

DESCRIPTION

Title of Invention

RESIN MOLDING APPARATUS AND METHOD FOR PRODUCING RESIN
5 MOLDED PRODUCT

Technical Field

[0001]

This disclosure relates to a resin molding apparatus and a method for producing
10 a resin molded product.

Background Art

[0002]

Substrates with chips mounted thereon are typically sealed up in resin for use as
15 electronic parts. A known resin molding apparatus for sealing up substrates in resin includes a film supply mechanism configured to supply a release film to a space between an upper die and a lower die (see, for example, Patent Literature 1).

[0003]

The film supply mechanism disclosed in Patent Literature 1, on the basis of the
20 amount of a release film having been supplied which amount is determined from (i) the diameter of a major roll near an unwinding shaft and (ii) the number of revolutions of the major roll, controls torque of the unwinding shaft applied in the direction opposite to the direction of conveyance of the release film to apply tension to the release film.

25 Citation List

Patent Literature

[0004]

Patent Literature 1

JP 2018-051841 A

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Summary

Technical Problem

[0005]

The film supply mechanism disclosed in Patent Literature 1 controls torque of
35 the unwinding shaft applied in the direction opposite to the direction of conveyance of the release film to apply tension to the release film. This has caused the release film to

receive excessive tension and have a disadvantageously narrowed width.

[0006]

The above circumstances have led to a demand for a resin molding apparatus and a method for producing a resin molded product each of which allows a release film to be conveyed while maintaining its shape.

Solution to Problem

[0007]

A resin molding apparatus according to this disclosure characteristically includes: a mold die including: an upper die; and a lower die; a mold clamp mechanism configured to clamp the mold die, a film supply mechanism configured to supply a release film to a space between the upper die and the lower die and including: an unwinding mechanism including an unwinding roller configured to unwind the release film; and a film conveyor mechanism configured to convey the release film; and a control section configured to control operation of the film supply mechanism, the control section being configured to, when the film conveyor mechanism conveys the release film, cause the unwinding roller to rotate in a direction in which the film conveyor mechanism conveys the release film.

[0008]

A method for producing a resin-molded product with use of the above resin-molding device characteristically includes: the film supply mechanism supplying the release film to a space between the upper die and the lower die; the mold clamp mechanism clamping the mold die; and supplying a molding target substrate and a resin material to the mold die and molding the molding target substrate with resin, wherein during the supplying of the release film, the film supply mechanism, when the film conveyor mechanism conveys the release film, causes the unwinding roller to rotate in a direction in which the film conveyor mechanism conveys the release film.

Advantageous Effects

[0009]

This disclosure provides a resin molding apparatus and a method for producing a resin molded product each of which allows a release film to be conveyed while maintaining its shape.

Brief Description of Drawings

[0010]

FIG. 1 is a diagram schematically illustrating a resin molding unit.

FIG. 2 is a diagram schematically illustrating a resin molding apparatus.

FIG. 3 is a diagram schematically illustrating a moving mechanism of a film supply mechanism.

FIG. 4 provides diagrams schematically illustrating a method for producing a resin molded product.

FIG. 5 is a flowchart of how to control a film conveyor mechanism.

FIG. 6 is a diagram schematically illustrating a resin molding apparatus as an alternative embodiment.

10 Description of Embodiments

[0011]

The description below deals with a resin molding apparatus and a method for producing a resin molded product 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.

[0012]

Substrates with semiconductor chips mounted thereon (objects to be molded) are sealed up in resin for use as electronic parts. Objects to be molded are sealed up in resin by, for example, a compression method (compression molding) or transfer method. An example of the compression method includes supplying liquid resin (resin material) onto a release film, causing the release film to be adsorbed on a lower die of a mold die, and immersing an object to be molded into the liquid resin on the release film for resin molding. The transfer method includes, for instance, placing an object to be molded onto a release film adsorbed on the lower die of a mold die, supplying resin tablets (resin material) prepared by compressing powder resin into pots in the mold die, heating the resin tablets to melt the resin tablets, and supplying the molten resin into cavities for resin molding of the object.

[0013]

The liquid resin is not necessarily resin that is liquid at normal temperature (room temperature), but may also be molten resin resulting from heating and melting solid resin into liquid form. The resin that is liquid at normal temperature may be a thermoplastic resin or a thermosetting resin. A thermosetting resin is liquid at normal temperature and has a viscosity that decreases when heated. Continuing to heat a thermosetting resin polymerizes and cures the thermosetting resin into a cured resin. As described later, a thermosetting resin is desirable in resin molding and sealing up molding target substrates on which semiconductor chips are mounted.

[0014]

The powder resin may be not only resin in powder form, but also resin tablets made of solid resin prepared by compressing resin powder. Heating either form of resin results in liquid, molten resin. The powder 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. As described later, a thermosetting resin is desirable in resin molding and sealing up molding target substrates on which semiconductor chips are mounted.

[0015]

[Overall Configuration]

The description below deals as an example with a resin molding apparatus based on a transfer method. FIG. 1 is a diagram schematically illustrating a resin molding unit D including resin molding apparatuses 30 as the present embodiment. The resin molding unit D includes two molding modules 3, a supply module 4, a control section 6, and a conveyor mechanism. The molding modules 3 each include a resin molding apparatus 30 configured to seal up an object to be molded in resin. The control section 6 includes programs as software for controlling how at least the resin molding apparatuses 30 are operated. The programs are stored on hardware such as a hard disc drive (HDD) or a memory, and are executed by a processor including an application-specific integrated circuit (ASIC), a field-programmable gate array (FPGA), a central processing unit (CPU), or other hardware for a computer.

[0016]

The resin molding apparatuses 30 as the present embodiment are each configured for resin molding of molding target substrates Sa on which semiconductor chips are mounted. The resin molding apparatuses 30 are included in the respective molding modules 3. The molding modules 3 may each be regarded as a resin molding apparatus. The resin molding unit D may be regarded as a resin molding apparatus. The resin molding apparatuses 30 is not limited to a particular configuration.

[0017]

The molding modules 3 are each configured to seal up molding target substrates Sa (object to be molded) in resin with use of its resin molding apparatus 30 to produce molded substrates Sb (resin molded product). The resin molding unit D includes a plurality of (two for the present embodiment) molding modules 3 that are independently attachable and detachable. The resin molding apparatuses 30 will be detailed later.

[0018]

The supply module 4 is configured to supply molding target substrates Sa and

resin tablets T to the molding modules 3 and receive molded substrates Sb from the molding modules 3 for storage. The supply module 4 includes a substrate supply mechanism 43, a substrate alignment mechanism 44, a resin supply mechanism 45, and a substrate container section 46. The conveyor mechanism includes a loader 41 and an unloader 42 both on standby in the supply module 4. The substrate supply mechanism 43 supplies molding target substrates Sa that it stores to the substrate alignment mechanism 44. Each molding target substrate Sa is provided with either a single semiconductor chip mounted thereon or two or more semiconductor chips mounted thereon and aligned lengthwise and/or widthwise. The substrate alignment mechanism 44 aligns the molding target substrates Sa, which it has received from the substrate supply mechanism 43, in a manner suitable for conveyance. The resin supply mechanism 45 stores resin tablets T in a pattern suitable for conveyance.

