

DESCRIPTION

PRODUCING METHOD AND PRODUCING DEVICE OF SEMICONDUCTOR DEVICE

Technical Field

[0001]

The present invention relates to a method for producing a semiconductor device and a producing device thereof, to be specific, to a method for producing a semiconductor device and a producing device of the semiconductor device.

Background Art

[0002]

It has been conventionally known that a semiconductor encapsulating device is produced by encapsulating a semiconductor element by an encapsulating sheet.

[0003]

A method for fabricating a resin encapsulating-type semiconductor device has been, for example, proposed (ref: for example, the following Patent Document 1). In the method, prepreg containing an epoxy resin is attached to one piece of integrated circuit chip mounted on a film carrier and then, the attached product is put into a metal mold to be compression molded.

Prior Art Document

Patent Document

[0004]

Patent Document 1: Japanese Unexamined Patent Publication No. H5-291319

Summary of the Invention

Problems to be solved by the Invention

[0005]

A semiconductor device encapsulating a plurality of semiconductor elements has been recently required in accordance with its intended use and purpose. In the method in Patent Document 1, however, the resin encapsulating-type semiconductor device having one piece of integrated circuit chip is obtained by encapsulating one piece of integrated circuit chip, so that the above-described requirement cannot be satisfied.

[0006]

It is an object of the present invention to provide a method for producing a semiconductor device and a producing device thereof in which a plurality of semiconductor elements can be

collectively encapsulated and a semiconductor device can be easily produced.

Solution to the Problems

[0007]

A method for producing a semiconductor device of the present invention, obtained by encapsulating a semiconductor element by an encapsulating sheet, includes the steps of preparing the encapsulating sheet and the plurality of semiconductor elements; after the preparing step, collectively encapsulating the plurality of semiconductor elements by the encapsulating sheet; and after the encapsulating step, collecting the encapsulating sheet and the plurality of semiconductor elements.

[0008]

According to the producing method, the encapsulating sheet and the plurality of semiconductor elements are prepared; then, the plurality of semiconductor elements are collectively encapsulated by the encapsulating sheet; and thereafter, the encapsulating sheet and the plurality of semiconductor elements are collected, so that a semiconductor device that collectively encapsulates the plurality of semiconductor elements and includes them can be easily produced. Thus, a semiconductor device in which the plurality of semiconductor elements are encapsulated by the encapsulating sheet can be used in accordance with various purposes and intended uses.

[0009]

In the method for producing a semiconductor device of the present invention, it is preferable that a removing step of removing an excess portion in the encapsulating sheet is further included.

[0010]

According to the producing method, the excess portion in the encapsulating sheet is removed, so that a semiconductor device in a desired shape can be obtained.

[0011]

In the method for producing a semiconductor device of the present invention, it is preferable that the preparing step includes a positioning step of positioning the encapsulating sheet with respect to the plurality of semiconductor elements.

[0012]

According to the producing method, the plurality of semiconductor elements can be encapsulated with excellent accuracy by the positioning step of positioning the encapsulating

sheet with respect to the plurality of semiconductor elements. Thus, a semiconductor device can be produced with excellent accuracy.

[0013]

In the method for producing a semiconductor device of the present invention, it is preferable that the collecting step includes an encapsulating sheet temperature controlling step of controlling the temperature of the encapsulating sheet.

[0014]

According to the producing method, by the encapsulating sheet temperature controlling step of controlling the temperature of the encapsulating sheet, deformation of the encapsulating sheet after encapsulation of the plurality of semiconductor elements can be effectively prevented. Thus, a semiconductor device in a desired shape can be produced.

[0015]

In the method for producing a semiconductor device of the present invention, it is preferable that the encapsulating step includes a preliminary heating step of heating the encapsulating sheet in advance and after the preliminary heating step, a main heating step of heating the encapsulating sheet to encapsulate the plurality of semiconductor elements.

[0016]

According to the producing method, by the preliminary heating step, the encapsulating sheet becomes flexible and thereafter, by the main heating step, the semiconductor elements can be surely encapsulated. Thus, while the encapsulating sheet is easily shaped into a desired shape, the semiconductor elements can be encapsulated by the encapsulating sheet. As a result, a semiconductor device in a desired shape can be produced.

[0017]

In the method for producing a semiconductor device of the present invention, it is preferable that the preparing step includes an ambient temperature/humidity controlling step of controlling an ambient temperature and/or humidity of the encapsulating sheet.

