.

30 [0008] The present invention also provides a release film cutting method

including: a piercing step of piercing a predetermined position of a long release film with a cutter; and a cutting out step of cutting out the release film into a circle by rotating the cutter that pierces the release film in a circumferential direction.

5 [0009] The present invention also provides a film cutting method using the film cutting apparatus of the present invention, including: a piercing step of piercing a predetermined position of the film with the cutter by moving the cutter toward the surface of the film; and a cutting out step of cutting out the film into a circle by rotation of the rotating arm and the cutter that pierces
10 the film in response to rotation of the rotating member around the rotation axis that penetrates through the rotating member and is substantially perpendicular to the surface of the film.

[0010] The present invention also provides a resin-molding apparatus, including: the film cutting apparatus of the present invention, a
15 resin-sprinkling unit sprinkling resin on a circular release film formed by the cutting apparatus, and a resin-molding unit molding the sprinkled resin.

[0011] The present invention also provides a resin-molding method, including: a cutting step of forming a circular release film by the film cutting method of the present invention; a resin-sprinkling step of sprinkling resin on
20 the formed circular release film; and a resin-molding step of molding the sprinkled resin on the circular release film.

[0012] The present invention also provides a production apparatus for a resin-molded article, including: the resin-molding apparatus of the present invention; and a transfer unit, wherein the transfer unit transfers at least the
25 resin-molded article after resin-molding.

[0013] According to the present invention, it is possible to provide a film cutting apparatus, a release film cutting method, a film cutting method, a resin-molding apparatus, a resin-molding method, and a production apparatus for a resin-molded article that can efficiently produce a large
30 circular release film.

BRIEF DESCRIPTION OF THE DRAWINGS

[0014] [FIG. 1] FIG. 1 is a front elevational view showing an example of the film cutting apparatus of the present invention.

5 [FIG. 2] FIG. 2 is a plan view showing an example of a part of the film cutting apparatus of the present invention.

[FIG. 3] FIG. 3 shows schematic views illustrating examples of the shape of the cutter of the film cutting apparatus of the present invention.

[FIG. 4] FIG. 4 is a process view showing an example of the film
10 cutting method of the present invention.

[FIG. 5] FIG. 5 is a plan view showing an example of the production apparatus for a resin-molded article of the present invention.

[FIG. 6] FIG. 6 is a perspective view schematically showing an
example of the resin-sprinkling step in Example 2.

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DETAILED DESCRIPTION OF THE INVENTION

[0015] Next, the present invention will be described in more detail with reference to exemplary embodiments. However, the present invention is not limited by the following description.

20 [0016] In the film cutting apparatus of the present invention, preferably, the apparatus further includes a base on which the film is placed, the base includes a groove along a circle that is a rotation locus of the cutter at its upper part, and the film is cut out into a circle in a state where a tip of the cutter is positioned in an inside of the groove.

25 [0017] In the film cutting apparatus of the present invention, preferably, the base is divided into an inner part member and an outer part member with the groove along the circle as a boundary.

[0018] In the film cutting apparatus of the present invention, preferably, the inner part member is a resin-sprinkling table.

30 [0019] In the film cutting apparatus of the present invention, preferably, the

apparatus further includes a vertical direction movement means (unit), and the vertical direction movement means moves at least one of the inner part member and the outer part member in a vertical direction.

[0020] In the film cutting apparatus of the present invention, preferably, the
5 apparatus further includes a film fixing means (unit) that is placed on a top surface of the film to fix the film, the film fixing means includes an inner part fixing member and an outer part fixing member, the inner part fixing member is positioned at an inside of the circle that is the rotation locus of the cutter, and the outer part fixing member is positioned at an outside of the
10 circle that is the rotation locus of the cutter.

[0021] In the film cutting apparatus of the present invention, preferably, the inner part fixing member is a substantially disc-shaped member, and the outer part fixing member is a substantially ring-shaped member that surrounds the circle that is the rotation locus of the cutter.

[0022] In the film cutting apparatus of the present invention, preferably, the
15 inner part fixing member and the outer part fixing member are both substantially ring-shaped members, the circle that is the rotation locus of the cutter is surrounded by the outer part fixing member, and a ring opening of the inner part fixing member serves as a resin supply portion.

[0023] In the film cutting apparatus of the present invention, preferably, the
20 apparatus further includes a rotation controlling means (unit), and the rotation controlling means is connected to the rotating member in such a manner that a part of a periphery of the rotating member is surrounded by the rotation controlling means. The rotation controlling means is preferably
25 a torque limiter, although there is no particular limitation on the rotation controlling means.

[0024] In the film cutting apparatus of the present invention, preferably, the rotating member is a rotating shaft.

[0025] In the film cutting method of the present invention, preferably, the
30 film cutting apparatus further includes a base on which the film is placed, the

base includes a groove along a circle that is a rotation locus of the cutter at its upper part, and the film is cut out into a circle in a state where a tip of the cutter is positioned in an inside of the groove. In this case, in the film cutting method of the present invention, preferably, the film is cut out into a circle in a state where the tip of the cutter is positioned in the inside of the groove in the cutting out step.

