RESIN-ENCAPSULATION APPARATUS AND MANUFACTURING METHOD OF RESIN-ENCAPSULATED ELECTRONIC COMPONENT

CROSS-REFERENCE TO RELATED APPLICATION

This application claims priority from Japanese Patent Application No. 2010-170011 filed on July 29, 2010. The entire subject matter of the Japanese Patent Application is incorporated herein by reference.

Technical Field

[0001]

The present invention relates to a resin-encapsulation apparatus and a manufacturing method of a resin-encapsulated electronic component (resin-encapsulation method) for performing resin-encapsulation of a chip-shaped electronic component (hereinafter, referred to as the "chip") composed of a chip of an integrated circuit (IC), a chip of a light emitting diode (LED), or the like.

Background Art

[0002]

Heretofore, resin-encapsulation of one or more than one chip mounted on a circuit board (hereinafter, referred to as the "substrate" as appropriate) such as a lead frame, a printed board, or the like has been performed using a molding die by a resin-molding technology. The molding die (a resin-encapsulation die) used in this case is heated to about 180°C. In a step of resin-encapsulation, first, a substrate is arranged on a die surface of a molding die, and the substrate is preheated (preliminary heated) using the molding die. Next, a chip mounted on the substrate is contained in a cavity having a space provided on the molding die. Then, the cavity is filled with a flowable resin, and the flowable resin is cured to form a cured resin. Thereby, the resin-encapsulation of the chip mounted on the substrate can be performed with the cured resin.

[0003]

In the meantime, in the case where the substrate arranged on the die surface of the molding die is preheated using the molding die, a certain time is required until the substrate is sufficiently preheated in the molding die. Therefore, there is a problem that the overall encapsulation time (molding time) is increased (see, for example, the paragraph [0004] in JP H07(1995)-321137 A).

[0004]

In order to solve the problem, the following technologies in which a substrate is preheated before the substrate is arranged on a die surface of a molding die have been proposed. First, "A so-called out-of-die preliminary heating method comprising the steps of: heating a lead frame to a predetermined temperature using a dedicated preliminary heating mechanism that is provided, for example, on an arrangement part for aligning the lead frame in a predetermined direction; and carrying and supplying the lead frame that has been preliminarily heated to cavity portions provided on both the dies through a carrying mechanism " has been proposed (see, for example, the paragraph [0005] in JP H07(1995)-321137 A and the paragraphs [0012] and [0015] and FIG. 10 in JP 2004-273773 A).

[0005]

Second, the configuration has been proposed in which plural molding units are provided in a resin-encapsulation apparatus and independent appropriate preliminary heating means are provided in the vicinities of die cavity portions in movable lower dies (molding dies) provided on the respective molding units. The preliminary heating means preliminarily heats a resin-unencapsulated lead frame (substrate) to a predetermined temperature (see, for example, the paragraph [0024] and FIGs. 1 and 5 (preliminary heating means 33 in the figures) in JP H07(1995)-321137 A).

Disclosure of Invention

Problem to be Solved by the Invention

[0006]

However, among the aforementioned conventional technologies, in the case

where the "out-of-die preliminary heating method" is employed, the following problems may arise. First, before the lead frame (substrate) that has been preliminarily heated is carried to the cavity portion of the molding die using the carrying means, the substrate is cooled. Thereby, the substrate is required to be preheated again in the molding die. Therefore, it is difficult to reduce the overall encapsulation time for performing the resin-encapsulation of the chip.

[0007]

Second, in the case where the configuration in which the independent appropriate preliminary heating means are provided in the vicinities of the cavities in the molding dies provided on the respective molding units is employed, there is a possibility that a worker is burned by the preliminary heating means when the maintenance of the molding die is performed.

[0008]

The problems to be solved by the present invention are that the reduction of the overall encapsulation time for the resin-encapsulation of the chip is difficult and there is a safety problem of the maintenance of the molding die.

Means for Solving Problem

[0009]

In order to solve the aforementioned problem, the resin-encapsulation apparatus according to the present invention is a resin-encapsulation apparatus for performing resin-encapsulation of an electronic component (chip) mounted on a substrate, comprising at least one first molding die, at least one second molding die and a first carrying means (carrying mechanism), wherein the first molding die and the second molding die are provided so as to face to each other, at least one cavity is provided on at least one of the first molding die and the second molding die, the first carrying means is capable of carrying a substrate to which an unencapsulated electronic component is mounted to a vicinity of the cavity and the first carrying means comprises a sheet-shaped first heater. The first heater is capable of heating the substrate planarly during the process of carrying the substrate to the vicinity of the cavity in a state where the first heater faces to a

substrate plane of the substrate, and in a state where the electronic component mounted on the planarly-heated substrate is immersed in an uncured thermosetting resin in the cavity, the thermosetting resin is capable of being cured.

[0010]

In order to solve the aforementioned problem, the manufacturing method of a resin-encapsulated electronic component (resin-encapsulation method) according to the present invention is a manufacturing method of a resin-encapsulated electronic component (chip) by encapsulating an electronic component mounted on a substrate, comprising a first carrying step for carrying the substrate to a vicinity of a cavity provided on at least one of a first molding die and a second molding die by a first carrying means, a fixing step for fixing the substrate on a die surface of the first molding die or the second molding die at a position where the substrate is overlapped with the cavity, a clamping step for clamping the first molding die and the second molding die, a resin-encapsulating step for performing resin-encapsulation of the electronic component by curing the thermosetting resin in a state where the electronic component is immersed in an uncured thermosetting resin in the cavity, an unclamping step for unclamping the first molding die and the second molding die, and a taking-out step for taking out a resin-encapsulated electronic component with the substrate and the thermosetting resin, wherein the substrate is planarly heated using a sheet-shaped first heater provided on the first carrying means in the first carrying step.