[0019]

The conveyor mechanism includes a loader 41 and an unloader 42. The loader 41 conveys, for example, molding target substrates Sa and resin tablets T. The molding target substrates Sa are substrates that are provided with semiconductor chips mounted thereon and that have not been sealed up in resin. The unloader 42 conveys molded substrates Sb, that is, substrates that have been sealed up in resin. The loader 41 is capable of (i) receiving molding target substrates Sa from the substrate alignment mechanism 44, (ii) receiving resin tablets T from the resin supply mechanism 45, (iii) moving on a rail from the supply module 4 to either of the molding modules 3, and (iv) supplying the molding target substrates Sa and the resin tablets T to the molding module 3. The unloader 42 is capable of (i) taking molded substrates Sb from each molding module 3, (ii) moving on a rail from the molding module 3 to the substrate container section 46, and (iii) storing the molded substrates Sb onto the substrate container section 46. Each molded substrate Sb is provided with a semiconductor chip(s) sealed up in cured resin resulting from hardening of molten resin.

[0020]

[Resin Molding Apparatuses in Detail]

FIG. 2 illustrates a resin molding apparatus 30 as the present embodiment. The resin molding apparatus 30 includes a fixing frame 3A, a mold die C, a movable platen 34, a mold clamp mechanism 35, and a film supply mechanism 1. The fixing frame 3A is placed on a horizontal surface and immovably fixed thereto by gravitation. The mold die C and the movable platen 34 are supported by the fixing frame 3A. The mold clamp mechanism 35 is configured to move the movable platen 34 to clamp the mold die C. The film supply mechanism 1 is configured to supply a release film F. The expression

"supported by the fixing frame 3A" as used herein refers to the state of being held directly or indirectly by the fixing frame 3A in such a manner as to be movable relative to the fixing frame 3A.

[0021]

5 The fixing frame 3A includes a frame body and a cover 32 covering the frame body. The frame body includes a lower fixed plate 31 and an upper fixed plate 33 that are each rectangular in a plan view and that are coupled to each other with use of a plurality of tie bars (not illustrated in the drawings) or plate-shaped members (not illustrated in the drawings). The movable platen 34 is rectangular in a plan view, and is between the lower
10 fixed plate 31 and the upper fixed plate 33. The mold die C includes an upper die UM and a lower die LM that are made of, for example, metal and that face each other. The upper die UM and the lower die LM each contain a heater (not illustrated in the drawings) configured to heat substrates and resin tablets supplied to the mold die C. The lower die LM includes an adsorption mechanism (not illustrated in the drawings) configured to
15 cause a release film F to be adsorbed on the molding surface with use of a vacuum pump or the like.

[0022]

 The movable platen 34 is movable upward and downward along the tie bars or plate-shaped members for the fixing frame 3A. The movable platen 34 is configured to
20 move the lower die LM upward and downward relative to the upper die UM. The mold clamp mechanism 35 is disposed on the lower fixed plate 31 and configured to move the movable platen 34 upward and downward. The mold clamp mechanism 35 is in the form of, for example, a combination of a servomotor and a ball screw or a combination of a hydraulic cylinder and a link mechanism. The mold clamp mechanism 35 is capable of
25 moving the movable platen 34 upward to clamp the mold die C and downward to open the mold die C.

[0023]

 The film supply mechanism 1 is configured to supply a release film F to a space between the upper die UM and the lower die LM. The release film F is made of a resin
30 material with properties such as heat resistance, releasing property, flexibility, and extensibility. Examples of the resin material include polytetrafluoroethylene (PTFE), ethylene tetrafluoroethylene (ETFE), polyethylene terephthalate (PET), tetrafluoroethylene hexafluoropropylene copolymer (FEP), polypropylene, polystyrene, and polyvinylidene chloride.

35 [0024]

 The film supply mechanism 1 includes an unwinding mechanism 11, a film

conveyor mechanism 7, a recovery mechanism 12, and a pair of moving mechanisms 13 and 13. The unwinding mechanism 11 is configured to unwind a release film F. The film conveyor mechanism 7 is configured to convey the release film F along a conveying path. The recovery mechanism 12 is configured to recover the release film F. One of the moving mechanisms 13 and 13 is disposed on the conveying path and toward the unwinding mechanism 11 (that is, between the mold die C and the unwinding mechanism 11), whereas the other moving mechanism 13 is disposed on the conveying path and toward the recovery mechanism 12 (that is, between the mold die C and nip rollers 16). The film conveyor mechanism 7 for the present embodiment, which is configured to convey a release film F, includes nip rollers 16. As detailed later, the control section 6 controls the rotation speed Na of the unwinding mechanism 11 and the rotation speed Nc of the nip rollers 16 for the release film F to be conveyed under a moderate tension.

[0025]

The unwinding mechanism 11 is fixed to the fixing frame 3A and capable of supplying an unused release film F to a space between the upper die UM and the lower die LM. The unwinding mechanism 11 for the present embodiment includes an unwinding roller 11a, a first motor M1, and a case 11b. The unwinding roller 11a is configured to supply an unused release film F from around a reel. The first motor M1 (which is an example of the "motor") is configured to rotate the unwinding roller 11a. The case 11b contains the unwinding roller 11a and is capable of being opened and closed. The first motor M1 is provided with a first sensor S1 (which is an example of the "sensor") configured to detect the amount of rotation (that is, rotational position) of the motor shaft (not illustrated in the drawings). The unwinding mechanism 11, which includes the case 11b, is outside the fixing frame 3A and is fixed to a side of the fixing frame 3A. The expression "fixed to the fixing frame 3A" as used herein refers to the state of being held directly or indirectly by the fixing frame 3A in such a manner as to be immovable relative to the fixing frame 3A. The first motor M1 is in the form of, for example, a servomotor configured to control the rotational position, the rotation speed, and the like. The first sensor S1 is in the form of an encoder (that is, a rotation detector) configured to detect the amount of rotation of, for example, a servomotor on the basis of the pulse number. The term "amount of rotation" as used herein refers to the degree by which a motor shaft has rotated, with 360 degrees as a single rotation.

[0026]

The recovery mechanism 12 is fixed to the fixing frame 3A and capable of recovering a release film F having been used for resin molding. The recovery mechanism 12 for the present embodiment includes a recovery roller 12a, a motor (not illustrated in

the drawings), and a case 12b. The recovery roller 12a is configured to wind a used release film F around a reel for recovery. The motor is configured to rotate the recovery roller 12a. The case 12b contains the recovery roller 12a and is capable of being opened and closed. The recovery mechanism 12, which includes the case 12b, is outside the fixing frame 3A and is fixed to a side of the fixing frame 3A which side is opposite to the unwinding mechanism 11.

[0027]

The resin molding apparatus 30 includes a plurality of (four for the present embodiment) supply rollers 14a to 14d between the unwinding mechanism 11 and the mold die C. The supply rollers 14a to 14d are rotatably fixed to the fixing frame 3A. The supply rollers 14a to 14d include first to fourth supply rollers 14a to 14d. The first and second supply rollers 14a and 14b are disposed between the unwinding mechanism 11 and one of the moving mechanisms 13 and arranged in this order from the side of the unwinding mechanism 11. The third and fourth supply rollers 14c and 14d are disposed between the moving mechanism 13 and the mold die C and arranged in this order from above to below. The supply rollers 14c and 14d, which are the closest to the mold die C, are configured to nip and guide a release film F so that the release film F is parallel to the molding surface of the mold die C.