[0026] In the film cutting method of the present invention, preferably, the film cutting apparatus is the film cutting apparatus of the present invention further including a film fixing means that is placed on a top surface of the film to fix the film, the film fixing means includes an inner part fixing member and an outer part fixing member, the inner part fixing member is positioned at an inside of the circle that is the rotation locus of the cutter, and the outer part fixing member is positioned at an outside of the circle that is the rotation locus of the cutter. In this case, preferably, the film cutting method of the present invention further includes a film fixing step of fixing the film by placing the film fixing means on the top surface of the film, the inner part fixing member is placed at the inside of the circle that is the rotation locus of the cutter and the outer part fixing member is placed at the outside of the circle that is the rotation locus of the cutter in the film fixing step, the predetermined position to be pierced with the cutter is positioned between the inner part fixing member and the outer part fixing member in the piercing step, and the film is cut out into a circle along a periphery of the inner part fixing member in the cutting out step.

[0027] In the resin-molding apparatus of the present invention, preferably, in the resin-molding, at least one electronic component is resin-encapsulated. Furthermore, in the resin-molding method of the present invention, preferably, in the resin-molding step, at least one electronic component is resin-encapsulated. In the resin-molding method of the present invention, preferably, a circular frame is placed on the release film and resin is sprinkled on the inside of the circular frame in the resin-sprinkling step.

[0028] In the production apparatus for a resin-molded article, preferably, the film cutting apparatus, the resin-sprinkling unit, the resin-molding unit, and the transfer unit are separately arranged as independent units, and at least one of the units is detachable to at least another one of the units.

5 [0029] Hereinafter, Embodiments of the present invention will be described with reference to Figures. Each Figure is schematically illustrated by appropriately omitting, exaggerating, and the like for convenience in explanation. Note here that, “substantially circular” and “substantially ring-shaped” in the following description do not necessarily take a shape of a
10 perfect circle and can be a substantial circle, although a perfect circle is ideal. Examples of the substantial circle include an ellipse, an ellipse that is nearly a perfect circle, and polygons (for example, hexagon, octagon, and decagon). Ideally, the length of the minor axis (shortest diameter) and the length of the major axis (longest diameter) of the resin-sprinkling area are the same (i.e.,
15 the resin-sprinkling area is a perfect circle). Moreover, “substantially vertical” is not necessarily strictly vertical, although vertical is ideal.

Example 1

[0030] In Example 1, an example of the cutting method of a release film of the present invention will be described.

20 [0031] FIG. 1 is a front elevational view schematically showing the outline of the film cutting apparatus in Example 1. The cutting apparatus 100 shown in FIG. 1 includes a rotating shaft (rotating member) 3, an L-shaped rotating arm 7, and a cutter 9 that pierces a predetermined position of the film to be cut as main components. The cutting apparatus 100 further includes a
25 motor 1, a pulley 2 connected to the motor 1, a pulley 4 connected to the rotating shaft 3, a timing belt 5 for coupling the pulley 2 and the pulley 4, a rotation controlling means (torque limiter) 6, a rotating arm adjusting means 8 for adjusting the rotating arm 7 in the vertical direction, a base 20 on which the film is placed, a fixing means 30 for fixing the film, a cutting apparatus
30 adjusting means 40 for adjusting the cutting apparatus 100 in the vertical

direction, and a vertical direction movement means (not shown).

[0032] The motor 1 is supported by a frame 24. One end of the rotating arm 7 is connected to the torque limiter 6 via the rotating arm adjusting means 8.

That is, a first end of the rotating arm 7 is indirectly connected to the rotating

5 shaft 3 via the rotating arm adjusting means 8 and the torque limiter 6. A

second end of the rotating arm 7 is connected to the cutter 9. When the

motor 1 is activated, the rotational force thereof is transmitted to the rotating

shaft 3 via the pulley 2, the timing belt 5, and the pulley 4, and the rotating

shaft 3 rotates around its rotation axis. The rotation axis of the rotating

10 shaft 3 penetrates through the rotating shaft 3 and is substantially

perpendicular to the surface of the film. The cutter 9 and the rotating arm 7

are rotated in response to the rotation of the rotating shaft 3, and this allows

the film to be cut out into a circle. That is, the rotating shaft 3 corresponds

to the "rotating member". The torque limiter 6 is connected to the rotating

15 shaft 3 in such a manner that a part of the periphery of the rotating shaft 3 is

surrounded by the torque limiter 6. Thereby, for example, in the case where

the cutting apparatus 100 is under a heavy load during cutting the film, the

rotating shaft 3 can be rotated idly and thus the rotating arm 7 and cutter 9

can be prevented from rotating.

20 [0033] The base 20 is divided into a lower base plate 11 that is fixed at the

cutting apparatus 100 side and a resin-sprinkling table 12. As shown in FIG.