Effects of the Invention

[0011]

According to the present invention, the first heater is provided on the first carrying means that carries an unencapsulated substrate to the vicinity of the cavity. The first heater has a sheet shape and planarly heats the unencapsulated substrate (a substrate to which an unencapsulated electronic component is mounted) during the process of carrying the unencapsulated substrate. Thereby the present invention achieves the following effects. First, since the unencapsulated substrate is heated during the process

of carrying the unencapsulated substrate to the vicinity of the cavity, the time for heating the unencapsulated substrate in the molding die is reduced or becomes unnecessary. Therefore, the overall encapsulation time, i.e., the cycle time in the molding die can be reduced.

[0012]

Second, in the molding die, there is no need to provide independent preliminary heating means in the vicinity of the cavity. Third, when the maintenance of the molding die is performed, the first carrying means on which the first heater is provided can be removed from the molding die. Therefore, the safety in maintenance of the molding die is increased.

BRIEF DESCRIPTION OF THE DRAWINGS

[0013]

FIG. 1 is a schematic plan view showing an example of the resin-encapsulation apparatus according to the present invention.

FIGs. 2A to 2C are partial cross sectional views showing an example of the process from the step in which a first carrying means carries an unencapsulated substrate to the step in which a second carrying means carries the unencapsulated substrate.

FIGs. 3A to 3D are partial cross sectional views showing an example of the process from the step in which the second carrying means delivers the unencapsulated substrate to a die surface to the step in which an encapsulated substrate is formed.

DETAILED DESCRIPTION OF THE INVENTION

[0014]

With respect to the resin-encapsulation apparatus according to the present invention, preferably, in the resin-encapsulation apparatus, the first molding die and the second molding die are provided more than one, and travel distances of the substrates to the vicinities of the cavities provided on the respective second molding dies are different.

[0015]

With respect to the resin-encapsulation apparatus according to the present

invention, preferably, in the resin-encapsulation apparatus, the first heater directly heats the substrate.

[0016]

With respect to the resin-encapsulation apparatus according to the present invention, preferably, in the resin-encapsulation apparatus, the first carrying means further carries the substrate to a die surface of the first molding die or the second molding die at a position where the substrate is overlapped with the cavity and delivers the substrate to the die surface, and the first heater planarly heats the substrate until the substrate is delivered to the die surface.

[0017]

With respect to the resin-encapsulation apparatus according to the present invention, preferably, the resin-encapsulation apparatus further comprising a second carrying means and a second heater, wherein the second carrying means is capable of receiving the substrate from the first carrying means and carrying the substrate to the die surface, and the second heater is provided on the second carrying means and is capable of heating the substrate planarly until the substrate is delivered to the die surface in a state where the second heater faces to the substrate plane.

[0018]

With respect to the resin-encapsulation apparatus according to the present invention, preferably, in the resin-encapsulation apparatus, the second heater has a sheet shape, and the second heater planarly heats the substrate in a state where it is not in contact with the electronic component.

[0019]

With respect to the manufacturing method of a resin-encapsulated electronic component according to the present invention, preferably, the first molding die and the second molding die are provided more than one, and travel distances of the substrates to the vicinities of the cavities provided on the respective second molding dies are different.

[0020]

With respect to the manufacturing method of a resin-encapsulated electronic component according to the present invention, preferably, the first heater directly heats

the substrate in the first carrying step.

[0021]

With respect to the manufacturing method of a resin-encapsulated electronic component according to the present invention, preferably, the first carrying means further carries the substrate to the die surface and delivers the substrate to the die surface in the first carrying step.

[0022]

With respect to the manufacturing method of a resin-encapsulated electronic component according to the present invention, preferably, further comprises a receiving step for receiving the substrate with a second carrying means from the first carrying means, a second carrying step for carrying the substrate to the die surface using the second carrying means, and a delivering step for delivering the substrate to the die surface. In the second carrying step, preferably, the substrate is planarly heated using a second heater provided on the second carrying means in a state where the second heater is not in contact with the electronic component.

[0023]

With respect to the manufacturing method of a resin-encapsulated electronic component according to the present invention, preferably, the second heater has a sheet shape.

[0024]

In the aforementioned resin-encapsulation apparatus and manufacturing method of a resin-encapsulated electronic component according to the present invention, preferably, the first molding die and the second molding die are provided more than one from the viewpoint of resin-encapsulation efficiency of an electronic component etc. In the aforementioned conventional technologies, in the case where plural molding units are provided in a resin-encapsulation apparatus, the difference is caused between the temperatures of the substrates depending on the travel distances of the substrates. Thereby, the time for preheating the substrate again in the molding die should be set differently. Therefore, the step of resin-encapsulation would unnecessarily be complicated (see, for example, the paragraph [0005] in JP H07(1995)-321137 A).

[0025]

In addition, due to the difference between the temperatures of the lead frames (substrates), the difference may be caused in the adhesion between the cured resin and the substrate. In the case where the adhesion between the cured resin and the substrate is decreased, there may arise the serious problem that the quality of a semiconductor package, an LED package, and the like (hereinafter, referred to as the "package") that are the products produced through the step of resin-encapsulation is decreased due to poor adhesion (see, for example, "Sealing (resin molding), Assembly Process" in "Table 1, Manufacturing Process Factors Affecting Reliability" in "Manufacturing Process Factors, Factors Affecting Reliability, Semiconductor Device Reliability" on the website of TOSHIBA Semiconductor Company, January 2010, (http://www.semicon.toshiba.co.jp/product/reliability/device/concept/1186198_7633.html) searched on July 12, 2010).

[0026]

Further, in the conventional apparatus, in the case where the configuration in which the independent appropriate preliminary heating means are provided in the vicinities of the cavities in the molding dies provided on the respective molding units is employed, since the same number of independent preliminary heating means as the number of the molding units are required to be provided, the cost for the apparatus is increased.