[0028]

The resin molding apparatus 30 includes a plurality of (four for the present embodiment) recovery rollers 15a to 15d between the mold die C and the recovery mechanism 12. The recovery rollers 15a to 15d are rotatably fixed to the fixing frame 3A. The recovery rollers 15a to 15d include first to fourth recovery roller 15a to 15d. The first and second recovery rollers 15a and 15b are disposed between the mold die C and the other moving mechanism 13 and arranged in this order from above to below. The third and fourth recovery rollers 15c and 15d are disposed between the moving mechanism 13 and the recovery mechanism 12 and arranged in this order from the side of the nip rollers 16. The recovery rollers 15a and 15b, which are the closest to the mold die C, are configured to nip and guide a release film F so that the release film F is parallel to the molding surface of the mold die C.

[0029]

Each moving mechanism 13 includes a movable roller 13a configured to move in conjunction with the relative movement of the upper die UM and the lower die LM to apply a moderate tension to a release film F. The movable roller 13a is supported by the fixing frame 3A. The present embodiment is configured such that since the unwinding mechanism 11, the recovery mechanism 12, the supply rollers 14a to 14d, and the

recovery rollers 15a to 15d are fixed to the fixing frame 3A, the movable roller 13a moving upward and downward in conjunction with the up-down movement of the lower die LM applies a moderate tension to a release film F. The moving mechanisms 13 will be detailed later.

5 [0030]

The film conveyor mechanism 7 includes nip rollers 16 and a second motor M2. The nip rollers 16 include a conveyor roller 16a, and are configured to press and hold a release film F. The second motor M2 is configured to rotate the conveyor roller 16a. The second motor M2 is provided with a second sensor S2 configured to detect the amount of rotation (that is, rotational position) of the motor shaft (not illustrated in the drawings). The nip rollers 16 are disposed on the conveying path for a release film F and toward the recovery mechanism 12 (that is, between the recovery mechanism 12 and the moving mechanism 13 on the side of the recovery mechanism 12). The nip rollers 16 are rotatably fixed to the fixing frame 3A. The nip rollers 16 include a conveyor roller 16a and a press roller 16b. The conveyor roller 16a is rotatable by the driving force from the second motor M2 to adjust the speed of the conveyance velocity V of the release film F. The press roller 16b is configured to press the release film F toward the conveyor roller 16a. The conveyor roller 16a and the press roller 16b each have a surface covered by, for example, a rubber or resin with a high coefficient of friction to hold the release film F. The second motor M2 is in the form of, for example, a servomotor configured to control the rotational position, the rotation speed, and the like. The second sensor S2 is in the form of an encoder (that is, a rotation detector) configured to detect the amount of rotation of, for example, a servomotor on the basis of the pulse number.

[0031]

25 The film supply mechanism 1 operates under control of the control section 6. The control section 6, when the film conveyor mechanism 7 conveys a release film F, causes the unwinding roller 11a of the unwinding mechanism 11 to rotate in the direction in which the film conveyor mechanism 7 conveys the release film F. The expression "cause the unwinding roller 11a to rotate in the direction in which the film conveyor mechanism 7 conveys the release film F" refers to causing the unwinding roller 11a to rotate such that at its unwinding point (from which the unwinding roller 11a unwinds the release film F), the rotation has a tangential direction identical to the direction in which the film conveyor mechanism 7 conveys the release film F.

[0032]

35 The control section 6 controls the rotation speed N_c of the conveyor roller 16a to control the conveyance velocity V of a release film F. Further, the control section 6,

when the conveyor roller 16a conveys a release film F, controls the rotation speed N_a of the unwinding roller 11a with the release film F therearound so that the release film F has a width within an acceptable range. This allows a moderate tension to be applied to the release film F. Specifically, the control section 6 controls the rotation speed N_a of the
5 unwinding roller 11a to achieve a predetermined velocity difference between the conveyance velocity V , with which the film conveyor mechanism 7 conveys the release film F, and the unwinding velocity V_a , with which the unwinding mechanism 11 unwinds the release film F. The control section 6, for instance, controls the rotation speed N_a of the unwinding roller 11a so that the unwinding velocity V_a of the release film F is slightly
10 smaller than the conveyance velocity V of the release film F, that is, so that the difference $(V - V_a)$ between the conveyance velocity V and the unwinding velocity V_a is a predetermined velocity difference $\alpha \times V$ (for example, $\alpha = 0.1$). The "predetermined velocity difference" may be selected in advance.

[0033]

15 The conveyance velocity V of the release film F has a preset value, and as represented by formula (1) below, equals to the rotation speed N_c of the conveyor roller 16a (included in the nip rollers 16) multiplied by the peripheral length of the conveyor roller 16a (diameter $D_c \times \pi$). The unwinding velocity V_a of the release film F, as represented by formula (2) below, equals to the rotation speed N_a of the unwinding roller
20 11a multiplied by the peripheral length of the unwinding roller 11a (diameter $D_a \times \pi$). The rotation speed N_c of the conveyor roller 16a is the quotient of the output value of the second sensor S2 (that is, the amount of rotation) divided by time and a second speed reducing ratio (that is, the number of revolutions of the second motor M2 during a single rotation of the conveyor roller 16a). The conveyor roller 16a has a constant diameter D_c .
25 The control section 6 thus controls the rotation speed N_c of the conveyor roller 16a for a predetermined value on the basis of the output value of the second sensor S2 so that the conveyance velocity V has a preset value. The rotation speed N_a of the unwinding roller 11a is the quotient of the output value of the first sensor S1 (that is, the amount of rotation) divided by time and a first speed reducing ratio (that is, the number of revolutions of the
30 first motor M1 during a single rotation of the unwinding roller 11a). The unwinding velocity V_a is calculated on the basis of the diameter D_a of the unwinding roller 11a, the diameter D_a changing in accordance with the amount of the release film F that the unwinding roller 11a has supplied.

[Math. 1]

35 $V = N_c \times D_c \times \pi$... Formula (1)

$V_a = N_a \times D_a \times \pi$... Formula (2)

[0034]

Achieving a predetermined velocity difference between the conveyance velocity V and the unwinding velocity Va ($V - Va$) as described above requires determining the diameter Da of the unwinding roller 11a and adjusting the rotation speed Na of the unwinding roller 11a in accordance with the diameter Da. The control section 6 thus controls the rotation speed Na of the unwinding roller 11a by adjusting the rotation speed Na in accordance with the diameter of the unwinding roller 11a with the release film F therearound (that is, the diameter Da).

[0035]

The diameter Da, as represented by formula (3) below, equals to the output value Ra of the first sensor S1, the output value Ra being proportional to the amount of actual rotation of the unwinding roller 11a which amount corresponds to the amount of a single conveyance of the release film F, multiplied by the diameter of the unwinding roller 11a with no release film F therearound (that is, the diameter Das), divided by the output value Ras of the first sensor S1, the output value Ras being proportional to the amount of virtual rotation of the unwinding roller 11a with no release film F therearound which amount corresponds to the amount of a single conveyance of the release film F. The amount of a single conveyance of the release film F has a preset value. The unwinding roller 11a with no release film F therearound has a constant diameter (that is, the diameter Das). The output value Ra of the first sensor S1 is measurable. The output value Ras of the first sensor S1 has a value uniquely determined in correspondence with the amount of conveyance of the release film F. The diameter Da of the unwinding roller 11a is calculable as a result. The amount of conveyance of the release film F may be calculated, as represented by formula (1) above, by dividing the output value of the second sensor S2 by the second speed reducing ratio and multiplying the quotient by the peripheral length of the conveyor roller 16a ($diameter\ Dc \times \pi$).

