

DESCRIPTION

TITLE OF INVENTION

RESIN MOLDING DEVICE AND METHOD FOR MANUFACTURING RESIN MOLDED ARTICLE

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Technical Field

[0001] The present invention relates to a resin molding device and a method for manufacturing a resin molded article.

Related Art

10 **[0002]** Japanese Patent Application Laid-Open No. 2012-045839 (Patent Literature 1) discloses a transport device for a resin-sealed substrate. In this transport device, the resin-sealed substrate is transported in a state of being sucked to a cooling plate, thereby cooling the resin-sealed substrate and preventing the resin-sealed substrate from warping (see Patent Literature 1).

Citation List

15 Patent Literature

[0003] [Patent Literature 1] Japanese Patent Application Laid-Open No. 2012-045839

SUMMARY OF INVENTION

Technical Problem

20 **[0004]** In the transport device disclosed in Patent Literature 1, the resin-sealed substrate is cooled in a state of being sucked to the cooling plate while the resin-sealed substrate is being transported. However, as cooling of the resin-sealed substrate is not completed when the resin-sealed substrate starts to be transported, it may not be possible to sufficiently prevent the resin-sealed substrate from warping. For example, it is conceivable that when a molding target is resin-
25 molded using a thermosetting resin, the molding target that has been resin-molded (hereinafter

also referred to as “resin molded article”) may warp immediately after the transport starts. In a case where the molding target includes a fragile member such as a wafer, for example, clamping and straightening a once warped resin molded article may cause bad effects on the resin molded article.

- 5 **[0005]** The present invention was made to solve such problems, and an object of the present invention is to provide a resin molding device that can suppress the warping of a resin molded article while suppressing bad effects on the resin molded article, and a method for manufacturing a resin molded article.

Solution to Problem

- 10 **[0006]** A resin molding device according to an aspect of the present invention is configured to perform resin molding of a molding target by using a thermosetting resin. The resin molding device includes a molding mold, a mold-clamping mechanism, and a temperature adjustment mechanism. The mold-clamping mechanism is configured to perform clamping of the molding mold. The temperature adjustment mechanism is configured to adjust a temperature of the
- 15 molding mold. The temperature adjustment mechanism is configured to heat the molding mold in a state where the clamping is completed during the resin molding, and to cool the molding mold while the state where the clamping is completed is maintained after the resin molding.

- [0007]** A method for manufacturing a resin molded article according to another aspect of the present invention is a method for manufacturing a resin molded article using the resin molding
- 20 device described above. The method includes supplying the molding target to the molding mold, performing the resin molding by performing clamping of the molding mold heated by the temperature adjustment mechanism, and cooling the molding mold by the temperature adjustment mechanism while the state where the clamping is completed is maintained after the resin molding.

Effects of Invention

- 25 **[0008]** According to the present invention, it is possible to provide a resin molding device that

can suppress warping of a resin molded article while suppressing bad effects on the resin molded article, and a method for manufacturing a resin molded article.

BRIEF DESCRIPTION OF DRAWINGS

5 **[0009]**

FIG. 1 is a diagram schematically showing a plan view of the resin molding device.

FIG. 2 is a diagram schematically showing a side view of the dispensing mechanism.

FIG. 3 is a diagram schematically showing a side view of a part of the compression molding module.

10 FIG. 4 is a diagram partially including a view schematically showing a cross-sectional view along IV-IV of FIG. 3.

FIG. 5 is a diagram schematically showing a side view of a part of the compression molding module during compression molding.

FIG. 6 is a diagram showing an example of temperature transition of the molding mold.

15 FIG. 7 is a flowchart showing an example of the operating procedure of the resin molding device.

FIG. 8 is a diagram schematically showing a cross-sectional view of the first upper mold member in the first modified example.

FIG. 9 is a diagram schematically showing a configuration connected to the piping in the second modified example.

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DESCRIPTION OF EMBODIMENTS

[0010] An embodiment (hereinafter also referred to as “this embodiment”) according to one aspect of the present invention will be described in detail below with reference to the drawings.

The same or corresponding parts in the drawings are denoted by the same reference numerals, and

25 the description thereof will not be repeated. Further, each drawing is schematically drawn with

objects omitted or exaggerated as appropriate to facilitate understanding.

[1. Configuration of the resin molding device]

[0011] FIG. 1 is a diagram schematically showing a plan view of a resin molding device 10 according to this embodiment. The resin molding device 10 is configured to resin-seal a molding target using a thermosetting resin and manufacture a resin molded article. An example of the molding target is a substrate to be resin molded 144A (substrate 144) on which electronic components such as semiconductor chips are mounted. For example, in the resin molding device 10, the surface of the substrate to be resin molded 144A, on which electronic components are mounted, is sealed with a resin. In this embodiment, a substrate 144 before resin molding is referred to as a substrate to be resin molded 144A, and a substrate 144 that has been resin-molded is referred to as a resin molded substrate 144B.