[0018]

According to the producing method, the ambient temperature and/or humidity of the encapsulating sheet are/is controlled, so that the encapsulating sheet before encapsulation of the semiconductor elements can be stored, while being retained at constant quality. Thus, the accuracy of encapsulation of the semiconductor elements by the encapsulating sheet can be improved.

[0019]

In the method for producing a semiconductor device of the present invention, it is preferable that the preparing step includes a shaping step of removing an excess portion in the encapsulating sheet and shaping the outer shape of the encapsulating sheet.

[0020]

According to the producing method, in the preparing step, the excess portion in the encapsulating sheet is removed and the outer shape of the encapsulating sheet is shaped, so that the semiconductor elements can be encapsulated by the shaped encapsulating sheet with excellent handleability.

[0021]

In the method for producing a semiconductor device of the present invention, it is preferable that the encapsulating sheet is protected by a protecting member and the preparing step and/or the collecting step include(s) a peeling step of peeling the protecting member from the encapsulating sheet.

[0022]

According to the producing method, the encapsulating sheet can be protected by the protecting member and by the peeling step, the protecting member that is unnecessary for the encapsulation of the semiconductor elements can be peeled from the encapsulating sheet.

[0023]

A producing device of a semiconductor device of the present invention, encapsulating a semiconductor element by an encapsulating sheet, includes a preparing device of preparing the encapsulating sheet and the plurality of semiconductor elements; an encapsulating device of collectively encapsulating the plurality of semiconductor elements by the prepared encapsulating sheet; and a collecting device of collecting the plurality of semiconductor elements encapsulated by the encapsulating sheet.

[0024]

According to the producing device, by the preparing device, the encapsulating sheet and the plurality of semiconductor elements are prepared; by the encapsulating device, the plurality of semiconductor elements are collectively encapsulated by the prepared encapsulating sheet; and by the collecting device, the plurality of semiconductor elements encapsulated by the encapsulating sheet are collected, so that a semiconductor device that collectively encapsulates the plurality of semiconductor elements and includes them can be easily produced. Thus, the

semiconductor device in which the plurality of semiconductor elements are encapsulated by the encapsulating sheet can be used in accordance with various purposes and intended uses.

[0025]

In the producing device of a semiconductor device of the present invention, it is preferable that a removing device of removing an excess portion in the encapsulating sheet is further included.

[0026]

According to the producing device, by the removing device, the excess portion in the encapsulating sheet can be removed, so that a semiconductor device in a desired shape can be obtained.

[0027]

In the producing device of a semiconductor device of the present invention, it is preferable that the preparing device includes a positioning device of positioning the encapsulating sheet with respect to the plurality of semiconductor elements.

[0028]

According to the producing device, by the positioning device, the encapsulating sheet is positioned with respect to the plurality of semiconductor elements, so that the plurality of semiconductor elements can be encapsulated with excellent accuracy. Thus, a semiconductor device can be produced with excellent accuracy.

[0029]

In the producing device of a semiconductor device of the present invention, it is preferable that the collecting device includes an encapsulating sheet temperature controlling device of controlling the temperature of the encapsulating sheet.

[0030]

According to the producing device, by the encapsulating sheet temperature controlling device, the temperature of the encapsulating sheet is controlled, so that deformation of the encapsulating sheet after encapsulation of the plurality of semiconductor elements can be effectively prevented. Thus, a semiconductor device in a desired shape can be produced.

[0031]

In the producing device of a semiconductor device of the present invention, it is preferable that the encapsulating device includes a preliminary heating device of heating the encapsulating sheet in advance and a main heating device of heating the preliminarily heated encapsulating

sheet to encapsulate the plurality of semiconductor elements.

[0032]

According to the producing device, by the preliminary heating device, the encapsulating sheet becomes flexible and thereafter, by the main heating device, the semiconductor elements can be surely encapsulated. Thus, while the encapsulating sheet is easily shaped into a desired shape, the semiconductor elements can be encapsulated by the encapsulating sheet. As a result, a semiconductor device in a desired shape can be produced.

[0033]

In the producing device of a semiconductor device of the present invention, it is preferable that the preparing device includes an ambient temperature/humidity controlling device of controlling an ambient temperature and/or humidity of the encapsulating sheet.