[Math. 2]

$Da = Ra \times Das / Ras \dots$ Formula (3)

[0036]

The diameter Da of the unwinding roller 11a may be calculated, as represented by formula (4) below, by multiplying the conveyance amount La (mm) of the release film F at the time the output value Ra of the first sensor S1 reaches a predetermined value (for example, a single rotation) by the diameter of the unwinding roller 11a with no release film F therearound (that is, the diameter Das) and dividing the product by the conveyance amount Las (mm) of the release film F at the time the amount of rotation of the unwinding roller 11a with no release film F therearound reaches a predetermined value equal to the

above predetermined value (that is, a single rotation). The conveyance amount L_a of the release film F is calculable by multiplying a predetermined conveyance velocity V (that is, a preset value) or a conveyance velocity V calculated on the basis of formula (1) above by time at which the output value R_a of the first sensor S1 reaches a predetermined value.

5 Stated differently, the conveyance amount L_a of the release film F is calculable by dividing a preset value proportional to time at which the output value R_a of the first sensor S1 reaches a predetermined value or the output value of the second sensor S2, the output value corresponding to time at which the output value R_a of the first sensor S1 reaches a predetermined value, by the second speed reducing ratio and multiplying the quotient by
10 the peripheral length of the conveyor roller 16a (diameter $D_c \times \pi$). The unwinding roller 11a with no release film F therearound has a constant diameter (that is, the diameter D_{as}). The respective output values R_a and R_c of the first and second sensors S1 and S2 are measurable. The conveyance amount L_{as} of the release film F at the time the amount of rotation of the unwinding roller 11a reaches a predetermined value (for example, a single
15 rotation) has a default value. The diameter D_a of the unwinding roller 11a is calculable as a result.

[Math. 3]

$D_a = L_a \times D_{as} / L_{as} \dots$ Formula (4)

[0037]

20 The diameter D_a of the unwinding roller 11a may alternatively be estimated, as represented by formula (5) below, by presuming that the conveyance amount L_f of the release film F, the conveyance amount L_f being calculated by multiplying a predetermined conveyance velocity V (that is, a preset value) or a conveyance velocity V calculated on the basis of formula (1) above by time, is approximated to the amount of
25 the release film F that the unwinding roller 11a supplies, dividing the conveyance amount L_f by the output value R_a of the first sensor S1, and multiplying the quotient by the first speed reducing ratio for estimation. In this case, the estimation has a higher accuracy with a smaller difference between the conveyance velocity V with which the film conveyor mechanism 7 conveys the release film F and the unwinding velocity V_a with which the
30 unwinding mechanism 11 unwinds the release film F.

[Math. 4]

$D_a = L_f \times \text{first speed reducing ratio} / (R_a \times \pi) \dots$ Formula (5)

[0038]

35 In particular, substituting the diameter D_a of the unwinding roller 11a as calculated on the basis of formula (3) or (4) above into formula (2) above allows accurate calculation of the unwinding velocity V_a of the release film F. This allows the control

section 6 to adjust the rotation speed N_a of the unwinding roller 11a accurately in real time to achieve a predetermined velocity difference between the conveyance velocity V , with which the film conveyor mechanism 7 conveys the release film F, and the unwinding velocity V_a , with which the unwinding mechanism 11 unwinds the release film F.

5 [0039]

As illustrated in FIGs. 2 and 3, the moving mechanisms 13, one of which is toward the unwinding mechanism 11 and the other of which is toward the recovery mechanism 12, each include, in addition to the movable roller 13a described above, springs 13b pressing the movable roller 13a, a holder plate 13c holding the movable roller
10 13a, and a support frame 13d holding the movable roller 13a, the springs 13b, and the holder plate 13c.

[0040]

The movable rollers 13a are disposed on the conveying path for the release film F, one toward the unwinding mechanism 11 and the other toward the recovery mechanism
15 12. The movable rollers 13a are each fixed to the corresponding holder plate 13c and supported by the fixing frame 3A with the corresponding support frame 13d in-between. The movable rollers 13a are each movable upward and downward in conjunction with the mold clamp mechanism 35 moving the lower die LM upward and downward relative to the upper die UM.

20 [0041]

The springs 13b are each in the form of, for example, a compression spring pressing the corresponding movable roller 13a in such a direction as to apply tension to the release film F (that is, downward) with the corresponding holder plate 13c in-between. The springs 13b each have a pressing force larger than the tension applied to the release
25 film F and smaller than the force by which the unwinding mechanism 11 and the recovery mechanism 12 hold the release film F (the force having a value equal to the quotient of the running torque applied to the unwinding roller 11a and the recovery roller 12a at rest divided by the radii). This configuration allows the springs 13b to extend and contract against the tension of the release film F with the unwinding mechanism 11 and the
30 recovery mechanism 12 holding the release film F when the lower die LM moves upward and downward. The pressing force of the springs 13b refers to the force applied to the movable rollers 13a as the springs 13b press the movable rollers 13a.

[0042]

The holder plates 13c are held by the support frame 13d, and each hold the
35 corresponding movable roller 13a in such a manner that the movable roller 13a is rotatable. The support frames 13d are each fixed to the fixing frame 3A. The support frames 13d

each include an upper plate 13d1, a lower plate 13d2, and a plurality of (four for the present embodiment) bar-shaped members 13d3 connected to the four corners of each of the upper and lower plates 13d1 and 13d2 to couple the upper and lower plates 13d1 and 13d2 to each other. The holder plates 13c each have holes through which the corresponding bar-shaped members 13d3 extend, and are each movable upward and downward along the corresponding bar-shaped members 13d3. The springs 13b are each around the corresponding bar-shaped member 13d3, and each have a first end in contact with the lower face of the corresponding upper plate 13d1 and a second end in contact with the upper face of the corresponding holder plate 13c.

[0043]

[Method for Producing Resin Molded Product]

The description below deals with a method for producing resin molded products with reference to FIGs. 1, 2, 4, and 5. The method for producing resin molded products (molded substrates Sb) includes a film supplying step during which the film supply mechanism 1 supplies a release film F to a space between the upper die UM and the lower die LM, a mold clamping step during which the mold clamp mechanism 35 clamps the mold die C, and a molding step during which to supply molding target substrates Sa and a resin material (that is, resin resulting from melting resin tablets T) to the mold die C and molding the molding target substrates Sa with the resin. The film supplying step involves, when the film supply mechanism 1 conveys a release film F, causing the unwinding roller 11a to rotate in the direction in which the film supply mechanism 1 conveys the release film F. During this operation, the control section 6 controls the rotation speed Na of the unwinding roller 11a with the release film F therearound so that the release film F has a width within an acceptable range.

[0044]

As illustrated in FIG. 1, the resin molding apparatus 30 preheats the loader 41 while thermally insulating the space for containing resin tablets T, and also preheats the mold die C. The loader 41 then receives molding target substrates Sa having been taken out from the substrate supply mechanism 43. The loader 41 also receives resin tablets T as aligned by the resin supply mechanism 45 into the space for containing resin tablets T. The loader 41 conveys the molding target substrates Sa and the resin tablets T to a molding module 3, and supplies the resin tablets T into the pots in the lower die LM. This allows a heater in the lower die LM to heat the resin tablets T into molten resin.