[0012] The substrate 144 is composed of, for example, a semiconductor substrate such as a silicon wafer, a lead frame, a printed wiring substrate, a metal substrate, a resin substrate, a glass substrate, or a ceramic substrate. The substrate 144 may be configured with a carrier used for FOWLP (Fan Out Wafer Level Packaging) and FOPLP (Fan Out Panel Level Packaging), for example. The substrate 144 may already have wiring or may not have wiring.

[0013] As shown in FIG. 1, the resin molding device 10 includes a release film cutting module 110, a resin material supply module 120, a compression molding module 130, a transport module 140, and a controller 150. Each module is configured to be attachable to and detachable from the adjacent module.

[0014] A release film 11 having a desired shape is manufactured in the release film cutting module 110, and a liquid resin (thermosetting resin) is supplied as a resin material onto the release film 11 in the resin material supply module 120. The viscosity of the liquid resin is not particularly limited, but in this embodiment, a liquid resin having relatively high viscosity is used.

[0015] In the compression molding module 130, a substrate to be resin molded 144A transported

by the transport module 140 and the release film 11 supplied with liquid resin are compression-molded in a state of being arranged at a predetermined position in a molding mold 231. As a result, a resin molded article (resin molded substrate 144B) is manufactured. In this specification, “predetermined” means preset. For example, “predetermined position” means a preset position.

5 The manufactured resin molded article is transported by the transport module 140 and stored at a predetermined position (molded substrate storage unit 146). Each module will be described in detail hereinafter.

[0016] The release film cutting module 110 is configured to cut and separate a circular release film 11 from a long release film. The release film 11 is used to prevent resin from adhering to
10 the molding mold 231 after compression molding in the compression molding module 130, and facilitate removal of the resin molded article from the molding mold 231. A resin material having properties such as heat resistance, mold releasability, flexibility, and extensibility is used as the material for the release film, such as PTFE (polytetrafluoroethylene), ETFE (ethylene/tetrafluoroethylene copolymer), PET (polyethylene terephthalate), FEP
15 (tetrafluoroethylene/hexafluoropropylene copolymer), polypropylene, polystyrene, or polyvinylidene chloride.

[0017] The release film cutting module 110 includes a film fixing table moving mechanism 111, a roll release film 112, and a film gripper 113. The film fixing table moving mechanism 111 is located between the roll release film 112 and the film gripper 113 in the direction of arrow Y.

20 **[0018]** The film fixing table moving mechanism 111 is configured to move between the release film cutting module 110 and the resin material supply module 120. The film fixing table moving mechanism 111 is movable, for example, in each of the direction of arrow X and the direction of arrow Y.

[0019] A table 12 is arranged on the upper surface of the film fixing table moving mechanism
25 111. The table 12 is a fixing table for fixing the release film 11. The release film pulled out

from the roll release film 112 is fixed on the table 12. The film gripper 113 is configured to pull out the release film from the roll release film 112 and fix a tip of the pulled out release film. On the film fixing table moving mechanism 111, the release film is cut by a cutter (not shown) to manufacture a circular release film 11. For example, the release film 11 may be fixed to the upper surface of the table 12 by suction using a suction mechanism (not shown) such as a vacuum pump from a suction hole (not shown) formed on the upper surface of the table 12.

[0020] The resin material supply module 120 is configured to supply the liquid resin onto the release film 11 and transport the release film 11 supplied with liquid resin to a predetermined position in the molding mold 231. The resin material supply module 120 includes a dispensing mechanism 17, a resin loader 121, and a post-processing mechanism 122.

[0021] FIG. 2 is a diagram schematically showing a side view of the dispensing mechanism 17. As shown in FIG. 2, the dispensing mechanism 17 includes a dispenser 13 and a nozzle 14 attached to the tip of the dispenser 13. The dispensing mechanism 17 is configured to dispense the liquid resin toward the release film 11 arranged on the table 12 in a state where the film fixing table moving mechanism 111 (table 12) is located below. The liquid resin is dispensed from the tip of the nozzle 14 and supplied onto the release film 11.

[0022] The dispensing mechanism 17 (dispenser 13 and nozzle 14) is movable, for example, in each of the direction of arrow X and the direction of arrow Y. For example, the dispensing position of the liquid resin on the release film 11 is adjusted by moving the dispensing mechanism 17 while dispensing the liquid resin. Besides, the dispensing position of the liquid resin on the release film 11 may be adjusted by moving the film fixing table moving mechanism 111 (table 12) while dispensing the liquid resin.

[0023] Referring to FIG. 1 again, the resin loader 121 and the post-processing mechanism 122 are, for example, integrally configured. The resin loader 121 and the post-processing mechanism 122 are configured to move between the resin material supply module 120, the compression

molding module 130, and the transport module 140 via a rail 142.

[0024] The resin loader 121 is configured to hold the release film 11 by suctioning a peripheral edge portion of the release film 11 supplied with liquid resin from above, and move the release film 11 from the film fixing table moving mechanism 111 to a predetermined position in the molding mold 231 (in a lower mold cavity 132). The post-processing mechanism 122 is configured to clean the molding mold 231 and remove the release film 11 from the molding mold 231 after compression molding by the molding mold 231.