1, the resin-sprinkling table 12 is a convex table with a raised center. A

circular film can be placed on the top surface of a raised portion 12A and a

bottom portion 12B is arranged such that one end of the lower base plate 11 is

25 placed thereon. That is, the lower base plate 11 corresponds to the "outer

part member" and the resin-sprinkling table 12 corresponds to the "inner part

member". A ring-shaped (circular) groove 13 is formed between the lower

base plate 11 and the resin-sprinkling table 12. In other words, the base 20

is divided into the resin-sprinkling table 12 and the lower base plate 11 with

30 the groove 13 along the circle as the boundary. The groove 13 is formed

along the rotation locus of the cutter 9. This allows the film to be cut out into a circle in a state where the tip of the cutter 9 is positioned in the inside of the groove 13. The resin-sprinkling table 12 can be moved in the vertical direction by the vertical direction movement means, although it is not shown in FIG. 1.

[0034] A film fixing means 30 includes a clamp 21 and a clamp 22. The clamp 21 is positioned at the inside of the circle that is the rotation locus of the cutter 9, the clamp 22 is positioned at the outside of the circle that is the rotation locus of the cutter 9, and the clamps 21 and 22 are coupled with the frame 24 via four columns 23. The clamps 21 and 22 are placed on the top surface of the film (not shown) to fix the film. FIG. 2 is a plan view showing the clamps 21 and 22 placed on the top surface of the film.

As shown in FIGs. 1 and 2, the clamp 21 is in a disc-shape with a raised center, the clamp 22 is in a ring-shape, and the clamps 21 and 22 are arranged in such a manner that they are not placed on the ring-shaped groove 13. By placing the clamps 21 and 22 on the top surface of the film in this manner, the film can be kept from becoming wrinkled. Furthermore, in Example 1, since the clamp 21 is in a disc-shape with a raised center and the clamp 22 is in a ring-shape, adjacent areas outside the circle can be grabbed and the film can be uniformly stretched from the center toward the outside.

This makes it possible to efficiently keep the film from becoming wrinkled. That is, the clamp 21 corresponds to the “disc-shaped member” and the clamp 22 corresponds to the “substantially ring-shaped member”. As shown in FIG. 1, a second end of the rotating arm 7 is placed on the clamp 21 and the clamp 22. This allows the cutter 9 to smoothly cut out the film into a circle along the periphery of the clamp 21.

[0035] The cutting apparatus adjusting means 40 includes a cylinder 31 and two guides 32 that move in the vertical direction, and is supported by an upper base plate 33 fixed at the cutting apparatus 100 side. This allows two guides 32 to guide the whole cutting apparatus 100 and allows the cylinder

31 to move the cutting apparatus 100 downward.

[0036] The cutting apparatus 100 of Example 1 may further include a grip for drawing a rolled release film.

[0037] There is no particular limitation on the shape of the cutter 9, and examples thereof include a shape of a knife with a linear blade as shown in FIG. 3(A) and a shape of a scalpel with a curved blade as shown in FIG. 3(B). In the case where the cutter 9 is in the shape of the knife, as will be described in the film cutting method that will be described below, first, the tip of the cutter 9 pierces a release film 201, and then the release film 201 is cut out into a circle with the middle part of the cutter 9.

[0038] In the film cutting method of Example 1, a rolled long release film is cut out into a circle using the cutting apparatus 100 shown in FIG. 1. FIG. 4 shows plan views illustrating the process of the film cutting method of Example 1. The cutting apparatus shown in FIG. 4 is the same as the cutting apparatus 100 shown in FIG. 1. In FIG. 4, for the sake of simplification, the components except for the rotating shaft 3, the torque limiter 6, the rotating arm 7, the rotating arm adjusting means 8, the cutter 9, the clamp 21, and the clamp 22 are not shown. The rolled release film 201 is drawn by the grip and placed on the lower base plate 11 and the resin-sprinkling table 12, although it is not shown in FIG. 4.

[0039] As shown in FIG. 4(A), the disc-shaped clamp 21 and the substantially ring-shaped clamp 22 fix the release film 201 (film fixing step). The clamp 21 is positioned at the inside of the circle that is the rotation locus of the cutter 9 and the clamp 22 is positioned at the outside of the circle that is the rotation locus of the cutter 9. As shown in FIG. 4(A), the point O, which is the center of the circle, is on the rotation axis L of the rotating shaft 3 and the cutter 9 is arranged at the position above the point P of the surface of the release film 201 to be pierced by the cutter 9. The direction of the cutter 9 is substantially perpendicular to the horizontal release film 201.