[0045]

The film supply mechanism 1 supplies an unused release film F to a space between the upper die UM and the lower die LM (see (a) of FIG. 4 [film supplying step]).

During the film supplying step, the resin molding apparatus 30 illustrated in FIG. 2 controls how the film supply mechanism 1 operates as illustrated in FIG. 5. If an operator sets a new film roll on the unwinding roller 11a for replacement of the release film F (yes in #51 in FIG. 5), the film supply mechanism 1 starts conveying the release film F. The control section 6 controls the rotation speed N_c of the conveyor roller 16a for a predetermined value on the basis of the output value of the second sensor S2 so that the conveyance velocity V reaches a preset value (#52 in FIG. 5). The control section 6 also controls the first motor M1 under a predetermined drive condition (for example, the rotation speed N_a of the unwinding roller 11a before the replacement of the release film F or a predetermined rotation speed N_a of the unwinding roller 11a) to rotate the conveyor roller 16a of the nip rollers 16 and the unwinding roller 11a in the same direction (#53 in FIG. 5). The control section 6 then stops the unwinding roller 11a from rotating and the conveyor roller 16a and the recovery roller 12a from rotating (#54 in FIG. 5).

[0046]

Next, the control section 6 calculates the diameter of the unwinding roller 11a on the basis of formula (3) or (4) above from (i) the output value that the first sensor S1 outputted when the control section 6 caused the unwinding roller 11a to rotate under the predetermined drive condition and (ii) the diameter of the unwinding roller 11a with no release film F therearound (#55 in FIG. 5). The control section 6 then calculates an unwinding velocity V_a for the release film F such that the difference ($V - V_a$) between the conveyance velocity V (preset value) and the unwinding velocity V_a is a predetermined velocity difference (#56 in FIG. 5). The control section 6, for instance, calculates an unwinding velocity V_a for the release film F such that the difference ($V - V_a$) between the conveyance velocity V (preset value) and the unwinding velocity V_a is a predetermined velocity difference $\alpha \times V$ (for example, $\alpha = 0.1$). The test run indicated with #52 to #54 in FIG. 5 makes it possible to determine the diameter of the unwinding roller 11a after replacement of the release film F and set an unwinding velocity V_a for a subsequent conveyance of the release film F.

[0047]

Next, after a test run following replacement of the release film F (yes in #51 in FIG. 5) or at the time of a second or later run following the replacement (no in #51 in FIG. 5), the control section 6 controls the first motor M1 and the second motor M2 to rotate the conveyor roller 16a of the nip rollers 16 and the unwinding roller 11a in the same direction (#57 and #58 in FIG. 5). When the film conveyor mechanism 7 conveys the release film F, the control section 6 controls the rotation speed N_c of the conveyor roller 16a for a predetermined value on the basis of the output value of the second sensor S2 so

that the conveyance velocity V reaches a preset value.

[0048]

As described above, the control section 6, when the film conveyor mechanism 7 conveys the release film F, causes the unwinding roller 11a to rotate in the direction in which the film conveyor mechanism 7 conveys the release film F. This prevents the release film F from receiving excessive tension F_a and having a disadvantageously narrowed width as compared to the case of rotating the unwinding roller 11a in the direction opposite to the direction in which the film conveyor mechanism 7 conveys the release film F. This allows the release film F to have an appropriate shape when the mold clamp mechanism 35 operates, with the result of increased molding accuracy. This in turn prevents the release film F from being damaged and incapable of being recovered to disadvantageously stop the apparatus.

[0049]

Next, the control section 6 controls the rotation speed N_a of the unwinding roller 11a while adjusting the rotation speed N_a in accordance with the diameter of the unwinding roller 11a with the release film F therearound to achieve a predetermined velocity difference between the conveyance velocity V , with which the film conveyor mechanism 7 conveys the release film F, and the unwinding velocity V_a , with which the unwinding mechanism 11 unwinds the release film F (#59 in FIG. 5). The control section 6, in other words, controls the rotation speed N_a on the basis of formula (2) above with reference to the diameter and unwinding velocity V_a of the unwinding roller 11a as calculated in #55 and #56 or #62 and #63 in FIG. 5. In response to the film conveyor mechanism 7 having conveyed the release film F by a predetermined amount, the control section 6 stops the unwinding roller 11a from rotating and the conveyor roller 16a and the recovery roller 12a from rotating to maintain the tensions F_a and F_b of the release film F (#60 in FIG. 5). During the film supplying step, the control section 6 also controls how the recovery mechanism 12 operates for recovery of the release film F with a predetermined tension applied to the release film F (details omitted).

[0050]

The control section 6, as described above, adjusts the rotation speed N_a of the unwinding roller 11a in accordance with the diameter of the unwinding roller 11a with the release film F therearound to achieve a predetermined velocity difference between the conveyance velocity V of the release film F and the unwinding velocity V_a . This allows the tension F_a of the release film F to be constant even in response to a change in the amount of the release film F wound around the unwinding roller 11a. This in turn prevents the release film F from receiving excessive tension F_a and having a disadvantageously

narrowed width.

[0051]

After the film supply mechanism 1 has supplied an unused release film F to a space between the upper die UM and the lower die LM, the mold clamp mechanism 35 performs the mold clamping step (described later). If the film supply mechanism 1 continues to supply the release film F after the mold clamping step (yes in #61 in FIG. 5), the control section 6 calculates the diameter of the unwinding roller 11a on the basis of formula (3) or (4) above from (i) the output value that the first sensor S1 outputted when the film conveyor mechanism 7 last conveyed the release film F and (ii) the diameter of the unwinding roller 11a with no release film F therearound (#62 in FIG. 5). The control section 6 then calculates an unwinding velocity V_a for the release film F such that the difference ($V - V_a$) between the conveyance velocity V (preset value) and the unwinding velocity V_a is a predetermined velocity difference (#63 in FIG. 5). The control section 6, for instance, calculates an unwinding velocity V_a for the release film F such that the difference ($V - V_a$) between the conveyance velocity V (preset value) and the unwinding velocity V_a is a predetermined velocity difference $\alpha \times V$ (for example, $\alpha = 0.1$). The control section 6 then repeats #57 to #60 in FIG. 5 to control the rotation speed N_a of the unwinding roller 11a. The control section 6 may alternatively calculate the diameter of the unwinding roller 11a and the unwinding velocity V_a of the release film F in real time while the film conveyor mechanism 7 conveys the release film F.

[0052]

Performing #51 to #60 in FIG. 5 supplies an unused release film F to a space between the upper die UM and the lower die LM, and then moves the movable platen 34 upward with use of the mold clamp mechanism 35 to move the lower die LM toward the upper die UM and bring the unused release film F into close contact with the lower die LM (see (b) of FIG. 4). This causes the springs 13b to contract slightly against the tension F_a of the release film F. The adsorption mechanism causes the release film F to be adsorbed on the molding surface of the lower die LM. The resin molding apparatus 30 then supplies molding target substrates S_a onto the release film F. The mold clamp mechanism 35 moves the lower die LM as described above by a predetermined amount to bring an unused release film F into close contact with the lower die LM. The predetermined amount secures a space for molding target substrates S_a to be supplied between the upper die UM and the lower die LM.