[0025] The transport module 140 is configured to transport the substrate to be resin molded 144A stored in a storage unit 145 of a substrate to be resin molded to a predetermined position in the molding mold 231 and transport the resin molded substrate 144B (resin molded article) manufactured in the compression molding module 130 to the molded substrate storage unit 146. The transport module 140 includes a substrate loader 141, the rail 142, a robot arm 143, the storage unit 145 of a substrate to be resin molded, and the molded substrate storage unit 146. In the transport module 140, for example, the substrate 144 is transported by moving the substrate loader 141 holding the substrate 144 (substrate to be resin molded 144A or resin-molded substrate 144B) on the rail 142.

[0026] The storage unit 145 of a substrate to be resin molded is configured to store the substrate to be resin molded 144A, and the molded substrate storage unit 146 is configured to store the resin molded substrate 144B. The robot arm 143 takes out the substrate to be resin molded 144A from the storage unit 145 of a substrate to be resin molded, turns over the front and back sides of the substrate to be resin molded 144A, and holds the substrate to be resin molded 144A on the lower surface of the substrate loader 141. As a result, the substrate to be resin molded 144A is held by the substrate loader 141 with the electronic component mounting surface facing downward.

[0027] Further, the robot arm 143 takes out the resin molded substrate 144B from the substrate loader 141 after compression molding by the molding mold 231, turns over the front and back

sides of the resin molded substrate 144B, and stores the resin molded substrate 144B in the molded substrate storage unit 146. As a result, the resin molded substrate 144B is stored in the molded substrate storage unit 146 with the resin molded surface facing upward.

[0028] The rail 142 extends across the areas of the transport module 140, the compression molding module 130, and the resin material supply module 120. The substrate loader 141 is configured to transport the substrate 144 by moving on the rail 142. For example, the substrate loader 141 is configured to transport the substrate to be resin molded 144A from a predetermined position near the robot arm 143 to a predetermined position in the molding mold 231, and transport the resin molded substrate 144B from the predetermined position in the molding mold 231 to the predetermined position near the robot arm 143.

[0029] The controller 150 is configured to control the entire resin molding device 10. The controller 150 controls each of the release film cutting module 110, the resin material supply module 120, the compression molding module 130, and the transport module 140, for example. The controller 150 includes a CPU (Central Processing Unit) that is a hardware processor, a RAM (Random Access Memory), a ROM (Read Only Memory), etc., and is configured to perform information processing based on programs and various data. The controller 150 may be placed anywhere within the resin molding device 10 or may be configured by a plurality of computers.

[0030] FIG. 3 is a diagram schematically showing a side view of a part of the compression molding module 130. The compression molding module 130 is configured to manufacture a resin molded article (resin molded substrate 144B) by using a so-called compression molding method.

[0031] Referring to FIG. 1 and FIG. 3, the compression molding module 130 includes a base 213, tie bars 214, a fixed platen 211, a movable platen 212, a mold-clamping mechanism 215, the molding mold 231, and a temperature regulator 133.

[0032] The base 213 is a plate-shaped member having a rectangular shape in plan view. Each

of the plurality of (four) tie bars 214 is a rod-shaped member that extends in the vertical direction. The plurality of tie bars 214 are respectively fixed to four corners of the base 213. The fixed platen 211 is a plate-shaped member having a rectangular shape in plan view, and is fixed to the upper portions of the plurality of tie bars 214. The movable platen 212 is a plate-shaped member
5 having a rectangular shape in plan view, and is attached to the tie bars 214 between the base 213 and the fixed platen 211 in a vertically movable state. The movable platen 212 faces both the fixed platen 211 and the base 213 in the compression molding module 130.

[0033] The mold-clamping mechanism 215 is fixed to each of the upper surface of the base 213 and the lower surface of the movable platen 212. The mold-clamping mechanism 215 includes
10 a drive source 216 and a transmission member 217 that transmits the driving force of the drive source 216. The drive source 216 is fixed to the upper surface of the base 213, and the transmission member 217 is fixed to the lower surface of the movable platen 212.

[0034] The driving force of the drive source 216 is transmitted to the movable platen 212 via the transmission member 217, and the movable platen 212 is raised, thereby clamping the molding
15 mold 231. Furthermore, the driving force of the drive source 216 is transmitted to the movable platen 212 via the transmission member 217, and the movable platen 212 is lowered, thereby opening the molding mold 231. The mold-clamping mechanism 215 is configured to move the movable platen 212 up and down in order to clamp and open the molding mold 231. That is, the mold-clamping mechanism 215 is configured to clamp and open the molding mold 231.

[0035] For example, the drive source 216 may be configured with an electric motor such as a servo motor, and the transmission member 217 may be configured with a ball screw. Furthermore, the drive source 216 may be configured with a hydraulic cylinder, and the transmission member 217 may be configured with a rod. Moreover, the mold-clamping mechanism 215 may be configured by using a toggle link mechanism.

[0036] The molding mold 231 includes a metal upper mold 201 and a metal lower mold 202

facing the upper mold 201. The upper mold 201 is fixed to the lower surface of the fixed platen 211 via a plurality of (for example, four) heat insulation mechanisms 210, the lower mold 202 is fixed to the upper surface of the movable platen 212 via a plurality of (for example, four) heat insulation mechanisms 209.