[0040] Next, the whole cutting apparatus 100 is guided by two guides 32 and

5 moved downward by the cylinder 31. Thereby, as shown in FIG. 4(B), the rolled long release film 201 placed on the lower base plate 11 and the resin-sprinkling table 12 is pressed and fixed by the clamps 21 and 22 of the cutting apparatus 100. As shown in FIG. 4(B), the rotating arm adjusting means 8 moves the rotating arm 7 and the cutter 9 downward, and the cutter 9 pierces the release film 201 at the point P (piercing step). At this time, the tip of the cutter 9 that is in the shape of the knife is positioned in the inside of the groove 13, although it is not shown. As shown in FIG. 4(B), the second end of the rotating arm 7 is placed on the clamp 21 and the clamp 22. Next, 10 the motor 1 is activated. Thereby, the rotational force of the motor is transmitted to the rotating shaft 3 via the pulley 2, the timing belt 5, and the pulley 4 to rotate the rotating shaft 3. The rotating shaft 3 rotates around the rotation axis that is substantially perpendicular to the surface of the release film.

15 [0041] Then, as shown in FIG. 4(C), the rotating arm 7 and the cutter 9 are rotated one turn in the direction of the arrow with the longitudinal direction of the rotating arm 7 as the radius direction, and the release film 201 is cut out into a circle with the middle part of the cutter 9 (cutting out step). Here, since the second end of the rotating arm 7 is placed on the clamp 21 and the clamp 22, the cutter 9 can be rotated smoothly along the periphery of the 20 clamp 21.

[0042] Then, as shown in FIG. 4(D), a large circular release film 202 can be obtained from the placed release film 201. Thereafter, the circular release film 202 is taken out downward from the base 20 by the vertical direction 25 movement means in the state where the circular release film 202 is placed on the resin-sprinkling table 12.

[0043] Although the fixing means 30 includes the substantially disc-shaped clamp 21 and the substantially ring-shaped clamp 22 in Example 1, the present invention is not limited thereto. For example, the clamp 21 may 30 also take a substantial ring-shape. This allows the ring opening of the

clamp 21 to serve as a resin supply portion.

[0044] The cutting apparatus 100 of Example 1 may further include a waste material disposal means. The waste material disposal means is a means for disposing a release film remaining after cutting and separating the circular release film (waste material).

[0045] The cutting apparatus 100 of Example 1 may further include a release film movement means. The release film movement means is a means for moving the resin-sprinkling table 12, on which the circular release film is placed, to the resin-sprinkling means side. This allows, for example, the circular release film to be moved easily to the resin-sprinkling means in the case where the cutting apparatus 100 and the resin-sprinkling means are arranged in parallel.

[0046] In the cutting apparatus 100 of Example 1, the lower base plate (the outer part member) 11 is fixed at the cutting apparatus 100 side. However, the present invention is not limited thereto. In the cutting apparatus 100 of the present invention, at least one of the inner part member and the outer part member can be moved in the vertical direction by the vertical direction movement means.

[0047] Although the release film cutting method is described in Example 1, the film cutting method of the present invention is not limited to a release film.

[0048] According to the present invention, as described above, it is possible to efficiently produce a large circular release film. Thereby, for example, one or more resin-encapsulated electronic components mounted on a large circular substrate can be produced. That is, for example, the present invention can be applied to the production of a plurality of resin-encapsulated electronic components from a resin-encapsulated substrate (molded substrate) having a large circular substrate.

Example 2

[0049] Next, another Example of the present invention will be described. In

Example 2, examples of the resin-molding apparatus for one or more electronic components and production apparatus for a resin-molded article of the present invention, and the resin-molding method (resin-encapsulation method for one or more electronic components) and production method for a resin-molded article using the aforementioned apparatuses will be described.

[0050] In the plan view of FIG. 5, the configuration of the production apparatus for a resin-molded article 500 of Example 2 is schematically shown. Hereinafter, the production apparatus 500 will be described with reference to one or more resin-encapsulated electronic components as a resin-molded article. As shown in FIG. 5, in the apparatus 500, a resin-molding apparatus (510, 520, and 530) and a transfer means (unit) 540 are arranged in this order from the right side. The resin-molding apparatus includes a release film cutting means (unit) 510 that includes the film cutting apparatus 100, a resin-sprinkling means (unit) 520, and a resin-encapsulation means (unit) 530. These units are separately arranged as independent units, and they are detachable to the adjacent units. Note here that the resin-encapsulation means 530 corresponds to a “resin-molding means (unit)”.

[0051] (Film cutting apparatus)

The cutting apparatus 100 is the same as the film cutting apparatus shown in Example 1. The circular release film 202 is cut out and separated from the long release film 201 in the same manner as the film cutting method described in Example 1. In FIG. 5, the tip of the release film drawn from the rolled release film 201 is fixed by a film gripper 513. The release film can be drawn from the rolled release film 201 by the film gripper 513.

[0052] (Resin-sprinkling means)

As shown in FIG. 5, the resin-sprinkling means 520 includes a resin-sprinkling apparatus 310 shown in FIG. 6 as a main component. The resin-sprinkling means 520 further includes a resin loader 521, an aftertreatment means 522, and a release film movement means (not shown).