[0053]

The above film supplying step is followed by moving the movable platen 34 further upward with use of the mold clamp mechanism 35 to move the lower die LM

closer to the upper die UM and clamp the mold die C (see (c) of FIG. 4 [mold clamping step]). This causes the springs 13b to contract against the tension Fa of the release film F from the state of (b) of FIG. 4 to the state of (c) of FIG. 4 with the unwinding mechanism 11 and the recovery mechanism 12 holding the release film F. This in turn moves the movable rollers 13a and 13a upward for the release film F to receive a moderate tension Fa. The present embodiment is configured such that the springs 13b each have a pressing force larger than the tension Fa applied to the release film F and smaller than the force by which the unwinding mechanism 11 and the recovery mechanism 12 hold the release film F. This allows a moderate force to be applied to the release film F without the need for a complicated control mechanism. This in turn prevents the release film F from being deformed to decrease the molding accuracy or conveyed on an unintended path. Further, if the mold clamping operation or the like has moved the release film F between (i) the supply rollers 14c and 14d and (ii) the recovery rollers 15a and 15b, the movable rollers 13a and 13a move in conjunction with each other to absorb the change in the length of the release film F. The release film F thus hardly moves at a portion extending from the second supply roller 14b toward the unwinding roller 11a and at a portion extending from the conveyor roller 16a toward the recovery roller 12a. This prevents the release film F from being conveyed on an unintended path.

[0054]

The above mold clamping step is followed by causing resin (which results from melting resin tablets T in the lower die LM) to flow into cavities MC with use of a pushing mechanism (not illustrated in the drawings) for resin molding of the molding target substrates Sa to produce molded substrates Sb (see (c) of FIG. 4 [molding step]). After the resin molding, the mold clamp mechanism 35 lowers the movable platen 34 to open the mold die C. This causes the springs 13b to expand against the tension Fa of the release film F. This in turn moves the movable rollers 13a and 13a downward for the release film F to receive a moderate tension Fa. The resin molding apparatus 30 then releases the molded substrates Sb from the cavities MC. The unloader 42 stores the molded substrates Sb onto the substrate container section 46 (see also FIG. 1).

[0055]

The resin molding apparatus 30 drives the conveyor roller 16a before subsequent molding target substrates Sa are supplied onto the lower die LM to remove the used release film F from the mold die C. This is followed by the film supplying step for supplying an unused release film F to the mold die C: The resin molding apparatus 30 repeats the film supplying step, the mold clamping step, and the molding step. When the unwinding roller 11a is short of the release film F or when the recovery roller 12a is no

longer capable of winding the release film F, an operator opens the case 11b or 12b to replace the unwinding roller 11a or recovery roller 12a (see also FIG. 2).

[0056]

The present embodiment is configured such that the unwinding mechanism 11 and the recovery mechanism 12 are fixed to respective opposite sides of the fixing frame 3A. This allows an operator to replace the release film F readily outside the fixing frame 3A. Further, the unwinding mechanism 11 and the recovery mechanism 12 being outside the fixing frame 3A means an ease of securing a space for the unwinding mechanism 11 and the recovery mechanism 12. This allows the unwinding mechanism 11 and the recovery mechanism 12 to be sized conveniently in accordance with the necessary amount of the release film F.

[0057]

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.

[0058]

[Alternative Embodiments]

FIG. 6 illustrates a resin molding apparatus 30 as an alternative embodiment. The embodiment described above is configured to cause a release film F to be adsorbed on the lower die LM. The present embodiment is configured to cause a release film F to be adsorbed on the upper die UM. Specifically, the upper die UM includes an adsorption mechanism (not illustrated in the drawings) configured to cause a release film F to be adsorbed on the molding surface with use of a vacuum pump or the like.

[0059]

The resin molding apparatus 30 includes a fixing frame 3A, a mold die C, a movable platen 34, a mold clamp mechanism 35, and a film supply mechanism 1. The mold die C and the movable platen 34 are supported by the fixing frame 3A. The mold clamp mechanism 35 is configured to move the movable platen 34 to clamp the mold die C. The film supply mechanism 1 is configured to supply a release film F. The resin molding apparatus 30 as the present embodiment does not include the moving mechanisms 13 described above, and includes an up-down movement mechanism 8 configured to move the unwinding mechanism 11 and the film conveyor mechanism 7 together upward and downward. The up-down movement mechanism 8 includes a movable member (not illustrated in the drawings) supported by the fixing frame 3A and a motor, an air cylinder, or the like (not illustrated in the drawings) configured to move the movable member upward and downward. The movable member is connected to the unwinding mechanism 11 and the film conveyor mechanism 7. This allows the up-down

movement mechanism 8 to move the unwinding mechanism 11 and the film conveyor mechanism 7 together upward and downward. The film conveyor mechanism 7 includes the nip rollers 16 and recovery mechanism 12 described above.

[0060]

5 The up-down movement mechanism 8 lifts the unwinding mechanism 11 and the film conveyor mechanism 7 for the film supply mechanism 1 to supply a release film F onto the upper die UM before the mold clamp mechanism 35 lifts the lower die LM. The up-down movement mechanism 8, which lifts the unwinding mechanism 11 and the film conveyor mechanism 7 before the mold clamp mechanism 35 lifts the lower die LM as
10 described above, allows the release film F to receive a moderate tension due to the movable rollers 13a when the mold clamp mechanism 35 operates. The film conveyor mechanism 7 operates as for the embodiment described above, and its description is omitted here.

[0061]

15 [Further Alternative Embodiments]

 <1> The embodiments described above are each configured to cause a release film F to be adsorbed on either the lower die LM or the upper die UM. The embodiment may alternatively cause a release film F to be adsorbed on both the upper die UM and the lower die LM.

20 [0062]

 <2> The embodiments described above are each configured such that the unwinding mechanism 11 and the recovery mechanism 12 are fixed to respective opposite sides of the fixing frame 3A. The unwinding mechanism 11 and the recovery mechanism 12 may alternatively be fixed to respective internal portions of the fixing frame 3A.

25 [0063]

 <3> The embodiment described above under "Description of Embodiments" is configured such that the springs 13b press the movable rollers 13a. The embodiment may alternatively include a cylinder configured to receive a fluid to press the movable rollers 13a. In this case, the cylinder may adjust its pressing force to the movable rollers 13a in
30 conjunction with the movement of the lower die LM relative to the upper die UM.

[0064]

 <4> The embodiment described above under "Description of Embodiments" may alternatively include an additional movable roller 13a other than the movable rollers 13a and 13a on the respective sides of the unwinding mechanism 11 and the recovery
35 mechanism 12.

[0065]

<5> The unwinding mechanism 11 for the embodiment described above under "Description of Embodiments" may be structured in any manner as long as the unwinding mechanism 11 is capable of unwinding a release film F. Similarly, the recovery mechanism 12 for the embodiment described above under "Description of Embodiments" may be structured in any manner as long as the recovery mechanism 12 is capable of recovering a release film F. In other words, the resin molding apparatuses 30 each include a mechanism configured to apply a moderate tension to a release film F while holding the release film F such that the release film F does not move at a portion on the unwinding side of the second supply roller 14b and at a portion on the recovery side of the conveyor roller 16a even if the mold clamping operation or the like has moved the release film F between (i) the supply rollers 14c and 14d and (ii) the recovery rollers 15a and 15b.