[0034]

According to the producing device, by the ambient temperature/humidity controlling device, the ambient temperature and/or humidity of the encapsulating sheet can be controlled, so that the encapsulating sheet before encapsulation of the semiconductor elements can be stored, while being retained at constant quality. Thus, the accuracy of encapsulation of the semiconductor elements by the encapsulating sheet can be improved.

[0035]

In the producing device of a semiconductor device of the present invention, it is preferable that the preparing device includes a shaping device of removing an excess portion in the encapsulating sheet and shaping the outer shape of the encapsulating sheet.

[0036]

According to the producing device, in the preparing device, the excess portion in the encapsulating sheet is removed and the outer shape of the encapsulating sheet can be shaped by the shaping device, so that the semiconductor elements can be encapsulated with excellent handleability by the shaped encapsulating sheet.

[0037]

In the producing device of a semiconductor device of the present invention, it is preferable that the encapsulating sheet is protected by a protecting member and the preparing device and/or the collecting device include(s) a peeling device of peeling the protecting member from the encapsulating sheet.

[0038]

According to the producing device, the encapsulating sheet can be protected by the protecting member and in the peeling device, the protecting member that is unnecessary for the encapsulation of the semiconductor elements can be peeled from the encapsulating sheet.

Effect of the Invention

[0039]

According to a method for producing a semiconductor device and a producing device thereof of the present invention, a semiconductor device that collectively encapsulates a plurality of semiconductor elements and includes them is easily produced and can be used in accordance with various purposes and intended uses.

BRIEF DESCRIPTION OF DRAWINGS

[0040]

[FIG. 1] FIG. 1 shows a schematic plan view of one embodiment of a producing device of a semiconductor device of the present invention.

[FIG. 2] FIG. 2 shows sectional views for illustrating producing steps of one embodiment of a producing method of a semiconductor device of the present invention:

- (a) illustrating a step of transmitting an encapsulating sheet with a transmitting device,
- (b) illustrating a first removing/shaping step,
- (c) illustrating a first peeling step, and
- (d) illustrating a step of disposing the encapsulating sheet on the upper surfaces of a plurality of semiconductor elements.

[FIG. 3] FIG. 3, subsequent to FIG. 2, shows sectional views for illustrating producing steps of one embodiment of a producing method of a semiconductor device of the present invention:

- (e) illustrating an encapsulating step,
- (f) illustrating a second peeling step,
- (g) illustrating a second removing/shaping step, and
- (h) illustrating a step of collecting a semiconductor device.

[FIG. 4] FIG. 4 shows a perspective view for illustrating a step of transmitting a long-length encapsulating sheet from a transmitting device and a step of cutting the encapsulating sheet into circular shapes with a first removing device.

Embodiment of the Invention

[0041]

In FIG. 1, the right-left direction of the paper surface is referred to as a front-rear direction (first direction), the up-down direction of the paper surface is referred to as a right-left direction (second direction), and the depth direction of the paper surface is referred to as an up-down direction (third direction). Directions in FIGS. 2 to 4 are in conformity with the directions shown by arrows in FIG. 1. The front side is a downstream side in a conveying direction of an encapsulating sheet to be described later. The rear side is an upstream side in the conveying direction of the encapsulating sheet.

[0042]

As shown in FIG. 1, a producing device 10 of a semiconductor device (hereinafter, may be simply referred to as the producing device 10) is a producing device for producing a semiconductor device 1 (ref: FIG. 3 (h)) that encapsulates semiconductor elements 2 by an encapsulating sheet 4.

[0043]

The producing device 10 of the semiconductor device integrally includes a preparing device 11, an encapsulating device 12 that is disposed at the front side thereof, and a collecting device 13 that is disposed at the front side thereof. In the producing device 10, the preparing device 11, the encapsulating device 12, and the collecting device 13 are disposed in alignment in the front-rear direction. By the above-described arrangement of the preparing device 11, the encapsulating device 12, and the collecting device 13, the producing device 10 is, in plane view, configured to extend in the front-rear direction. In the producing device 10, the encapsulating sheet 4 encapsulates the plurality of semiconductor elements 2 to be then collected, while being conveyed from the rear side forwardly in the preparing device 11, the encapsulating device 12, and the collecting device 13.