[0027]

However, in the present invention, even in the case where the molding dies are provided more than one and the travel distances of the unencapsulated substrates to the molding dies are different, the difference between the temperatures of the heated unencapsulated substrates can be prevented from causing. This makes it possible to reduce the difference in the adhesion between the cured resin and the substrate among the molding dies. Therefore, the decrease in the quality of the package can effectively be prevented. Further, there is no need to provide the difference in the time for preheating the unencapsulated substrates again in the molding dies.

[0028]

Further, even in the case where plural molding dies are provided, there is no need to provide the same number of independent preliminary heating means as the number of the molding dies. Therefore, the cost for the apparatus can be reduced.

[0029]

Furthermore, in the resin-encapsulation apparatus of an electronic component and the manufacturing method of a resin-encapsulated electronic component of the present invention, preferably, the second heater provided on the transfer mechanism (second carrying means) planarly heats the unencapsulated substrate during the process in which the second carrying means receives the unencapsulated substrate from the first carrying means, transfers the unencapsulated substrate to the die surface, and delivers the unencapsulated substrate to the die surface. This makes it possible to heat the unencapsulated substrate until just before the delivery of the unencapsulated substrate to the die surface. Therefore, the overall encapsulation time can greatly be reduced. Further, even in the case where the travel distances of the unencapsulated substrates to the molding dies are different, the difference between the temperatures of the heated unencapsulated substrates can further be prevented from causing. Therefore, the decrease in the quality of the product can further effectively be prevented.

[Embodiment 1]

[0030]

Embodiment 1 of the resin-encapsulation apparatus according to the present invention will be described referring to FIGs. 1 to 3D. In order to make it clearly understandable, the figures of the present application are schematically illustrated by appropriately omitting or exaggerating.

[0031]

As shown in FIG. 1, a resin-encapsulation apparatus 1 according to the Embodiment 1 includes a loading and unloading module 2 and four molding modules 3A, 3B, 3C, and 3D. The loading and unloading module 2 is provided with a means (mechanism) for supplying a resin material for resin-encapsulation to a molding die, a means (mechanism) for unloading an encapsulated substrate to the next step, a control portion for controlling the whole of the resin-encapsulation apparatus 1, and the like.

Illustration of these components is omitted.

[0032]

A substrate supply portion 4 is provided on the loading and unloading module 2. The substrate supply portion 4 receives an unencapsulated substrate 5 from the previous step and supplies it to the inside of the resin-encapsulation apparatus 1. Further, a rotation means (rotation mechanism) 6, a relay means (relay mechanism) 7, and a passing board 8 are provided on the loading and unloading module 2.

[0033]

In FIG. 1, the positions where the unencapsulated substrates 5 are arranged on the respective components are virtually illustrated by rectangles of thin chain double-dashed line and rectangles of thin dashed line. The thin chain double-dashed line shows that the unencapsulated substrate 5 is arranged on the upper surface of the component. The thin dashed line shows that the unencapsulated substrate 5 is held on the lower surface of the component.

[0034]

A first carrying means 9 that moves in the X direction over the four molding modules 3A, 3B, 3C, and 3D is provided (when the symbol "+" or "-" is not described, the "X direction" indicates both of the "+X direction" and "-X direction"). Lower dies 10 are provided on the respective molding modules 3A, 3B, 3C, and 3D. Concaved cavities 11 to be filled with a flowable resin (that will be described below) are formed on the die surfaces of the respective lower dies 10. The positions where the unencapsulated substrates 5 are arranged (the positions viewed in the planar view) in the step of resin-encapsulation are virtually illustrated as substrate positions 12. Furthermore, second carrying means s 13 are arranged on the respective molding modules 3A, 3B, 3C, and 3D. Further, upper dies (that will be described below) are provided so as to face the respective lower dies 10. The lower die 10 and the upper die together form a molding die.

[0035]

In a real-world resin-encapsulation apparatus, the lower die 10 is often composed of an outer part that is called a chase holder, an inner part that is called a chase,

and a part on which a cavity is provided that is called a cavity block. Illustration of these components and the upper die is omitted in FIG. 1.

[0036]

Hereinafter, referring to FIG. 1, the passage in which the unencapsulated substrate 5 is carried from the substrate supply portion 4 to the substrate position 12 will be described. First, the unencapsulated substrate 5 carried from the previous step is placed on the upper surface of the substrate supply portion 4. Next, the unencapsulated substrate 5 is transferred from the substrate supply portion 4 to the upper surface of the rotation means 6 using an appropriate transfer means (not shown). Then, the rotation means 6 is rotated 90 degrees in the state where the unencapsulated substrate 5 is placed thereon. Thereafter, the relay means 7 fixes the unencapsulated substrate 5 that has been placed on the rotation means 6 on the lower surface thereof by adsorption, clamping, or the like. Subsequently, the relay means 7 moves in the -Y direction so as to be placed above the passing board 8 and then releases the adsorption or the like with respect to the unencapsulated substrate 5. Thereby, the unencapsulated substrate 5 can be placed on the upper surface of the passing board 8.

[0037]

Next, the first carrying means 9 fixes the unencapsulated substrate 5 that has been placed on the upper surface of the passing board 8 on the lower surface thereof by adsorption. Thereafter, the first carrying means 9 moves in the +X direction along a rail (not shown) in the state where the unencapsulated substrate 5 is fixed on the lower surface thereof. The first carrying means 9 carries the unencapsulated substrate 5 to a molding module (the molding module 3C in FIG. 1) that includes the lower die 10 that is used at the time of the resin-encapsulation of the unencapsulated substrate 5.