[0066]

<6> The embodiment described above under "Description of Embodiments" may alternatively be configured such that the recovery mechanism 12 is included in the film conveyor mechanism 7 instead of or in addition to the nip rollers 16. This alternative embodiment includes, separately from the recovery mechanism 12, a mechanism configured to recover a release film F to prevent the diameter of the recovery roller 12a from changing. The embodiment described above under "Description of Embodiments" may further alternatively include (i) a pair of nip rollers 16 between the unwinding mechanism 11 and the mold die C or (ii) two pairs of nip rollers 16 one pair of which is toward the unwinding mechanism 11 relative to the mold die C and the other pair of which is toward the recovery mechanism 12 relative to the mold die C.

[0067]

<7> The resin molding apparatuses 30 for the embodiment described above under "Description of Embodiments" are based on a transfer method, but may alternatively be based on a compression method. The resin molding apparatuses 30 are each configured for resin molding of such substrates as semiconductor substrates (for example, silicon wafers), metal substrates (for example, lead frames), glass substrates, ceramic substrates, resin substrates, and wiring substrates.

[0068]

[Summary of Above Embodiments]

The description below summarizes the resin molding apparatus 30 and the method for producing a resin molded product each described above as an embodiment.

[0069]

(1) The resin molding apparatus 30 characteristically includes: a mold die C including: an upper die UM; and a lower die lower die LM; a mold clamp mechanism 35

configured to clamp the mold die C, a film supply mechanism 1 configured to supply a release film F to a space between the upper die UM and the lower die Lower die LM and including: an unwinding mechanism 11 including an unwinding roller 11a configured to unwind the release film F; and a film conveyor mechanism 7 configured to convey the release film F; and a control section 6 configured to control operation of the film supply mechanism 1, the control section 6 being configured to, when the film conveyor mechanism 7 conveys the release film F, cause the unwinding roller 11a to rotate in a direction in which the film conveyor mechanism 7 conveys the release film F.

[0070]

With the above configuration, the control section 6, when the film conveyor mechanism 7 conveys the release film F, causes the unwinding roller 11a to rotate in the direction in which the film conveyor mechanism 7 conveys the release film F. This prevents the release film F from receiving excessive tension and having a disadvantageously narrowed width as compared to the case of rotating the unwinding roller 11a in the direction opposite to the direction in which the film conveyor mechanism 7 conveys the release film F. This allows the release film F to have an appropriate shape when the mold clamp mechanism 35 operates, with the result of increased molding accuracy. This in turn prevents the release film F from being damaged and incapable of being recovered to disadvantageously stop the apparatus. The resin molding apparatus 30 thereby allows a release film F to be conveyed while maintaining its shape.

[0071]

(2) The resin molding apparatus 30 may be configured such that the control section 6 adjusts a rotation speed N_a of the unwinding roller 11a in accordance with a first diameter D_a of the unwinding roller 11a with the release film F therearound to achieve a predetermined velocity difference between a conveyance velocity V with which the film conveyor mechanism 7 conveys the release film F and an unwinding velocity V_a with which the unwinding mechanism 11 unwinds the release film F.

[0072]

The control section 6, as described above, adjusts the rotation speed N_a of the unwinding roller 11a in accordance with the first diameter D_a of the unwinding roller 11a with the release film F therearound to achieve a predetermined velocity difference between the conveyance velocity V of the release film F and the unwinding velocity V_a . This allows the tension of the release film F to be constant even in response to a change in the amount of the release film F wound around the unwinding roller 11a. This in turn prevents the release film F from receiving excessive tension and having a disadvantageously narrowed width.

[0073]

(3) The resin molding apparatus 30 may be configured such that the control section 6 calculates the first diameter D_a based on a second diameter D_{as} of the unwinding roller 11a with no release film F therearound.

5 [0074]

The above configuration simplifies the calculation by calculating the first diameter D_a of the unwinding roller 11a with the release film F therearound on the basis of the second diameter D_{as} of the unwinding roller 11a with no release film F therearound, as the latter diameter is constant.

10 [0075]

(4) The resin molding apparatus 30 may be configured such that the unwinding mechanism 11 includes: a motor (first motor M1) configured to rotate the unwinding roller 11a; and a sensor (first sensor S1) configured to detect an amount of the rotation of the first motor M1, and the control section 6 calculates the first diameter D_a by multiplying a first output value of the first sensor S1 by the second diameter D_{as} and dividing a resulting product by a second output value of the first sensor S1 for the unwinding roller 11a with no release film F therearound which second output value corresponds to an amount of the release film F having been conveyed.

[0076]

20 Calculating the first diameter D_a of the unwinding roller 11a with the release film F therearound as described above speeds up the calculation. This allows the rotation speed of the unwinding roller 11a to be control in real time.

[0077]

(5) The resin molding apparatus 30 may be configured such that the unwinding mechanism 11 includes: a motor (first motor M1) configured to rotate the unwinding roller 11a; and a sensor (first sensor S1) configured to detect an amount of the rotation of the first motor M1, and the control section 6 calculates the first diameter D_a by multiplying a first amount of the release film F having been conveyed when an output value of the first sensor S1 has reached a predetermined value by the second diameter D_{as} and dividing a resulting product by a second amount of the release film F having been conveyed when an amount of the rotation of the unwinding roller 11a with no release film F therearound has reached the predetermined value.

[0078]

35 Calculating the first diameter D_a of the unwinding roller 11a with the release film F therearound as described above speeds up the calculation. This allows the rotation speed of the unwinding roller 11a to be control in real time.

[0079]

(6) The resin molding apparatus 30 may further include: a fixing frame 3A supporting the mold die C; and a pair of movable rollers 13a a first one of which is on a path of the conveyance of the release film F and toward the unwinding mechanism 11 and
5 a second one of which is on the path and toward the film conveyor mechanism 7, the movable rollers 13a being supported by the fixing frame 3A and movable in conjunction with a change in a relative position between the lower die LM and the upper die UM of the mold clamp mechanism 35.

[0080]

10 The above resin molding apparatus 30 includes a pair of movable rollers 13a, one toward the unwinding mechanism 11 and the other toward the film conveyor mechanism 7. The movable rollers 13a are movable in conjunction with the movement of the lower die LM relative to the upper die UM, and thereby allow the release film F to receive a moderate tension when the mold clamp mechanism 35 operates.

15 [0081]

(7) The resin molding apparatus 30 may be configured such that the movable rollers 13a are being pressed by springs 13b in such a direction as to apply tension to the release film F.

[0082]

20 The movable rollers 13a are being pressed by the springs 13b as described above. This allows a moderate tension to be applied to the release film F without the need for a complicated control mechanism.

[0083]

(8) The resin molding apparatus 30 may be configured such that the springs 13b
25 each have a pressing force larger than the tension F_a applied to the release film F and smaller than a force by which the recovery mechanism 12 holds the release film F.

[0084]

The springs 13b having such a pressing force allows the unwinding mechanism 11 to hold the release film F and a moderate tension to be applied to the release film F
30 with use of the movable rollers 13a when the mold clamp mechanism 35 operates.