The resin loader 521, the aftertreatment means 522, and the release film movement means are optional components and are dispensable. The resin loader 521 and the aftertreatment means 522 are formed integrally. In the state where the resin is supplied on the release film 202 (resin containing
5 portion), the circular frame 512 and the release film 202 can be attached by engaging using the resin loader 521. The release film 202 may be attracted by the undersurface of the circular frame 512. Then, in that state, resin can be set in the lower die cavity for compression molding that will be described below in the resin-encapsulation means in the state where the release film
10 202 is covered with the resin. On the release film movement means, the resin-sprinkling table and the release film are placed. By moving or rotating the release film movement means in the horizontal direction, it is possible to move or rotate the resin-sprinkling table placed on the release film movement means together with the release film. Thereby, the resin-sprinkling table
15 and the release film can be moved between the release film cutting apparatus and the resin-sprinkling means.

[0053] (Resin-sprinkling apparatus)

As shown in FIG. 6, the resin-sprinkling apparatus 310 places a circular frame (frame) 512 on the formed circular release film 202 and
20 sprinkles resin 60 in the circular frame 512. As shown in FIG. 6, the resin-sprinkling apparatus 310 includes a hopper 514, which is a resin supply means, and a linear feeder 515. The hopper 514 and the linear feeder 515 can be, for example, the same as those described in JP 2010-36542A.

[0054] (Resin-encapsulation means)

25 As shown in FIG. 5, the resin-encapsulation means 530 includes a die (molding die) 531. The die 531 includes an upper die and a lower die (not shown) as main components, and a lower die cavity 532 is circular as shown in FIG. 5. The die 531 is further provided with an upper die substrate set portion (not shown) and a cavity bottom surface member for resin
30 pressurization (not shown). In the resin-encapsulation means 530, by

performing resin-encapsulation of one or more electronic components (for example, semiconductor chip) mounted on the not-yet-resin-encapsulated substrate (not-yet-molded substrate) that will be described below in encapsulation resin (resin package) in the lower die cavity, a
5 resin-encapsulated substrate (molded substrate) can be formed.

[0055] (Transfer means)

The transfer means 540 allows transfer of one or more electronic components (component to be resin-encapsulated) before resin-encapsulation together with a substrate and transfer of one or more resin-encapsulated
10 electronic components (resin-encapsulated molded article) after resin-encapsulation. As shown in FIG. 5, the transfer means 540 includes a substrate loader 541, rails 542, and a robot arm 543. The rails 542 stick out from the transfer means 540 and reach the areas of the resin-encapsulation means 530 and the resin-sprinkling means 520. On the substrate loader 541,
15 a substrate 544 can be placed. The substrate 544 may be a not-yet-resin-encapsulated substrate (not-yet-molded substrate) 544a or a resin-encapsulated substrate (molded substrate) 544b. The substrate loader 541 and the resin loader 521 (aftertreatment means 522) can be moved on the rails 542 among the resin-sprinkling means 520, the resin-encapsulation
20 means 530, and the transfer means 540. As shown in FIG. 5, the transfer unit 540 further includes substrate containing portions and is capable of containing the not-yet-resin-encapsulated substrate (not-yet-molded substrate) 544a and the resin-encapsulated substrate (molded substrate) 544b respectively. On the not-yet-molded substrate 544a, one or more
25 electronic components (not shown, for example, semiconductor chip) are mounted. On the molded substrate 544b, one or more resin-encapsulated electronic components (resin-encapsulated molded article) is formed by encapsulating the electronic component(s) with resin (encapsulation resin) 516b. The robot arm 543 can be used, for example, as follows. That is, first,
30 by flipping the not-yet-molded substrate 544a taken out from the containing

portion for the not-yet-molded substrate 544a over, the not-yet-molded substrate 544a can be placed on the substrate loader 541 with the electronic component(s) mounted side down. Second, by taking out the molded substrate 544b from the substrate loader 541 and flipping the molded substrate 544b over, the molded substrate 544b can be contained in the containing portion for the molded substrate with the encapsulation resin 516b side up.

[0056] The production method for a resin-encapsulated electronic component(s) (resin-molded article) using the production apparatus for a resin-molded article shown in FIG. 5 can be performed, for example, as follows.

[0057] (Cutting step)

First, in the cutting apparatus 100, the tip of the release film is drawn from the rolled release film 201 by the film gripper 513 and the release film is cut in the same manner as the cutting method described in Example 1 to obtain the circular release film 202. A release film remaining after cutting and separating the circular release film 202 (waste material) is disposed by a waste material disposal means (not shown).