[0038]

Next, the second carrying means 13 provided on the molding module 3C moves in the -Y direction so as to be placed below the first carrying means 9. Then, the first carrying means 9 releases the adsorption with respect to the unencapsulated substrate 5. Thereby, the unencapsulated substrate 5 can be placed on the upper surface of the second carrying means 13.

[0039]

Next, the second carrying means 13 moves in the +Y direction in the state where the unencapsulated substrate 5 is placed on the upper surface thereof. The second carrying means 13 stops when the unencapsulated substrate 5 reaches the substrate position 12, and then moves in the +Z direction and delivers the unencapsulated substrate 5 to the die surface of the upper die (not shown). The upper die fixes the unencapsulated substrate 5 on the die surface (lower surface) of the upper die by adsorption, clamping, or the like.

[0040]

In Embodiment 1, the unencapsulated substrate 5 is preheated during the process of carrying the unencapsulated substrate 5 to the vicinity of the cavity 11 provided on one of the molding modules 3A, 3B, 3C, and 3D and the process of transferring the unencapsulated substrate 5 from the vicinity of the cavity 11 to the substrate position 12. Hereinafter, preheating of the unencapsulated substrate 5 in these two processes will be described by referring to FIGs. 1 to 3D.

[0041]

As shown in FIG. 2A, the unencapsulated substrate 5 includes a substrate 14 such as a lead frame, a printed board, or the like. The substrate 14 is divided into grid-like regions 16 by virtual boundaries 15. One or more than one chip 17 is mounted on each of the regions 16. Terminals of the substrate 14 and terminals of the chip 17 are electrically connected through leads 18 by wire bonding.

[0042]

In Embodiment 1, the unencapsulated substrate 5 is placed on the upper surface of the substrate supply portion 4 shown in FIG. 1 with the surface to which the chips 17 are mounted down (-Z direction). Thus, concaved containing portions (not shown) for containing the chips 17 and the leads 18 are provided on the upper surface of the substrate supply portion 4. Among the other components of the resin-encapsulation apparatus 1, containing portions are provided on the rotation means 6, the passing board 8, and the second carrying means 13 in the same manner as the substrate supply portion 4 (the containing portion provided on the second carrying means 13 will be described below).

[0043]

The first carrying means 9 includes a main body 19, a heater 20, a surface part 21, and a suction passage 22. The heater 20 is a first heater provided for preheating the unencapsulated substrate 5 and is a sheet-shaped (thin plate-shaped) heat generating member fitted in a concaved portion of the main body 19. The heater 20 generates heat by conducting electricity. Thereby, the heater 20 planarly heats the unencapsulated substrate 5 through the surface part 21. The surface part 21 is provided on the surface of the main body 19 for the purpose of protecting the heater 20. The suction passage 22 is connected to a pressure reduction tank (not shown) through a pipe (not shown). By sucking the unencapsulated substrate 5 through the suction passage 22, the unencapsulated substrate 5 is adsorbed on the lower surface of the first carrying means 9.

[0044]

As shown in FIGs. 2B and 2C, the second carrying means 13 includes a main body 23, a heater 24, a frame portion 25, a suction passage 26, and a containing portion 27. The heater 24 is a second heater provided for preheating the unencapsulated substrate 5 and is a sheet-shaped (thin plate-shaped) heat generating member fitted in a concaved portion of the main body 23. The heater 24 generates heat by conducting electricity. Thereby, the heater 24 planarly heats the unencapsulated substrate 5. The frame portion 25 is a frame member fixed to the main body 23 so as to overlap with the rim of the heater 24. The containing portion 27 is a space formed by the main body 23 and the frame portion 25. The chips 17 and the leads 18 are contained in the containing portion 27 in the state where the unencapsulated substrate 5 is placed on the second carrying means 13 (see FIG. 2C).

[0045]

Hereinafter, the manufacturing method of a resin-encapsulated electronic component in Embodiment 1, namely the process after the adsorption of the unencapsulated substrate 5 to the lower surface of the first carrying means 9 until the resin-encapsulation of the chips 17 mounted on the unencapsulated substrate 5 will be described referring to FIGs. 1 to 3D. In Embodiment 1, an encapsulated substrate (that will be described later) is formed by performing the resin-encapsulation of the chips 17

mounted on the unencapsulated substrate 5 by a compression molding method. In the compression molding method, uncured thermosetting resin is filled in the cavity and is cured in a state where the electronic component (chip) which is mounted on a planarly-heated substrate is immersed in the uncured thermosetting resin.

[0046]

First, as shown in FIGs. 1 and 2A, above the passing board 8, the unencapsulated substrate 5 is adsorbed to the lower surface of the first carrying means 9. Thereafter, the first carrying means 9 moves in the +X direction. During this process, the heater 20 planarly heats the unencapsulated substrate 5 through the surface part 21. Therefore, the unencapsulated substrate 5 can planarly be heated during the process in which the first carrying means 9 carries the unencapsulated substrate 5 from the passing board 8 to the molding module 3C in FIG. 1. This means that the first carrying means 9 planarly preheats the unencapsulated substrate 5 from the passing board 8 to the vicinity of the cavity 11 of the molding module 3C.

[0047]

Next, as shown in FIGs. 1 and 2B, the second carrying means 13 provided on the molding module 3C moves in the -Y direction so as to be placed below the first carrying means 9. Thereafter, the second carrying means 13 moves in the +Z direction and the first carrying means 9 releases the adsorption with respect to the unencapsulated substrate 5. Thereby, as shown in FIG. 2C, the unencapsulated substrate 5 can be placed on the upper surface of the second carrying means 13.

[0048]

Next, as shown in FIG. 2C, the rim of the unencapsulated substrate 5 placed on the upper surface of the second carrying means 13 is adsorbed using the suction passage 26. The absorbed unencapsulated substrate 5 is heated by heat transfer from the heater 24 at the part that is in contact with the frame portion 25. Further, the absorbed unencapsulated substrate 5 is heated by radiation of the heat from the heater 24 at the part that is not in contact with the frame portion 25, i.e., the part that is overlapped with the containing portion 27 in the planar view. Accordingly, the unencapsulated substrate 5 is planarly heated using the heater 24.