[0044]

The preparing device 11 is disposed at the rear portion of the producing device 10. The preparing device 11 includes a transmitting device 8; as a removing device, a first removing device 17 that is disposed at the front side of the transmitting device 8; as a peeling device, a first peeling device 49 that is disposed at the front side of the first removing device 17; a disposing device 51 that is disposed at the front side of the first peeling device 49; and a substrate preparing device 24 that is disposed at the left side (one side in a direction orthogonal to the conveying direction) of the disposing device 51. By the above-described arrangement of the transmitting device 8, the first removing device 17, the first peeling device 49, the disposing

device 51, and the substrate preparing device 24, the preparing device 11 is provided in a generally L-shape in plane view.

[0045]

As shown in FIGS. 2 (a) and 4, the transmitting device 8 includes a transmitting roll 29 that is disposed so that an axis thereof is along the right-left direction. In the transmitting device 8, the long-length encapsulating sheet 4 to be described later is wound around the transmitting roll 29. In this manner, the transmitting device 8 is configured so as to transmit the encapsulating sheet 4 in a long-length shape forwardly. The transmitting roll 29 is configured to transmit the encapsulating sheet 4 with a supporting layer 43 facing downwardly and a first peeling layer 33 facing upwardly.

[0046]

The first removing device 17 is configured to remove a margin portion 36 (described later) in the encapsulating sheet 4. To be specific, as shown in FIG. 2 (b), the first removing device 17 includes, as a shaping device, pre-cutters 44, a margin portion peeling device (not shown), and a first conveying device 14.

[0047]

An example of the pre-cutter 44 includes a Thomson blade. The pre-cutter 44 is configured, in the encapsulating sheet 4, to cut an encapsulating layer 31 and peeling layers 32 in a thickness direction but not to cut the supporting layer 43 in the thickness direction.

[0048]

The margin portion peeling device (not shown) has a structure of peeling, from the supporting layer 43, as an excess portion, the margin portion 36 that is cut with the pre-cutters 44 and is not subjected to encapsulation of the plurality of semiconductor elements 2. An example thereof includes a known peeling structure.

[0049]

An encapsulating portion 55 that is subjected to encapsulation of the plurality of semiconductor elements 2 can be obtained by being separated from the margin portion 36 in the encapsulating sheet 4, so that the pre-cutters 44 and the margin portion peeling device configure a removing device that removes the margin portion 36 in the encapsulating sheet 4.

[0050]

The first conveying device 14 includes a rail 38; an arm 37 that is supported by the rail 38; an absorbing device 39 that is provided at the lower end portion of the arm 37; and, as an

encapsulating sheet temperature controlling device, a conveying heater 16 that is incorporated into the absorbing device 39.

[0051]

As shown in FIG. 1, the rail 38 is provided at the upper portion of the producing device 10 so as to extend in the front-rear direction. The rail 38 is, for example, provided to be continuous to the preparing device 11, the encapsulating device 12, and the collecting device 13. To be more specific, the rail 38 is provided to be continuous to the first removing device 17, the first peeling device 49, and the disposing device 51 in the preparing device 11; the encapsulating device 12; and a second peeling device 50 in the collecting device 13. As shown in FIG. 2 (b), the rail 38 is configured to support the arm 37 movably in the front-rear direction. To be more specific, as referred to FIG. 1, the rail 38 is configured to support the arm 37 movably in the preparing device 11, the encapsulating device 12, and the collecting device 13.

[0052]

As shown in FIGS. 2 and 3, the arm 37 is formed so as to extend in the up-down direction and the upper end portion thereof is supported by the rail 38. The arm 37 is configured to be stretchable in the up-down direction. To be specific, the arm 37 is configured to allow the lower end portion thereof to move downwardly, that is, extend and move upwardly, that is, shorten. Furthermore, the arm 37 is configured to enable the lower end portion thereof to slightly move in the right-left direction.

[0053]

The absorbing device 39 is configured to absorb the encapsulating sheet 4 by an absorbing function and release the encapsulating sheet 4 by the termination of the absorbing function. To be specific, the absorbing device 39 is formed into a generally flat plate shape extending in the front-rear and right-left directions and is, in plane view, formed into the same size as or a slightly larger size than that of the sheet-shaped encapsulating sheet 4.

[0054]

The conveying heater 16 is incorporated into the absorbing device 39. The heating temperature thereof is changeably set to the desired temperature of each of the producing devices, to be specific, the first removing device 17, the first peeling device 49, the disposing device 51, the encapsulating device 12, and the second peeling device 50 in accordance with the corresponding each of the steps.