[0058] (Resin-sprinkling step)

Next, the release film movement means is moved to the position below the resin supply port of the linear feeder 515 in the resin-sprinkling means 520 together with the resin-sprinkling table (not shown) and the release film placed on the release film movement means. Then, the circular frame 512 is placed on the release film 202 and the release film 202 is attracted and fixed at the undersurface of the circular frame 512. In this state, on the release film 202 in the circular frame 512, resin (for example, resin granules) is sprinkled. The sprinkling of the resin may be performed according to a common method, and may be performed, for example, according to JP 2010-36542A. That is, as shown in FIG. 6, first, the lower opening of the through-hole in the circular frame 512 for resin containment is

closed by the release film 202 to form a resin containing portion 220. Then, in the resin-encapsulation apparatus 310, by vibrating granular resins 60 from the hopper 514 using a linear vibration feeder 515 to move, a needed amount of the granular resins 60 can be supplied to the resin containing
5 portion.

[0059] (Transfer step)

Next, the release film 202 (and resin sprinkled on circular frame 512) is moved from the release film movement means and is held by the resin loader 521 together with the circular frame 512. The movement of the
10 release film 202 from the release film movement means to the resin loader 521 can be performed by holding the circular frame 512 including the release film 202 (resin) by a holding means (not shown) of the resin loader 521.

[0060] Next, as described above, the not-yet-molded substrate 544a taken out from the containing portion for the not-yet-molded substrate 544a is

15 flipped over by the robot arm 543. Then, the not-yet-molded substrate 544a is placed on the substrate loader 541 with the electronic component(s) mounted side down and is transferred into the resin-encapsulation means 530. At this time, the not-yet-molded substrate 544a is set at the die surface of the upper die (die 531). Next, the resin loader 521 that holds the circular
20 frame 512 (including release film 202 and resin) is moved on the rails 542 together with the aftertreatment means 522 that is integrally formed with the resin loader 521 and is transferred into the resin-encapsulation means 530. At this time, by placing the circular frame 512 (including resin) on which the release film 202 is fixed on the die surface of the lower die, the
25 lower die cavity 532 having a circular opening is covered with the release film 202, and the resin can be supplied into the lower die cavity 532. Thereafter, the resin loader 521 in the state of holding the circular frame 512 is moved to the resin-sprinkling means 520 side. Then, the circular frame 512 is placed on the release film 202 placed on the resin-sprinkling table in the
30 resin-sprinkling means 520, and resin is again sprinkled on the release film

202 in the circular frame 512.

[0061] Next, the resin is melted, and further, in the resin-encapsulation unit 530, the die 531 (upper die and lower die) is clamped. Thereby, one or more electronic components mounted on the not-yet-molded substrate 544a set at the upper die are in the state of being soaked in resin in the lower die cavity 532, and the resin in the lower die cavity 532 can be pressurized by the cavity bottom surface member. Then, by solidifying the resin in the die 531 (lower die cavity 532), the electronic component(s) is encapsulated (resin-molded) with solidified resin 516b. Thereby, the resin-encapsulated substrate 544b (molded substrate, resin-encapsulated electronic component(s)) is formed. Next, by unclamping the die 531 (upper die and lower die), the resin-encapsulated substrate 544b is taken out by the substrate loader 541 and is transferred to and contained at the transfer means 540 side. Furthermore, after taking out the resin-encapsulated substrate (molded substrate, resin-encapsulated electronic component(s)) 544b from the die 531 by the substrate loader 541, the substrate set portion of the upper die is cleaned using an upper die surface cleaner (not shown) of the aftertreatment means 522. In parallel with this or by shifting the timing, the release film that is no longer required can be taken out from the lower die surface using a release film removal means (not shown) of the aftertreatment means 522.

[0062] Alternatively, the substrate loader 541 on which the resin-encapsulated substrate 544b (resin-encapsulated electronic component(s)) is placed may be moved from the resin-encapsulation means 530 to the transfer means 540. In this case, as described above, the resin-encapsulated substrate (molded substrate, resin-encapsulated electronic component(s)) 544b is taken out from the substrate loader 541 and is flipped over by the robot arm 543. Thereby, the resin-encapsulated substrate (molded substrate, resin-encapsulated electronic component(s)) 544b is contained in the containing portion for the resin-encapsulated substrate (molded substrate, resin-encapsulated electronic component(s))

with the encapsulation resin 516b side up. In this manner, the resin-encapsulated electronic component(s) (resin-encapsulated molded article) can be produced.

[0063] Here, in the production apparatus for a resin-molded article of the present invention, further, a controller may control each of the components. That is, the production apparatus for a resin-molded article of the present invention may work as a hand-operated machine or may work as a fully automatic machine by controlling each of the components by the controller.

[0064] Furthermore, there is no particular limitation on the arrangement of the units of the production apparatus for a resin-molded article of the present invention. However, as shown in FIG. 5, the transfer unit that supplies a substrate and the resin-sprinkling unit that sprinkles resin on a release film are preferably arranged facing each other with the resin-encapsulation unit being interposed therebetween. Such an arrangement can, for example,

restrict fine powders of resin granules from being in contact with a substrate. Particularly, adhesion of fine powders of resin granules to a not-yet-molded (not-yet-resin-encapsulated) substrate, for example, may cause molding defects. Moreover, adhesion of fine powders of resin granules to a molded (resin-encapsulated) substrate, for example, may give a deleterious effect on the following steps.