[0049]

Next, as shown in FIG. 1, the second carrying means 13 transfers the unencapsulated substrate 5 in the +Y direction so that the unencapsulated substrate 5 overlaps with the substrate position 12 in the planar view. Thereafter, as shown in FIG. 3A, the second carrying means 13 moves in the +Z direction and releases the adsorption with respect to the unencapsulated substrate 5. The upper die 28 provided so as to face the lower die 10 adsorbs the unencapsulated substrate 5 using a suction passage 29 at the die surface (lower surface) thereof. Therefore, the unencapsulated substrate 5 can planarly be preheated using the heater 24 during the process after the placement of the unencapsulated substrate 5 on the upper surface of the second carrying means 13 until the absorption of the unencapsulated substrate 5 on the lower surface of the upper die 28.

[0050]

In parallel to the steps so far, as shown in FIG. 3B, a flowable resin 30 composed of a thermosetting resin such as an epoxy resin, a silicone resin, or the like is supplied to the cavity 11 provided on the lower die 10.

[0051]

The transfer of the unencapsulated substrate 5 by the second carrying means 13 is summarized as follows. First, the second carrying means 13 transfers the unencapsulated substrate 5 so as to be placed below the die surface of the upper die 28 at the position where the unencapsulated substrate 5 is overlapped with the cavity 11 provided on the lower die 10 in the planar view. Next, the second carrying means 13 moves in the +Z direction. Then, the second carrying means 13 delivers the unencapsulated substrate 5 to the die surface of the upper die 28 at the position where the unencapsulated substrate 5 is overlapped with the cavity 11 provided on the lower die 10 in the planar view. Finally, the unencapsulated substrate 5 is adsorbed to the die surface of the upper die 28 at the position where the unencapsulated substrate 5 is overlapped with the cavity 11 provided on the lower die 10 in the planar view. Thereafter, the second carrying means 13 moves in the -Z direction and -Y direction in order, and is removed from the substrate position 12 (see FIG. 1).

[0052]

Next, as shown in FIG. 3C, the lower die 10 and the upper die 28 are clamped. Thereby, the chips 17 and the leads 18 of the unencapsulated substrate 5 are immersed in the flowable resin 30. Subsequently, the flowable resin 30 is heated using a heater (not shown) provided on the lower die 10. Thereby, the flowable resin 30 is cured to form a cured resin 31 (see FIG. 3D).

[0053]

Next, as shown in FIGs. 3C and 3D, the lower die 10 and the upper die 28 are unclamped. By the steps so far, a encapsulated substrate 32 in which the chips 17 and the leads 18 of the unencapsulated substrate 5 are encapsulated with the cured resin 31 is formed.

[0054]

Next, the adsorption with respect to the encapsulated substrate 32 at the upper die 28 is released and the encapsulated substrate 32 is taken out from the upper die 28. Thereafter, the encapsulated substrate 32 is divided at boundaries 15 using a dicer or the like if needed. Thereby, one or more than one package corresponding to the number of the regions 16 can be produced from the encapsulated substrate 32.

[0055]

The Embodiment 1 achieves the following effects. First, the heater 20 provided on the first carrying means 9 heats the unencapsulated substrate 5 during the process of carrying the unencapsulated substrate 5 to the vicinity of the cavity 11. Thereby, the time for heating the unencapsulated substrate 5 in the molding die composed of the lower die 10 and the upper die 28 is reduced or becomes unnecessary. Therefore, the overall encapsulation time, i.e., the cycle time in the molding die can be reduced.

[0056]

Further, even in the case where the travel distances of the unencapsulated substrates 5 to the molding dies are different, the difference between the temperatures of the heated unencapsulated substrates 5 can be prevented from causing. This makes it possible to reduce the difference in the adhesion between the cured resin 31 and the substrate 14 among the molding dies. Therefore, the decrease in the quality of the package can effectively be prevented. Further, there is no need to provide the difference

in the time for preheating the unencapsulated substrates 5 again in the molding dies.

[0057]

Further, even in the case where plural molding dies are provided, there is no need to provide the same number of independent preliminary heating means as the number of the molding dies. Therefore, the cost for the apparatus can be reduced.

[0058]

Further, in the molding die, there is no need to provide the independent preliminary heating means in the vicinity of the cavity 11. In addition, when the maintenance of the molding die is performed, the first carrying means 9 on which the heater 20 is provided and the second carrying means 13 on which the heater 24 is provided can be removed from the molding die. Therefore, the safety in maintenance of the molding die is increased.

[0059]

Further, the heater 24 provided on the second carrying means 13 planarly heats the unencapsulated substrate 5 during the process in which the second carrying means 13 receives the unencapsulated substrate 5 from the first carrying means 9 and delivers the unencapsulated substrate 5 to the die surface of the upper die 28. This makes it possible to heat the unencapsulated substrate 5 until just before the delivery of the unencapsulated substrate 5 to the die surface of the upper die 28. Therefore, the overall encapsulation time can greatly be reduced. Further, even in the case where the travel distances of the unencapsulated substrates 5 to the molding dies are different, the difference between the temperatures of the heated unencapsulated substrates 5 can further be prevented from causing. Therefore, the decrease in the quality of the product can further effectively be prevented.

[0060]

Further, the sheet-shaped heater 20 and the sheet-shaped heater 24 planarly heat the unencapsulated substrate 5. Thereby, even in the case where the unencapsulated substrate 5 is large in size, the unencapsulated substrate 5 can be heated uniformly.