[0055]

In the first removing device 17, a receiving roll, which is not shown, for receiving the supporting layer 43 is provided.

[0056]

As shown in FIG. 1, in the first peeling device 49, the first conveying device 14 that is continuous to the first removing device 17 is provided. As shown in FIG. 2 (c), the first peeling device 49 has a peeling structure that is provided at the lower side of the first conveying device 14. The peeling structure is configured to enable a second peeling layer 34 to be peeled from the encapsulating layer 31. Examples thereof include a peeling structure including a pressure-sensitive adhesive tape 52 and a roll 53 having it wound therearound and a known peeling structure.

[0057]

As shown in FIG. 1, in the disposing device 51, the first conveying device 14 that is continuous to the first peeling device 49 is provided. As shown in FIG. 2 (d), the disposing device 51 includes a disposing plate 56 that incorporates a disposing heater 61 as a preliminary heating device thereinto and a positioning device that is not shown.

[0058]

The disposing plate 56 is formed into a generally flat plate shape extending in a plane direction. In this manner, the disposing device 51 is configured to be capable of receiving a substrate 3 that is supplied from the substrate preparing device 24 (ref: FIG. 1). The disposing heater 61 is incorporated into the disposing plate 56, so that the disposing plate 56 is configured to be capable of preliminarily heating the encapsulating sheet 4 that is disposed on the substrate 3.

[0059]

The positioning device that is not shown includes, for example, a camera for detecting the position of the encapsulating sheet 4 with respect to the plurality of semiconductor elements 2 mounted on the substrate 3 and a controlling device (CPU etc.) that adjusts the position of (the lower end portion of) the arm 37 in the front-rear and right-left directions based on the position of the encapsulating sheet 4 detected by the camera.

[0060]

In the disposing device 51 and the encapsulating device 12 to be described next, a second conveying device, which is not shown, for conveying the substrate 3 disposed on the disposing plate 56 from the disposing device 51 to the encapsulating device 12 is provided. The

disposing device 51 configures a device for performing a part of the encapsulating step (preliminary heating step) to be described later.

[0061]

The substrate preparing device 24 is configured to be capable of preparing the sheet-shaped substrate 3 on which the plurality of semiconductor elements 2 are mounted shown in FIG. 2 (d) and supply (transmit) the substrate 3 to the disposing device 51.

[0062]

The preparing device 11 includes an ambient temperature/humidity controlling device (not shown). The ambient temperature/humidity controlling device is a device that controls the ambient temperature and/or humidity of the encapsulating sheet 4 that is prepared in the preparing device 11. An example thereof includes a known ambient temperature/humidity controlling device. A case that is not shown is provided around the preparing device 11. The preparing device 11 is covered with the case. In this manner, the preparing device 11 is separated from the outside air. The case prevents the outside air from flowing into the preparing device 11 and the temperature and/or humidity inside the case is further surely controlled.

[0063]

As shown in FIG. 1, the encapsulating device 12 includes the first conveying device 14 that is continuous to the preparing device 11. As shown in FIG. 3 (e), the encapsulating device 12 includes a hot pressing device 26 as a main heating device. The hot pressing device 26 includes, as two pieces of pressing members, a first pressing plate 27 and a second pressing plate 28 that are disposed in opposed relation at spaced intervals to each other in the up-down direction.

[0064]

The first pressing plate 27 is formed into a flat plate shape extending in the front-rear and right-left directions and is disposed at the lower portion of the hot pressing device 26. The second pressing plate 28 is disposed in opposed relation to the upper side of the first pressing plate 27 at spaced intervals thereto. The second pressing plate 28 is disposed so as to be substantially in parallel to the first pressing plate 27.

[0065]

The second pressing plate 28 is formed into the same shape as that of the first pressing plate 27 and is configured to be capable of relatively moving in the up-down direction with

respect to the first pressing plate 27. To be specific, the second pressing plate 28 is configured to be capable of pressing the encapsulating sheet 4 sandwiched between the first pressing plate 27 and the second pressing plate 28.

[0066]

A heater that is not shown is incorporated into each of the first pressing plate 27 and the second pressing plate 28.

[0067]

The encapsulating device 12 includes the above-described hot pressing device 26, so that it is configured to collectively encapsulate the plurality of semiconductor elements 2 by the prepared encapsulating sheet 4.