[0065] In the production apparatus for a resin-molded article shown FIG. 5, as described above, the transfer unit 540 that supplies a substrate and the resin-sprinkling unit 520 that sprinkles resin on a release film are arranged facing each other with the resin-encapsulation unit 530 being interposed therebetween. Furthermore, the release film cutting unit 510 (cutting apparatus 100) that makes a circular release film is arranged at the outside of the resin-sprinkling unit 520. This production apparatus for a resin-molded article is a separated-type production apparatus for a resin-molded article in which the units are arranged separately. As

described above, there is no particular limitation on the arrangement of the

units of the production apparatus for a resin-molded article of the present invention, and the arrangement may be different from that shown in FIG. 5. For example, a configuration in which a needed amount of resin-encapsulation units are detachably arranged can be employed.

5 Furthermore, the cutting unit, the resin-sprinkling unit, and the transfer unit may be arranged at the one side of the resin-encapsulation unit. In this case, the cutting unit, the resin-sprinkling unit, and the transfer unit serve as a master unit, and the resin-encapsulation unit serves as a slave unit (master-slave type). In this case, a needed number of resin-encapsulation
10 units can be arranged in order. Furthermore, the cutting unit, the resin-sprinkling unit, and the transfer unit may be integrated. Moreover, the cutting unit, the resin-sprinkling unit, and the transfer unit may be integrated as one resin-encapsulation unit, and the whole of the integrated components may work singly as a production apparatus for a resin-molded
15 article (for example, compression molding apparatus).

[0066] In the case where plural resin-encapsulation units are arranged between the transfer unit and the resin-sprinkling unit and in the case where plural resin-encapsulation units are arranged in order with respect to the master unit, the following arrangement is preferable. That is, each of the
20 resin-encapsulation units is arranged along the extending direction of the rails that are used at the time when the components including the substrate loader, the resin loader, and the aftertreatment means are moved. Further, the units of the production apparatus for a resin-molded article of the present invention are detachable with one another using, for example, coupling
25 means such as a bolt, a nut, and the like or an appropriate positioning means. Moreover, the production apparatus for a resin-molded article of the present invention may have a configuration in which a resin-encapsulation unit is detachable to another resin-encapsulation unit. This makes it possible to increase or decrease the number of the resin-encapsulation units later on.

30 [0067] In FIG. 5, the production apparatus for one or more

resin-encapsulated electronic components of the present invention and the production method for the resin-encapsulated electronic component(s) using the same were described. However, the uses of the resin-sprinkling method, the resin-molding method, the resin-sprinkling apparatus, the resin-molding apparatus, and the production apparatus for a resin-molded article of the present invention are not limited to the resin-encapsulated electronic component(s), and they can be applied to any other resin-molded articles. For example, the present invention can be applied to the production of resin products of optical components such as lenses, optical modules, and light guide plates, and the like by compression molding.

[0068] The present invention is not limited to the aforementioned Examples; and arbitrary and appropriate combinations, changes, or selective adoption thereof can be made as necessary without departing from the spirit and scope of the present invention. For example, in the cutting apparatus 100 shown in FIG. 1, the components except for the rotating member 3, the rotating arm 7, and the cutter 9 can be replaced, omitted, or added appropriately.

[0069] The invention may be embodied in other forms without departing from the spirit or essential characteristics thereof. The embodiments disclosed in this application are to be considered in all respects as illustrative and not limiting. The scope of the invention is indicated by the appended claims rather than by the foregoing description, and all changes which come within the meaning and range of equivalency of the claims are intended to be embraced therein.

Explanation of Reference Numerals

[0070]

- | | |
|------|----------------|
| 1 | motor |
| 2, 4 | pulley |
| 3 | rotating shaft |
| 4 | pulley |

	5	timing belt
	6	torque limiter
	7	rotating arm
	8	rotating arm adjusting means
5	9	cutter
	10	rotating means
	11	lower base plate
	12	resin-sprinkling table
	13	groove
10	21, 22	clamp
	23	column
	24	frame
	31	cylinder
	32	guide
15	33	upper base plate
	40	cutting apparatus adjusting means
	100	cutting apparatus
	202	release film

CLAIMS

1. A film cutting apparatus, comprising:
 - a rotating member;
 - 5 a rotating arm; and
 - a cutter, wherein

the rotating member is directly or indirectly connected to a first end of the rotating arm and the cutter is directly or indirectly connected to a second end of the rotating arm,

10 a rotation axis of the rotating member penetrates through the rotating member and is substantially perpendicular to a surface of the film to be cut, the cutter pierces a predetermined position of the film by moving the cutter toward the surface of the film, and

the film is cut out into a circle by rotation of the rotating arm and the cutter

15 that pierces the film in response to rotation of the rotating member around the rotation axis.
2. The apparatus according to claim 1, further comprising:
 - a base on which the film is placed, wherein

20 the base includes a groove along a circle that is a rotation locus of the cutter at its upper part, and

the film is cut out into a circle in a state where a tip of the cutter is positioned in an inside of the groove.
- 25 3. The apparatus according to claim 2, wherein
- the base is divided into an inner part member and an outer part member with the groove along the circle as a boundary.
4. The apparatus according to claim 3, wherein
- 30 the inner part member is a resin-sprinkling table.