[0085]

(9) The resin molding apparatus 30 may further include: a fixing frame 3A supporting the mold die C; and an up-down movement mechanism 8 supported by the fixing frame 3A and configured to move the unwinding mechanism 11 and the film
35 conveyor mechanism 7 together upward and downward, wherein the up-down movement mechanism 8 moves the unwinding mechanism 11 and the film conveyor mechanism 7

upward to supply the release film F onto the upper die UM before the mold clamp mechanism 35 moves the lower die LM upward.

[0086]

The up-down movement mechanism 8, which lifts the unwinding mechanism 11 and the film conveyor mechanism 7 before the mold clamp mechanism 35 lifts the lower die LM as described above, allows the release film F to receive a moderate tension due to the movable rollers 13a when the mold clamp mechanism 35 operates.

[0087]

(10) A method for producing a resin molded product (molded substrate Sb) with use of the resin molding apparatus 30 according to any one of (1) to (9) above includes: the film supply mechanism 1 supplying the release film F to a space between the upper die UM and the lower die LM; the mold clamp mechanism 35 clamping the mold die C; and supplying a molding target substrate Sa and a resin material (that is, resin resulting from melting resin tablets T) to the mold die C and molding the molding target substrate Sa with resin, wherein during the supplying of the release film F, the film supply mechanism 1, when the film conveyor mechanism 7 conveys the release film F, causes the unwinding roller 11a to rotate in a direction in which the film conveyor mechanism 7 conveys the release film F.

[0088]

The above method includes, when the film conveyor mechanism 7 conveys the release film F, causing the unwinding roller 11a to rotate in the direction in which the film conveyor mechanism 7 conveys the release film F. This prevents the release film F from having a disadvantageously narrowed width. This allows the release film F to have an appropriate shape when the mold clamp mechanism 35 operates, with the result of increased molding accuracy. This in turn prevents the release film F from being damaged and incapable of being recovered to disadvantageously stop the apparatus. The resin molding method thereby allows a release film F to be conveyed while maintaining its shape.

[0089]

The arrangements disclosed for the above embodiments (including the alternative embodiments; hereinafter the same applies) may each be combined with an arrangement disclosed for another embodiment, as long as such a combination does not cause a contradiction. Further, the embodiments disclosed in the present specification are mere examples. This disclosure is not limited to those embodiments, and may be altered as appropriate, as long as such an alteration does not result in a failure to attain an object of this disclosure.

Industrial Applicability

[0090]

5 This disclosure is applicable to a resin molding apparatus and a method for producing a resin molded product.

Reference Signs List

[0091]

	1	Film supply mechanism
10	3A	Fixing frame
	6	Control section
	7	Film conveyor mechanism
	8	Up-down movement mechanism
	11	Unwinding mechanism
15	11a	Unwinding roller
	13	Moving mechanism
	13a	Movable roller
	13b	Spring
	30	Resin molding apparatus
20	35	Mold clamp mechanism
	C	Mold die
	Da	Diameter (of the unwinding roller with a release film therearound, first diameter)
25	Das	Diameter (of the unwinding roller with no release film therearound, second diameter)
	F	Release film
	LM	Lower die
	M1	First motor (motor)
	Na	Rotation speed
30	S1	First sensor (sensor)
	Sa	Molding target substrate
	UM	Upper die
	V	Conveyance velocity
35	Va	Unwinding velocity

CLAIMS

1. A resin molding apparatus, comprising:
5 a mold die including:
an upper die; and
a lower die;
a mold clamp mechanism configured to clamp the mold die,
a film supply mechanism configured to supply a release film to a space between
10 the upper die and the lower die and including:
an unwinding mechanism including an unwinding roller configured to
unwind the release film; and
a film conveyor mechanism configured to convey the release film; and
a control section configured to control operation of the film supply mechanism,
15 the control section being configured to, when the film conveyor mechanism
conveys the release film, cause the unwinding roller to rotate in a direction in which the
film conveyor mechanism conveys the release film, and
the control section adjusts a rotation speed of the unwinding roller in accordance
with a first diameter of the unwinding roller with the release film therearound to achieve
20 a predetermined velocity difference between a conveyance velocity with which the film
conveyor mechanism conveys the release film and an unwinding velocity with which the
unwinding mechanism unwinds the release film.
- 25 2. The resin molding apparatus according to claim 1, wherein
the control section calculates the first diameter based on a second diameter of
the unwinding roller with no release film therearound.
- 30 3. The resin molding apparatus according to claim 2, wherein
the unwinding mechanism includes:
a motor configured to rotate the unwinding roller; and
a sensor configured to detect an amount of the rotation of the motor, and
the control section calculates the first diameter by multiplying a first output value
35 of the sensor by the second diameter and dividing a resulting product by a second output
value of the sensor for the unwinding roller with no release film therearound which

second output value corresponds to an amount of the release film having been conveyed.

4. The resin molding apparatus according to claim 2, wherein
the unwinding mechanism includes:

a motor configured to rotate the unwinding roller; and

a sensor configured to detect an amount of the rotation of the motor, and

the control section calculates the first diameter by multiplying a first amount of the release film having been conveyed when an output value of the sensor has reached a predetermined value by the second diameter and dividing a resulting product by a second amount of the release film having been conveyed when an amount of the rotation of the unwinding roller with no release film therearound has reached the predetermined value.

5. The resin molding apparatus according to any one of claims 1 to 4, further comprising:

a fixing frame supporting the mold die; and

an up-down movement mechanism supported by the fixing frame and configured to move the unwinding mechanism and the film conveyor mechanism together upward and downward,

wherein the up-down movement mechanism moves the unwinding mechanism and the film conveyor mechanism upward to supply the release film onto the upper die before the mold clamp mechanism moves the lower die upward.

6. A resin molding apparatus, comprising:

a mold die including:

an upper die; and

a lower die;

a mold clamp mechanism configured to clamp the mold die,

a film supply mechanism configured to supply a release film to a space between the upper die and the lower die and including:

an unwinding mechanism including an unwinding roller configured to unwind the release film; and

a film conveyor mechanism configured to convey the release film;

a control section configured to control operation of the film supply mechanism;

a fixing frame supporting the mold die; and

a pair of movable rollers a first one of which is on a path of the conveyance of the release film and toward the unwinding mechanism and a second one of which is on the path and toward the film conveyor mechanism, the movable rollers being supported
5 by the fixing frame and movable in conjunction with a change in a relative position between the lower die and the upper die of the mold clamp mechanism; wherein

the control section being configured to, when the film conveyor mechanism conveys the release film, cause the unwinding roller to rotate in a direction in which the film conveyor mechanism conveys the release film, and

10 the movable rollers are being pressed by springs in such a direction as to apply tension to the release film.

7. The resin molding apparatus according to claim 6, wherein

15 the springs each have a pressing force larger than the tension applied to the release film and smaller than a force by which the unwinding mechanism holds the release film.

20 8. A method for producing a resin molded product with use of a resin molding apparatus according to any one of claims 1 to 7,

the method comprising:

the film supply mechanism supplying the release film to a space between the upper die and the lower die;

25 the mold clamp mechanism clamping the mold die; and

supplying a molding target substrate and a resin material to the mold die and molding the molding target substrate with resin,

wherein during the supplying of the release film, the film supply mechanism, when the film conveyor mechanism conveys the release film, causes the unwinding roller
30 to rotate in a direction in which the film conveyor mechanism conveys the release film.