[0068]

As shown in FIG. 1, the collecting device 13 includes, as a peeling device, the second peeling device 50 that is connected to the front side of the encapsulating device 12; as a removing device, a second removing device 18 that is disposed at the front side of the second peeling device 50; and a semiconductor device-collecting device 40 that is disposed at the front side of the second removing device 18. By the above-described arrangement of the second peeling device 50, the second removing device 18, and the semiconductor device-collecting device 40, the collecting device 13 is, in plane view, formed into a generally linear shape in plane view extending from the encapsulating device 12 forwardly.

[0069]

As shown in FIG. 3 (f), the second peeling device 50 includes a peeling structure and a supporting plate 54.

[0070]

The peeling structure is configured to enable the first peeling layer 33 to be peeled from the encapsulating layer 31. An example thereof includes the same peeling structure (to be specific, a peeling structure including the pressure-sensitive adhesive tape 52 and the roll 53) as that of the above-described first peeling device 49.

[0071]

The supporting plate 54 is disposed at the lower portion of the second peeling device 50, to be specific, at the lower side of the peeling structure. A supporting heater 62, as an encapsulating sheet temperature controlling device, is incorporated into the supporting plate 54. The second peeling device 50 is configured to be capable of heating the semiconductor device 1

that is disposed on the upper surface of the supporting plate 54 by the supporting heater 62.

[0072]

As shown by phantom lines in FIG. 3 (f), the second peeling device 50 includes the first conveying device 14 that is continuous to the preparing device 11 and the encapsulating device 12.

[0073]

As shown in FIG. 3 (g), the second removing device 18 includes a case 22 for housing the semiconductor device 1 and a cutting member 45 as a first cutting member.

[0074]

The case 22 is formed into a bottomed box shape having an opening upwardly and integrally includes a bottom wall and four side walls extending from the circumferential end portion of the bottom wall upwardly. In each of the side walls of the case 22, a suction port 23 passing through the thickness direction thereof is formed and a suction device that is not shown is connected thereto.

[0075]

Furthermore, a spray port (not shown) that is capable of spraying gas to the semiconductor device 1 is provided at the upper portion of the case 22.

[0076]

The cutting member 45 includes a main axis that extends in the up-down direction and is capable of freely moving in the front-rear and right-left directions and a rotary blade that is disposed at the lower end portion of the main axis and is formed to be rotatable with respect to the main axis. To be specific, an example thereof includes a milling machine (preferably, a horizontal milling machine or the like) including a plain milling cutter as a rotary blade. The cutting member 45 is configured to allow the main axis to move circumferentially around the semiconductor device 1 and remove (cut) an excess portion 35 (described later) in the encapsulating sheet 4.

[0077]

In the semiconductor device-collecting device 40, a cassette that is not shown is provided detachably with respect to the semiconductor device-collecting device 40. In this manner, the semiconductor device-collecting device 40 is configured to allow the obtained semiconductor device 1 to be housed in the cassette and collect the semiconductor device 1 together with the cassette.

[0078]

In this manner, the semiconductor device-collecting device 40 is configured to collect the plurality of semiconductor elements 2 encapsulated by the encapsulating sheet 4.

[0079]

The collecting device 13 includes a third conveying device that is not shown. To be specific, the third conveying device is disposed over the second peeling device 50, the second removing device 18, and the semiconductor device-collecting device 40 in the collecting device 13. An example of the third conveying device includes a known conveying device such as a conveying device that supports (scoops up) the semiconductor device 1 from which the first peeling layer 33 is peeled by the second peeling device 50 from the lower side thereof and conveys it forwardly.

[0080]

Next, a method for producing the semiconductor device 1 is described using the producing device 10.

[0081]

In this method, the semiconductor device 1 is obtained by encapsulating the semiconductor elements 2 by the encapsulating sheet 4. To be specific, the method includes the steps of preparing the encapsulating sheet 4 and the plurality of semiconductor elements 2; after the preparing step, collectively encapsulating the plurality of semiconductor elements 2 by the encapsulating sheet 4; and after the encapsulating step, collecting the encapsulating sheet 4 and the plurality of semiconductor elements 2.

[0082]

In this method, first, the preparing step is performed with the preparing device 11 in the producing device 10.