5 **[0037]** The upper mold 201 includes a first upper mold member 203 and a second upper mold member 205 connected to the lower surface of the first upper mold member 203. The first upper mold member 203 is a metal member having a rectangular shape in plan view, and is fixed to the lower surface of the fixed platen 211 via a plurality of heat insulation mechanisms 210. Each heat insulation mechanism 210 is made of metal, for example, and has a pillar shape (columnar
10 shape). For example, the heat insulation mechanism 210 is arranged near each of the four corners of the upper surface of the first upper mold member 203. Further, piping 204 is arranged inside the first upper mold member 203.

[0038] FIG. 4 is a diagram partially including a view schematically showing a cross-sectional view along IV-IV of FIG. 3. As shown in FIG. 4, the piping 204 connected to the temperature
15 regulator 133 is arranged inside the first upper mold member 203.

[0039] The temperature regulator 133 is configured to adjust the temperature of the upper mold 201 (or lower mold 202) by supplying a heat medium to the piping 204 (or piping 207 (FIG. 3)) and circulating the heat medium in the piping 204 (or piping 207). The heat medium may be a liquid such as water or oil, or may be a gas. The temperature regulator 133 raises the temperature
20 of the upper mold 201 by, for example, making the temperature of the heat medium higher than the temperature of the upper mold 201 and circulating the heat medium in the piping 204. Further, the temperature regulator 133 lowers the temperature of the upper mold 201 by, for example, making the temperature of the heat medium lower than the temperature of the upper mold 201 and circulating the heat medium in the piping 204. In the compression molding module 130, the
25 temperature of the substrate 144 is indirectly adjusted by adjusting the temperature of the molding

mold 231.

[0040] A temperature sensor 250 is configured, for example, to detect the temperature of the second upper mold member 205 connected to the first upper mold member 203. The controller 150 controls the temperature regulator 133 based on the detection result obtained by the temperature sensor 250, for example. Since a plurality of heat insulation mechanisms 210 are arranged between the first upper mold member 203 and the fixed platen 211, a space is formed between the first upper mold member 203 and the fixed platen 211. Because this space functions as a heat insulation layer, heat transfer between the upper mold 201 and the fixed platen 211 is suppressed. As a result, temperature control for the upper mold 201 is relatively easy.

[0041] Referring to FIG. 3 again, the second upper mold member 205 is a metal member having a circular shape in plan view, and is connected to the lower surface of the first upper mold member 203. The second upper mold member 205 is configured to hold the substrate 144. The substrate to be resin molded 144A is attached to the lower surface of the second upper mold member 205 before compression molding.

[0042] The lower mold 202 includes a first lower mold member 206 and a second lower mold member 208 connected to the upper surface of the first lower mold member 206. The first lower mold member 206 is a metal member having a rectangular shape in plan view, and is fixed to the upper surface of the movable platen 212 via a plurality of heat insulation mechanisms 209. Each heat insulation mechanism 209 may be the same as or different from the heat insulation mechanism 210, for example. For example, the heat insulation mechanism 209 is arranged near each of the four corners of the lower surface of the first lower mold member 206.

[0043] Further, piping 207 is arranged inside the first lower mold member 206. Like the piping 204, the temperature regulator 133 is connected to the piping 207. Like the upper mold 201, the temperature of the lower mold 202 is adjusted by the temperature regulator 133. The controller

150 controls the temperature regulator 133, for example, based on the detection result of a

temperature sensor (not shown) that detects the temperature of the second lower mold member 208. Since a plurality of heat insulation mechanisms 209 are arranged between the first lower mold member 206 and the movable platen 212, a space is formed between the first lower mold member 206 and the movable platen 212. Because this space functions as a heat insulation layer, heat transfer between the lower mold 202 and the movable platen 212 is suppressed. As a result, temperature control for the lower mold 202 is relatively easy.

[0044] The second lower mold member 208 is a metal member having a circular shape in plan view, and is connected to the upper surface of the first lower mold member 206. A lower mold cavity 132 is formed on the upper surface of the second lower mold member 208. Before compression molding, the release film 11 supplied with liquid resin is placed in the lower mold cavity 132. The molding mold 231 is clamped in a state where a liquid resin is placed in the lower mold cavity 132 of the second lower mold member 208 and the substrate to be resin molded 144A is attached to the lower surface of the second upper mold member 205, thereby performing compression molding.

[2. Suppression of warping of the resin molded article]

[0045] As described above, in the resin molding device 10, compression molding is performed using a thermosetting liquid resin. That is, in the resin molding device 10, compression molding is performed by heating and curing the liquid resin.

[0046] FIG. 5 is a diagram schematically showing a side view of a part of the compression molding module 130 during compression molding (a cross-sectional view is included in part). As shown in FIG. 5, the molding mold 231 is clamped in a state where the substrate to be resin molded 144A, on which a chip 15 is mounted, is held in the upper mold 201 and a liquid resin 16 is placed in the lower mold 202 via the release film 11. For example, when the molding mold 231 is clamped, both the upper mold 201 and the lower mold 202 are heated. By clamping with the heated upper mold 201 and lower mold 202, the liquid resin 16 is cured, and the resin molded

substrate 144B (resin molded article) is manufactured.