[Embodiment 2]

[0061]

As Embodiment 2 according to the present invention, there can be the configuration in which the heater 24 is not provided on the second carrying means 13 shown in FIGs. 2A to 3D. Whether or not the configuration can be employed is preferably determined after considering the following points.

[0062]

The first point is a property of the unencapsulated substrate 5, especially heat capacity, heat conductivity, or the like. In the case where the heat capacity of the unencapsulated substrate 5 is high and in the case where the heat conductivity of the unencapsulated substrate 5 is low, the temperature of the unencapsulated substrate 5 less likely decreases during the transfer of the unencapsulated substrate 5 that has been preheated using the first carrying means 9 by the second carrying means 13. Therefore, in these cases, Embodiment 2 may be employed.

[0063]

The second point is a preset temperature at the time of preheating the unencapsulated substrate 5 using the heater 20 provided on the first carrying means 9. Preferably, the preset temperature is set at an appropriate temperature higher than the temperature of the unencapsulated substrate 5 that is required for the resin-encapsulation of the unencapsulated substrate 5 in prospection of the decrease in the temperature of the unencapsulated substrate 5 during the transfer of the unencapsulated substrate 5 by the second carrying means 13.

[0064]

The third point is a time between the receipt of the unencapsulated substrate 5 with the second carrying means 13 and the absorption of the unencapsulated substrate 5 to the lower surface of the upper die 28. In the case where the time is short, the temperature of the unencapsulated substrate 5 less likely decreases during the transfer of the unencapsulated substrate 5 by the second carrying means 13. Therefore, in this case, Embodiment 2 may be employed.

[0065]

According to Embodiment 2, the heater 24 is not provided on the second carrying means 13. Therefore, the configuration of the second carrying means 13 is

simple as compared to Embodiment 1, and therefore the cost for apparatus can further be reduced.

[0066]

Hereinafter, variations of Embodiment 1 and 2 are described. In the description so far, the molding method was described with reference to the compression molding. However, in the present invention, the molding method is not limited to the compression molding, and transfer molding and injection molding can be employed. Further, in the molding methods excluding the compression molding, the molding die is not limited to the lower die 10 and the upper die 28. The molding die is applicable as long as it includes two molding dies that are facing each other.

[0067]

In the manufacturing method of a resin-encapsulated electronic component of the present invention, in the case where the transfer molding or the injection molding is employed, preferably, the resin-encapsulation apparatus for performing resin-encapsulation of an electronic component further includes a member having a space for containing the uncured thermosetting resin other than the molding dies (upper die and lower die) is used. The space can be connected to the molding dies through a resin passage (= runner) and a filling opening (= gate). In the transfer molding or the injection molding by using such an apparatus, the resin-encapsulating step can be performed by the following (a) to (d).

(a) In a condition where the molding dies (upper die and lower die) are unclamped, a substrate is fixed to the upper die or the lower die.

(b) In a state where the cavity is empty, the upper die and the lower die are clamped.

(c) An uncured thermosetting resin that is present in the space other than the cavity is pressed. Thereby, the cavity is filled with the uncured thermosetting resin via a resin passage (= runner) and a filling opening (= gate) in order.

(d) The uncured thermosetting resin in the cavity is heated. Thereby, the thermosetting resin is cured.

[0068]

In the description so far, the case was described in which the unencapsulated

substrate 5 is placed on the upper surface of the substrate supply portion 4 shown in FIG. 1 with the surface to which the chips 17 are mounted down (-Z direction). The present invention is not limited thereto, and the unencapsulated substrate 5 may be placed on the upper surface of the substrate supply portion 4 with the surface to which the chips 17 are mounted up (+Z direction). In this case, concaved containing portions (not shown) for containing the chips 17 and the leads 18 are provided on the lower surface of the relay means 7 and the first carrying means 9 shown in FIG. 1. The second carrying means 13 moves in the +Y direction in the state where the unencapsulated substrate 5 is placed on the upper surface thereof with the surface to which the chips 17 are mounted up (+Z direction). The second carrying means 13 stops when the unencapsulated substrate 5 reaches the substrate position 12, and then delivers the unencapsulated substrate 5 to the die surface (lower surface) of the upper die (not shown). The chips 17 and the leads 18 are contained in the cavity provided on the upper die. In this case, the transfer molding and injection molding can be employed as the molding method.

[0069]

The unencapsulated substrate 5 may be transferred from the upper surface of the passing board 8 to the upper surface of the first carrying means 9 using an appropriate transfer means (transfer mechanism) (not shown) in FIG. 1. In this case, the unencapsulated substrate 5, which is adsorbed with the surface to which the chips 17 are mounted up (+Z direction), is transferred to the upper surface of the first carrying means 9. The second carrying means 13 that has received the unencapsulated substrate 5 from the first carrying means 9 moves in the +Y direction in the state where the unencapsulated substrate 5 is held on the lower surface thereof. The second carrying means 13 stops by positioning the unencapsulated substrate 5 and the upper die so that the chips 17 and the leads 18 are overlapped with the cavity provided on the upper die in the planar view. The second carrying means 13 moves in the -Z direction and delivers the unencapsulated substrate 5 to the die surface (upper surface) of the lower die 10 with the surface to which the chips 17 are mounted up. By clamping the lower die 10 and the upper die (not shown), the chips 17 and the leads 18 are contained in the cavity provided on the upper die. In this case, the transfer molding and injection molding can be employed as the

molding method.