5. The apparatus according to claim 3 or 4, further comprising:
a vertical direction movement unit, wherein
the vertical direction movement unit moves at least one of the inner part
5 member and the outer part member in a vertical direction.
6. The apparatus according to any one of claims 1 to 5, further
comprising:
a film fixing unit that is placed on a top surface of the film to fix the
10 film, wherein
the film fixing unit comprises an inner part fixing member and an outer part
fixing member,
the inner part fixing member is positioned at an inside of the circle that is the
rotation locus of the cutter, and
15 the outer part fixing member is positioned at an outside of the circle that is
the rotation locus of the cutter.
7. The apparatus according to claim 6, wherein
the inner part fixing member is a substantially disc-shaped member, and
20 the outer part fixing member is a substantially ring-shaped member that
surrounds the circle that is the rotation locus of the cutter.
8. The apparatus according to claim 6, wherein
the inner part fixing member and the outer part fixing member are both
25 substantially ring-shaped members,
the circle that is the rotation locus of the cutter is surrounded by the outer
part fixing member, and
a ring opening of the inner part fixing member serves as a resin supply
portion.

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9. The apparatus according to any one of claims 1 to 8, further comprising:

a rotation controlling unit, wherein
the rotation controlling unit is connected to the rotating member in such a
5 manner that a part of a periphery of the rotating member is surrounded by
the rotation controlling unit.

10. The apparatus according to claim 9, wherein
the rotation controlling unit is a torque limiter.

10

11. The apparatus according to any one of claims 1 to 10, wherein
the rotating member is a rotating shaft.

12. A release film cutting method, comprising:

15 a piercing step of piercing a predetermined position of a long release
film with a cutter; and

a cutting out step of cutting out the release film into a circle by
rotating the cutter that pierces the release film in a circumferential direction.

20 13. A film cutting method using the film cutting apparatus according to
any one of claims 1 to 11, comprising:

a piercing step of piercing a predetermined position of the film with
the cutter by moving the cutter toward the surface of the film; and

25 a cutting out step of cutting out the film into a circle by rotation of the
rotating arm and the cutter that pierces the film in response to rotation of the
rotating member around the rotation axis that penetrates through the
rotating member and is substantially perpendicular to the surface of the film.

14. The method according to claim 13, wherein

30 the film cutting apparatus is the film cutting apparatus according to claim 2

or 3, and

in the cutting out step, the film is cut out into a circle in a state where the tip of the cutter is positioned in the inside of the groove.

- 5 15. The method according to claim 13 or 14, wherein
the film cutting apparatus is the film cutting apparatus according to any one
of claims 6 to 8,
the method further comprises:

10 a film fixing step of fixing the film by placing the film fixing unit on
the top surface of the film,
in the film fixing step, the inner part fixing member is placed at the inside of
the circle that is the rotation locus of the cutter and the outer part fixing
member is placed at the outside of the circle that is the rotation locus of the
cutter,
15 in the piercing step, the predetermined position to be pierced with the cutter
is positioned between the inner part fixing member and the outer part fixing
member, and
in the cutting out step, the film is cut out into a circle along a periphery of the
inner part fixing member.

20

16. A resin-molding apparatus, comprising:
the film cutting apparatus according to any one of claims 1 to 11,
a resin-sprinkling unit sprinkling resin on a circular release film
formed by the cutting apparatus, and
25 a resin-molding unit molding the sprinkled resin.

17. The apparatus according to claim 16, wherein
in the resin-molding, at least one electronic component is resin-encapsulated.

- 30 18. A resin-molding method, comprising:

a cutting step of forming a circular release film by the film cutting method according to any one of claims 12 to 15;

a resin-sprinkling step of sprinkling resin on the formed circular release film; and

5 a resin-molding step of molding the sprinkled resin on the circular release film.

19. The method according to claim 18, wherein
in the resin-molding step, at least one electronic component is
10 resin-encapsulated.

20. The method according to claim 18 or 19, wherein
in the resin-sprinkling step, a circular frame is placed on the release film and
resin is sprinkled on an inside of the circular frame.

15 21. A production apparatus for a resin-molded article, comprising:
the resin-molding apparatus according to claim 16 or 17; and
a transfer unit, wherein
the transfer unit transfers at least the resin-molded article after
20 resin-molding.

22. The apparatus according to claim 21, wherein
the film cutting apparatus, the resin-sprinkling unit, the resin-molding unit,
and the transfer unit are separately arranged as independent units, and
25 at least one of the units is detachable to at least another one of the units.