[0047] It is assumed that the molding mold 231 is opened at a timing immediately after the liquid resin 16 is cured. In this case, the clamp (hereinafter also simply referred to as “clamp”) of the molding mold 231 on the resin molded substrate 144B is released while the resin molded substrate 144B is at a high temperature. “Clamp” refers to fixing the substrate 144 by sandwiching the substrate 144 with the upper mold 201 and the lower mold 202. For example, a case where the substrate 144 is composed of a silicon wafer is taken into consideration. In this case, the thermal contraction rate of the resin is greater than the thermal contraction rate of the silicon wafer, so the silicon wafer is pulled in the warping direction due to the thermal contraction of the resin. In other words, when the clamp is released while the resin molded substrate 144B is at a high temperature, the force resulting from thermal contraction of the resin causes the resin molded substrate 144B to warp.

[0048] In order to suppress such warping of the resin molded substrate 144B, it is conceivable to keep the upper mold 201 and the lower mold 202 at a relatively low temperature (for example, 100°C to 120°C) during compression molding, rather than a high temperature (for example, 120°C or higher). In this case, however, it takes a long time to cure the resin, and as a result, it takes a long time to manufacture the resin molded article.

[0049] To solve such problems, in the resin molding device 10 according to this embodiment, the controller 150 controls the temperature regulator 133 to heat the molding mold 231 in a state where the molding mold 231 is clamped during compression molding, and cool the molding mold 231 in a state where the molding mold 231 continues to be clamped after compression molding. That is, the temperature regulator 133 heats the molding mold 231 in a state where the molding mold 231 is clamped during compression molding, and cools the molding mold 231 in a state where the molding mold 231 continues to be clamped after compression molding.

[0050] In the resin molding device 10 according to this embodiment, the molding mold 231 is

cooled in a state where the molding mold 231 continues to be clamped after compression molding. Since the resin molded substrate 144B is cooled while the resin molded substrate 144B is clamped by the molding mold 231, even if compression molding is performed at a high temperature, the resin molded substrate 144B is suppressed from warping due to thermal contraction of the resin.

Moreover, since compression molding is performed at a high temperature, the resin is cured in a short time as a result, and the speed of manufacturing the resin molded substrate 144B is improved.

[0051] Furthermore, since the warping of the resin molded substrate 144B is not straightened out once the resin molded substrate 144B is warped, the bad effects that occur on the resin molded substrate 144B due to straightening the warping are suppressed. For example, the occurrence of failures of the resin molded substrate 144B resulting from straightening the warping is suppressed. In addition, since the resin molded substrate 144B is transported after cooling, the requirements for heat resistance in the transport module 140 are lowered. As a result, the resin molded substrate 144B can be easily transported and can be transported at high speed.

[0052] FIG. 6 is a diagram showing an example of temperature transition of the molding mold 231 (upper mold 201 and lower mold 202). Referring to FIG. 6, the horizontal axis represents time and the vertical axis represents the temperature of the molding mold 231. The line L1 indicates the temperature transition of the molding mold 231 in the resin molding device 10 according to this embodiment, and the line L2 indicates the temperature transition of the molding mold 231 in the comparison target. Nevertheless, it should be noted that the specific numerical values of the time and temperature in FIG. 6 are merely examples.

[0053] Referring to the transition of line L1, from time 0 to time t1, for example, the substrate to be resin molded 144A is transported to the molding mold 231. Then, the substrate to be resin molded 144A is attached to the upper mold 201. From time 0 to time t1, the temperature of the molding mold 231 is H1. An example of the temperature H1 is 50°C. The lower limit of the temperature H1 is not particularly limited, but the upper limit of the temperature H1 is, for example,

preferably 60°C or lower, more preferably 50°C or lower, and even more preferably 40°C or lower.

[0054] From time t1 to time t2, for example, the temperature regulator 133 increases the temperature of the molding mold 231 (upper mold 201 and lower mold 202). The temperature regulator 133 adjusts the temperature of the heat medium so that the temperature of the molding mold 231 reaches a target temperature H3. The temperature H3 is higher than the temperature H1. An example of the temperature H3 is 180°C. The temperature H3 is, for example, preferably 120°C or higher and 200°C or lower, more preferably 160°C or higher and 200°C or lower, and even more preferably 160°C or higher and 180°C or lower.

[0055] From time t2 to time t3, for example, the release film 11 supplied with liquid resin is transported to the molding mold 231. Then, the release film 11 supplied with liquid resin is placed on the lower mold 202 (inside the lower mold cavity 132). The liquid resin placed on the lower mold 202 is heated to reduce its viscosity. After the liquid resin is placed on the lower mold 202, the mold is clamped by raising the lower mold 202 using the mold-clamping mechanism 215. When the mold clamping is completed, a predetermined force is applied to the upper mold 201 and the lower mold 202, and the lower mold 202 stops rising. The gas in the liquid resin may be removed by reducing the pressure inside the molding mold 231 after the liquid resin is placed on the lower mold 202 and until the mold clamping is completed.