[0070]

The following variation can be employed. The variation employs the configuration in which the unencapsulated substrate 5 with the surface to which the chips 17 are mounted up (+Z direction) in FIG. 1 is transferred from the upper surface of the passing board 8 to the upper surface of the first carrying means 9 by pushing. In this case, the second carrying means 13 that has received the unencapsulated substrate 5 from the first carrying means 9 moves in the +Y direction in the state where the unencapsulated substrate 5 is held on the lower surface thereof. The second carrying means 13 stops by positioning the unencapsulated substrate 5 and the upper die so that the chips 17 and the leads 18 are overlapped with the cavity provided on the upper die in the planar view. The second carrying means 13 moves in the -Z direction and delivers the unencapsulated substrate 5 to the upper surface of the lower die 10 with the surface to which the chips 17 are mounted up. In this case, the transfer molding and injection molding can be employed as the molding method.

[0071]

Another variation can be employed. The variation employs the configuration in which the first carrying means 9 and the second carrying means 13 can move as follows with respect to the passage from the passing board 8 to each of the substrate positions 12 in the resin-encapsulation apparatus 1 shown in FIG. 1. First, the overlapped first carrying means 9 and the second carrying means 13 move an integrated manner. Second, the first carrying means 9 and the second carrying means 13 individually move in a separated manner.

[0072]

In this variation, the first carrying means 9 that has received the unencapsulated substrate 5 with the surface to which the chips 17 are mounted down (-Z direction) from the upper surface of the passing board 8 holds the unencapsulated substrate 5 at the lower surface thereof. Next, the first carrying means 9 moves so as to be placed right above the second carrying means 13 (or second carrying means 13 moves so as to be placed right below the first carrying means 9) and the first carrying means 9 overlaps with the

second carrying means 13. Then, the first carrying means 9 and the second carrying means 13 integrally move in the +X direction and the +Y direction in order and reach the substrate position 12. In this case, the first carrying means 9 and the second carrying means 13 are further close to each other in FIG. 2B. Next, the unencapsulated substrate 5 is delivered to the upper surface of the second carrying means 13 from the lower surface of the first carrying means 9. Then, the first carrying means 9 moves in the -Y direction and is removed from the substrate position 12. Thereafter, the second carrying means 13 moves in the +Z direction and delivers the unencapsulated substrate 5 to the die surface (lower surface) of the upper die 28 (see FIG. 3A). Subsequently, the second carrying means 13 moves in the -Z direction and the -Y direction in order, and is removed from the substrate position 12 (see FIG. 1).

[0073]

As still another variation regarding the aforementioned variation, the configuration in which the unencapsulated substrate 5 is transferred to the upper surface of the first carrying means 9 from the upper surface of the passing board 8 with the surface to which the chips 17 are mounted up (+Z direction) can be employed. According to this variation, the first carrying means 9 and the second carrying means 13 integrally move in the +X direction and the +Y direction in order and reach the substrate position 12. Finally, the second carrying means 13 moves in the -Z direction and delivers the unencapsulated substrate 5 to the die surface (upper surface) of the lower die (not shown).

[0074]

Yet another variation having the following configuration can be also employed. In this variation, the second carrying means 13 is not provided in FIG. 1 and the unencapsulated substrate 5 is arranged on the upper surface of the lower die 10 using the first carrying means 9 that is movable in the Y direction in addition to the X direction. In this case, the first carrying means 9 moves in the state where the unencapsulated substrate 5 with the surface to which the chips 17 are mounted up (+Z direction) is held on the lower surface thereof. The unencapsulated substrate 5 is arranged on the upper surface of the lower die 10 by positioning the unencapsulated substrate 5 and the upper

die so that the chips 17 and the leads 18 are contained in the cavity provided on the upper die. In this case, the transfer molding and injection molding can be employed as the molding method.

[0075]

In the description so far, the case in which the cavity 11 is provided on the lower die 10 (see FIG. 3B) and the case in which the cavity is provided on the upper die were described. The present invention is not limited thereto and can be applied to the case of using the molding die in which the cavities are provided on both the lower die and the upper die.

[0076]

In the description so far, in the case where the unencapsulated substrate 5 is planarly heated using the sheet-shaped heater 20 as the first heater through the surface part 21 of the first carrying means 9 was described. The present invention is not limited thereto, and the unencapsulated substrate 5 may planarly and directly be heated using the heater 20 without involving the surface part 21. In this case, a sheet-shaped heater having the surface covered with a glass cloth, a plastic film, or the like, is preferably used as the heater 20.

[0077]

As the heater 24 that is the second heater, a planar infrared heater that heats the unencapsulated substrate 5 by radiating infrared rays including at least near infrared rays or far infrared rays may be used.

[0078]

In the description so far, as shown in FIG. 2C, in the case where the unencapsulated substrate 5 is adsorbed to the second carrying means 13 at the rim thereof was described. And in the case where the part of the unencapsulated substrate 5 in the vicinity of the adsorbed part, i.e., the part of the unencapsulated substrate 5 that is in contact with the frame portion 25 is heated by heat transfer from the heater 24 was described. In this case, the part of the unencapsulated substrate 5 that is not in contact with the frame portion 25 is heated by radiation of the heat from the heater 24. The present invention is not limited thereto, and the unencapsulated substrate 5 may be heated

by heat transfer by pressing the parts of the unencapsulated substrate 5 between the chips 17 using presser portions provided on the second carrying means 13. Thereby, the unencapsulated substrate 5 can further efficiently be heated using the heater 24. As the presser portions, protruded presser portions each having a flat end surface can intermittently be provided in the planar view. Alternatively, as the presser portions, wall-like presser portions each having a flat end surface can be provided in a grid pattern in the planar view.

[0079]

In the description so far, in the case where the first carrying means 9 and the second carrying means 13 hold the unencapsulated substrate 5 by adsorption was described. Instead of this, the first carrying means 9 and the second carrying means 13 may hold the unencapsulated substrate 5 by securing the rim of the unencapsulated substrate 5 using plural nails that are rotatable in a predetermined angle.

[0080]

In each Embodiment, in the case where wire bonding is employed for the purpose of electrically connecting the chips 17 and the substrate 14 was described. The present invention is not limited thereto, and other methods such as flip chip bonding and the like may be employed.