[0056] The period from time t3 to time t4 is the so-called curing time. Curing time refers to the period of time from the timing when mold clamping is completed until the liquid resin is cured to an extent that the resin molded article can be appropriately released at least when the mold is opened. From time t2 to time t4, the temperature regulator 133 continues to heat the molding mold 231 so as to maintain the temperature of the molding mold 231 at H3. Since the temperature of the molding mold 231 is high, the resin is cured in a relatively short time, and as a result, compression molding is completed in a short time. The timing of starting the curing time does not have to be exactly the timing at which the mold clamping is completed, and may be, for

example, the timing immediately after the mold clamping is completed.

[0057] After time t4 (after compression molding), for example, the temperature regulator 133 lowers the temperature of the molding mold 231 while the state where the clamping of the molding mold 231 is completed is maintained. The temperature regulator 133 adjusts the temperature of the heat medium so that the temperature of the molding mold 231 becomes the target temperature H1. It should be noted that the target temperature during cooling of the molding mold 231 is not necessarily H1. The target temperature during cooling may be, for example, a temperature higher than H1 or a temperature lower than H1. When the temperature of the molding mold 231 falls to the target temperature, the molding mold 231 is opened and the resin molded substrate 144B is transported.

[0058] In contrast, referring to the transition of line L2, for the comparison target, the temperature of the molding mold 231 is kept constant at H2 (for example, 120°C), for example. For example, in this embodiment, when mold clamping is completed in a state where the temperature of the molding mold 231 is 175°C, the curing time (time t3 to time t4) is about 120 seconds. When mold clamping is completed in a state where the temperature of the molding mold 231 is 120°C, the curing time is about 600 seconds. That is, when the temperature of the molding mold 231 is 120°C, the curing time is approximately 5 times longer than when the temperature of the molding mold 231 is 175°C. As a result, when the temperature of the molding mold 231 is kept constant at 120°C, the time required to manufacture a resin molded article (the time required for temperature rise, transport, mold clamping, and cooling of the molding mold 231) is approximately 1.5 times longer than the time required to manufacture a resin molded article in the resin molding device 10 according to this embodiment.

[3. Operation of the resin molding device]

[0059] FIG. 7 is a flowchart showing an example of the operating procedure of the resin molding device 10. The processing shown in this flowchart is executed, for example, by the controller

150 in a predetermined cycle.

[0060] Referring to FIG. 7, the controller 150 controls the transport module 140 to transport the molding target (substrate to be resin molded 144A) to a predetermined position in the molding mold 231 (step S100). The controller 150 controls the temperature regulator 133 to start heating the molding mold 231 (step S110). The controller 150 determines whether the temperature of the molding mold 231 (upper mold 201 and lower mold 202) has risen to a first predetermined temperature based on the detection result of the temperature sensor 250 or the like (step S120). The first predetermined temperature (for example, temperature H3 in FIG. 6) is, for example, a temperature at which the liquid resin (thermosetting resin) cures relatively smoothly.

[0061] When determining that the temperature of the molding mold 231 has not risen to the first predetermined temperature (NO in step S120), the controller 150 continues to control the temperature regulator 133 so that the temperature of the molding mold 231 rises at a predetermined rate.

[0062] However, when determining that the temperature of the molding mold 231 has risen to the first predetermined temperature (YES in step S120), the controller 150 continues to control the temperature regulator 133 so that the temperature of the molding mold 231 is maintained at the first predetermined temperature, and controls the resin material supply module 120 to transport the release film 11 supplied with liquid resin to a predetermined position in the molding mold 231 (step S130). The liquid resin is supplied to the release film 11, for example, in the resin material supply module 120, in parallel with the processing shown in this flowchart.

[0063] Then, the controller 150 controls the mold-clamping mechanism 215 to start clamping the molding mold 231 (step S140). Even when the clamping of the molding mold 231 is completed (during compression molding), the temperature regulator 133 continues to heat the molding mold 231, and the temperature of the molding mold 231 is maintained at, for example, the first predetermined temperature. In addition, “completely clamped state,” “mold clamping-

completed state,” and “state where mold clamping is completed” all refer to, for example, a state where two mutually opposing molds (for example, upper mold 201 and lower mold 202) that constitute a molding mold (for example, molding mold 231) move relatively in a direction toward each other, a predetermined force is applied to these two molds, and the relative movement of these two molds is stopped.

[0064] The controller 150 determines whether a predetermined time has elapsed since the mold clamping is completed (step S150). The predetermined time is a time for the liquid resin (thermosetting resin) to sufficiently cure to an extent that at least allows the mold to be opened and the resin molded article to be appropriately released in the case of heating at the first predetermined temperature. When determining that the predetermined time has not elapsed (NO in step S150), the controller 150 controls the mold-clamping mechanism 215 to maintain the mold clamping-completed state, and controls the temperature regulator 133 so that the temperature of the molding mold 231 is maintained at the first predetermined temperature.

[0065] Further, when determining that the predetermined time has elapsed (YES in step S150), the controller 150 controls the mold-clamping mechanism 215 to maintain the mold clamping-completed state, and controls the temperature regulator 133 to start cooling the molding mold 231 (step S160). For example, the controller 150 controls the temperature regulator 133 so that the temperature of the molding mold 231 decreases at a predetermined rate.

[0066] The controller 150 determines whether the temperature of the molding mold 231 has decreased to a second predetermined temperature based on the detection result of the temperature sensor 250 or the like (step S170). The second predetermined temperature (for example, temperature H1 in FIG. 6) is, for example, a temperature at which the resin has almost no thermal contraction. When determining that the temperature of the molding mold 231 has not decreased to the second predetermined temperature (NO in step S170), the controller 150 controls the mold-clamping mechanism 215 to maintain the mold clamping-completed state, and controls the

temperature regulator 133 so that the temperature of the molding mold 231 continues to decrease.

[0067] Further, when determining that the temperature of the molding mold 231 has decreased to the second predetermined temperature (YES in step S170), the controller 150 controls the mold-clamping mechanism 215 to open the molding mold 231 (step S180). When the mold opening is completed, the controller 150 controls the transport module 140 to transport the manufactured resin molded article (resin molded substrate 144B) (step S190).

[4. Features]

[0068] As described above, in the resin molding device 10 according to this embodiment, the controller 150 heats the molding mold 231 in a state where clamping of the molding mold 231 is completed during compression molding, and controls the temperature regulator 133 to cool the molding mold 231 while the state where clamping of the molding mold 231 is completed is maintained after compression molding. That is, the temperature regulator 133 heats the molding mold 231 in a state where clamping of the molding mold 231 is completed during compression molding, and cools the molding mold 231 while the state where clamping of the molding mold 231 is completed is maintained after compression molding.

[0069] Thus, in the resin molding device 10, the molding mold 231 is cooled while maintaining the state where clamping of the molding mold 231 is completed after compression molding. Therefore, according to the resin molding device 10, the resin molded substrate 144B is cooled while being clamped by the molding mold 231, which makes it possible to suppress the occurrence of warping of the resin molded substrate 144B due to thermal contraction of the resin even if compression molding is performed at a high temperature.

[0070] The resin molding device 10 is an example of the “resin molding device” of the present invention. The molding mold 231 is an example of the “molding mold” of the present invention. The mold-clamping mechanism 215 is an example of the “mold-clamping mechanism” of the present invention. The configuration composed of the temperature regulator 133 and the piping

204 and the piping 207 is an example of the “temperature adjustment mechanism” of the present invention. The liquid resin 16 is an example of the “thermosetting resin” of the present invention. The substrate to be resin molded 144A is an example of the “molding target” of the present invention. The piping 204 and the piping 207 are examples of the “piping” of the present invention. The transport module 140 is an example of the “transport mechanism” of the present invention.

[5. Other embodiments]

[0071] The idea of the above embodiment is not limited to the embodiment described above. Hereinafter, an example of another embodiment to which the idea of the above embodiment can be applied will be described.

<5-1>

[0072] In the resin molding device 10 according to the above embodiment, the piping 204 and the piping 207 are arranged inside the upper mold 201 and the lower mold 202, respectively, and the upper mold 201 and the lower mold 202 are each heated by the temperature regulator 133 supplying the heat medium into each piping. However, the method for heating the upper mold 201 and the lower mold 202 is not limited thereto.

[0073] FIG. 8 is a diagram schematically showing a cross-sectional view of the first upper mold member 203A in the first modified example. As shown in FIG. 8, in addition to the piping 204, a plurality of heaters 300 are arranged inside the first upper mold member 203A. The heaters 300 are heaters for heating metal. By arranging the heaters 300 in addition to the piping 204 and the piping 207 inside the upper mold and the lower mold, the speed for raising the temperatures of the upper mold and the lower mold can be further increased.

<5-2>

[0074] In the resin molding device 10 according to the above embodiment, the temperature of the heat medium supplied to the piping 204 and the piping 207 is lowered by the temperature

regulator 133. However, the method for lowering the temperature of the heat medium is not limited thereto.

[0075] FIG. 9 is a diagram schematically showing a configuration connected to the piping 204 and the piping 207 in the second modified example. As shown in FIG. 9, the temperature regulator 133 and an oil cooler 350 are connected to the piping 204 and the piping 207. That is, the heat medium flowing in the piping 204 and the piping 207 is cooled by the temperature regulator 133 and the oil cooler 350, thereby further increasing the speed for lowering the temperatures of the upper mold and the lower mold.

<5-3>

[0076] In the resin molding device 10 according to the above embodiment, the resin molding is performed by a compression molding method. However, the resin molding method is not limited thereto. For example, the resin molding may be performed by a transfer molding method. Even if the resin molding is performed by the transfer molding method, the molding mold is cooled while maintaining the state where the mold clamping is completed, which suppresses warping of the substrate. Furthermore, since the substrate is transported after being cooled, the requirements for heat resistance in the transport module 140 are lowered. As a result, the resin molded article can be easily transported and can be transported at high speed.