[0081]

The flowable resin 30 may be a liquid resin that is in a liquid form at room temperature. Alternatively, the flowable resin 30 may be a molten resin that is formed by melting a resin material that is in a solid form (powder, particle, sheet, tablet, or the like) at room temperature.

[0082]

In FIG. 1, the configuration in which the loading and unloading module 2 is mechanically fixed to the molding module 3A and three molding modules 3B, 3C, and 3D are fixed to the molding module 3A in order was employed. Instead of this, the configuration in which the loading and unloading module 2 and the molding module 3A are formed as a parent module having a function of resin-encapsulation and three molding modules 3B, 3C, and 3D are fixed to the parent module in order may be employed.

Both the cases achieve the resin-encapsulation apparatus with the desired number of the molding modules such as the resin-encapsulation apparatus including one molding module 3A and the resin-encapsulation apparatus 1 including more than one molding module (four molding modules 3A, 3B, 3C, and 3D in the example of FIG. 1). Further, the number of the molding modules can be increased or decreased afterwards.

[0083]

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

EXPLANATION OF LETTERS OR NUMERALS

[0084]

1 resin-encapsulation apparatus
2 loading and unloading module
3A, 3B, 3C, and 3D molding modules
4 substrate supply portion
5 unencapsulated substrate
6 rotation means
7 relay means
8 passing board
9 first carrying means
10 lower die (second molding die)
11 cavity
12 substrate position
13 second carrying means
14 substrate
15 boundary

16 region

17 chip (electronic component)

18 lead

19 and 23 main bodies

20 heater (first heater)

21 surface part

22, 26, and 29 suction passages

24 heater (second heater)

25 frame portion

27 containing portion

28 upper die (first molding die)

30 thermosetting resin (flowable resin)

31 cured resin

32 encapsulated substrate

WHAT IS CLAIMED IS:

1. A resin-encapsulation apparatus for performing resin-encapsulation of an electronic component mounted on a substrate, comprising:

at least one first molding die;

at least one second molding die; and

a first carrying means, wherein

the first molding die and the second molding die are provided so as to face to each other, at least one cavity is provided on at least one of the first molding die and the second molding die,

the first carrying means is capable of carrying a substrate to which an unencapsulated electronic component is mounted to a vicinity of the cavity, and the first carrying means comprises a sheet-shaped first heater, and wherein

the first heater is capable of heating the substrate planarly during the process of carrying the substrate to the vicinity of the cavity in a state where the first heater faces to a substrate plane of the substrate, and

in a state where the electronic component mounted on the planarly-heated substrate is immersed in an uncured thermosetting resin in the cavity, the thermosetting resin is capable of being cured.

2. The resin-encapsulation apparatus according to claim 1, wherein the first molding die and the second molding die are provided more than one, and travel distances of the substrates to the vicinities of the cavities provided on the respective second molding dies are different.

3. The resin-encapsulation apparatus according to claim 1, wherein the first heater directly heats the substrate.

4. The resin-encapsulation apparatus according to claim 1, wherein the first carrying means further carries the substrate to a die surface of the first molding die or the

second molding die at a position where the substrate is overlapped with the cavity and delivers the substrate to the die surface, and

the first heater planarly heats the substrate until the substrate is delivered to the die surface.

5. The resin-encapsulation apparatus according to claim 1, further comprising a second carrying means and a second heater, wherein

the second carrying means is capable of receiving the substrate from the first carrying means and carrying the substrate to the die surface, and

the second heater is provided on the second carrying means and is capable of heating the substrate planarly until the substrate is delivered to the die surface in a state where the second heater faces to the substrate plane.

6. The resin-encapsulation apparatus according to claim 5, wherein

the second heater has a sheet shape, and

the second heater planarly heats the substrate in a state where it is not in contact with the electronic component.

7. A manufacturing method of a resin-encapsulated electronic component by encapsulating an electronic component mounted on a substrate, comprising:

a first carrying step for carrying the substrate to a vicinity of a cavity provided on at least one of a first molding die and a second molding die by a first carrying means,

a fixing step for fixing the substrate on a die surface of the first molding die or the second molding die at a position where the substrate is overlapped with the cavity,

a clamping step for clamping the first molding die and the second molding die,

a resin-encapsulating step for performing resin-encapsulation of the electronic component by curing the thermosetting resin in a state where the electronic component is immersed in an uncured thermosetting resin in the cavity,

an unclamping step for unclamping the first molding die and the second molding die, and

a taking-out step for taking out a resin-encapsulated electronic component with the substrate and the thermosetting resin, wherein

the substrate is planarly heated using a sheet-shaped first heater provided on the first carrying means in the first carrying step.

8. The manufacturing method of a resin-encapsulated electronic component according to claim 7, wherein the first molding die and the second molding die are provided more than one, and travel distances of the substrates to the vicinities of the cavities provided on the respective second molding dies are different.

9. The manufacturing method of a resin-encapsulated electronic component according to claim 7, wherein the first heater directly heats the substrate in the first carrying step.

10. The manufacturing method of a resin-encapsulated electronic component according to claim 7, wherein the first carrying means further carries the substrate to the die surface and delivers the substrate to the die surface in the first carrying step.

11. The manufacturing method of a resin-encapsulated electronic component according to claim 7, further comprising:

a receiving step for receiving the substrate with a second carrying means from the first carrying means,

a second carrying step for carrying the substrate to the die surface using the second carrying means, and

a delivering step for delivering the substrate to the die surface, where in the second carrying step, the substrate is planarly heated using a second heater provided on the second carrying means in a state where the second heater is not in contact with the electronic component.

12. The manufacturing method of a resin-encapsulated electronic component according to claim 11, wherein the second heater has a sheet shape.