<5-4>

[0077] In the resin molding device 10 according to the above embodiment, the heat insulation mechanisms 209 and 210 do not need to be pillar-shaped and may be plate-shaped. In this case, the heat insulation mechanisms 209 and 210 may be made of a heat insulation material, for example. The heat insulation mechanisms 209 and 210 may be made of, for example, a metal material and a ceramic material. For example, zirconia, alumina, etc. may be used as the ceramic material.

<5-5>

[0078] In the resin molding device 10 according to the above embodiment, the resin molding is performed with a liquid resin. However, the resin used for resin molding is not necessarily a liquid resin. For example, in the resin molding device 10 according to the above embodiment, the resin molding may be performed with a powdered resin (granular resin).

5 <5-6>

[0079] In the resin molding device 10 according to the above embodiment, heating of the molding mold 231 is started before transport of the release film 11 supplied with liquid resin and before clamping of the molding mold 231. However, the timing to start heating the molding mold 231 is not limited thereto. For example, the release film 11 supplied with liquid resin may be transported before the heating of the molding mold 231 starts, the clamping of the molding mold 231 may be started before the heating the molding mold 231 starts, and the heating of the molding mold 231 may be started during the clamping of the molding mold 231. Further, the release film 11 supplied with liquid resin may be transported before the heating of the molding mold 231 starts, and then, the heating of the molding mold 231 may be started and the clamping of the molding mold 231 may be started before the temperature of the molding mold 231 rises to the target temperature (first predetermined temperature).

<5-7>

[0080] The resin molding device 10 according to the above embodiment includes one compression molding module 130. However, the number of compression molding modules 130 included in the resin molding device 10 is not limited thereto. For example, the resin molding device 10 may include two or more compression molding modules 130.

<5-8>

[0081] In the resin molding device 10 according to the above embodiment, the dispensing mechanism 17 and the film fixing table moving mechanism 111 may respectively be movable in each of the direction of arrow X, the direction of arrow Y, and the direction of arrow Z.

<5-9>

[0082] In the resin molding device 10 according to the above embodiment, the first upper mold member 203 and the second upper mold member 205 may be integrally formed, and the first lower mold member 206 and the second lower mold member 208 may be integrally formed.

5 **[0083]** The embodiments of the present invention have been exemplarily described above. That is to say, the detailed description and accompanying drawings have been disclosed for the purpose of illustration. Thus, some of the components described in the detailed description and accompanying drawings may not be essential for solving the problems. Therefore, the inclusion of these non-essential components in the detailed description and accompanying drawings does
10 not imply that these non-essential components are essential.

[0084] Furthermore, the above embodiments are merely illustrative of the present invention in all respects. Various improvements and changes can be made to the above embodiments within the scope of the present invention. In other words, in implementing the present invention, specific configurations can be adopted as appropriate according to the embodiments.

15 Reference Signs List

[0085]

10 resin molding device, 11 release film, 12 table, 13 dispenser, 14 nozzle, 15 chip, 16 liquid resin, 17 dispensing mechanism, 110 release film cutting module, 111 film fixing table moving mechanism, 112 roll release film, 113 film gripper, 120 resin material supply module, 121 resin
20 loader, 122 post-processing mechanism, 130 compression molding module, 132 lower mold cavity, 133 temperature regulator, 140 transport module, 141 substrate loader, 142 rail, 143 robot arm, 144 substrate, 144A substrate to be resin molded, 144B resin molded substrate, 145 storage unit of a substrate to be resin molded, 146 molded substrate storage unit, 150 controller, 201 upper mold, 202 lower mold, 203, 203A first upper mold member, 204, 207 piping, 205 second upper
25 mold member, 206 first lower mold member, 208 second lower mold member, 209, 210 heat

insulation mechanism, 211 fixed platen, 212 movable platen, 213 base, 214 tie bar, 215 mold-clamping mechanism, 216 drive source, 217 transmission member, 231 molding mold, 250 temperature sensor, 300 heater, 350 oil cooler, L1, L2 line.

CLAIMS:

[Claim 1]

A resin molding device, configured to perform resin molding of a molding target by using a thermosetting resin, the resin molding device comprising:

- 5 a molding mold;
- a mold-clamping mechanism configured to perform clamping of the molding mold; and
- a temperature adjustment mechanism configured to adjust a temperature of the molding mold,
- wherein the temperature adjustment mechanism is configured to heat the molding mold in a
- state where the clamping is completed during the resin molding, and to cool the molding mold
- 10 while the state where the clamping is completed is maintained after the resin molding.

[Claim 2]

The resin molding device according to claim 1, wherein piping is arranged inside the molding mold, and

- the temperature adjustment mechanism is configured to adjust the temperature of the molding
- 15 mold by supplying a heat medium to the piping.

[Claim 3]

The resin molding device according to claim 1 or 2, further comprising a transport mechanism configured to transport the molding target that has been molded with resin.

[Claim 4]

- 20 A method for manufacturing a resin molded article using the resin molding device according
- to any one of claims 1 to 3, the method comprising:

- supplying the molding target to the molding mold;
- performing the resin molding by performing clamping of the molding mold heated by the
- temperature adjustment mechanism; and
- 25 cooling the molding mold by the temperature adjustment mechanism while the state where

the clamping is completed is maintained after the resin molding.