[0083]

To be specific, as shown in FIGS. 2 (a) and 4, first, the long-length encapsulating sheet 4 is wound around the transmitting roll 29 of the transmitting device 8.

[0084]

As shown in FIG. 4, the encapsulating sheet 4 is prepared as a long-length sheet. Thereafter, the encapsulating sheet 4 is shaped into a sheet in a generally circular shape in plane view corresponding to the substrate 3 to be subjected to encapsulation of the semiconductor elements 2 (described later).

[0085]

As shown in FIG. 2 (a), the encapsulating sheet 4 is prepared as a laminated sheet including the encapsulating layer 31 and as a protecting member, the peeling layers 32 that are laminated on the upper and lower surfaces of the encapsulating layer 31.

[0086]

The encapsulating layer 31 is formed from an encapsulating material into a sheet shape. Examples of the encapsulating material include thermosetting resins such as thermosetting silicone resin, epoxy resin, thermosetting polyimide resin, phenol resin, urea resin, melamine resin, unsaturated polyester resin, diallylphthalate resin, and thermosetting urethane resin. An example thereof also includes a thermosetting resin composition containing the above-described thermosetting resin and an additive at an appropriate proportion.

[0087]

Examples of the additive include fillers and phosphors. Examples of the fillers include inorganic microparticles such as silica, titania, talc, alumina, aluminum nitride, and silicon nitride and organic microparticles such as silicone particles. The phosphors have a wavelength conversion function. Examples thereof include yellow phosphors capable of converting blue light into yellow light and red phosphors capable of converting blue light into red light. Examples of the yellow phosphors include garnet-type phosphors such as $\text{Y}_3\text{Al}_5\text{O}_{12}:\text{Ce}$ (YAG (yttrium aluminum garnet):Ce). Examples of the red phosphors include nitride phosphors such as $\text{CaAlSiN}_3:\text{Eu}$ and $\text{CaSiN}_2:\text{Eu}$.

[0088]

The encapsulating layer 31 is prepared in a semi-solid state before encapsulation of the semiconductor elements 2. To be specific, when the encapsulating material contains a thermosetting resin, for example, the encapsulating layer 31 is prepared in a state before complete curing (C-stage), that is, in a semi-cured (B-stage) state.

[0089]

The size of the encapsulating layer 31 is appropriately set in accordance with the size of the semiconductor element 2 and the substrate 3. To be specific, when the encapsulating sheet 4 is prepared as a long-length sheet, the encapsulating layer 31 has a length in the right-left direction, that is, a width of, for example, 100 mm or more, or preferably 200 mm or more, and, for example, 1500 mm or less, or preferably 700 mm or less. The thickness thereof is appropriately set in accordance with the size of the semiconductor element 2. The

encapsulating layer 31 has a thickness of, for example, 30 μm or more, or preferably 100 μm or more, and, for example, 3000 μm or less, or preferably 1000 μm or less.

[0090]

As shown in FIG. 2 (a), the peeling layers 32 are a protecting sheet that protects the upper and lower surfaces (both surfaces) of the encapsulating layer 31 before encapsulation of the semiconductor elements 2. The peeling layers 32 include the first peeling layer 33 that is laminated on the entire upper surface of the encapsulating layer 31 and the second peeling layer 34 that is laminated on the entire lower surface thereof.

[0091]

The first peeling layer 33 is a protecting sheet that protects the upper surface (one surface) of the encapsulating layer 31 before and at the time of encapsulation of the semiconductor elements 2. To be specific, examples thereof include polymer sheets such as polyethylene sheet, polyester sheet (PET and the like), polystyrene sheet, polycarbonate sheet, and polyimide sheet; ceramic sheets; and metal foils. In the first peeling layer 33, peeling treatment such as fluorine treatment can be also applied to a contact surface thereof in contact with the encapsulating layer 31. The size of the first peeling layer 33 is appropriately set in accordance with the peeling conditions of the second peeling device 50 (ref: FIG. 3 (f)) to be described later. The first peeling layer 33 has a thickness of, for example, 15 μm or more, or preferably 25 μm or more, and, for example, 125 μm or less, or preferably 75 μm or less.

[0092]

The second peeling layer 34 is a protecting sheet that protects the lower surface (one surface) of the encapsulating layer 31 before, at the time of, and after encapsulation of the semiconductor elements 2. The material and the size thereof are appropriately set in accordance with the peeling conditions of the first peeling device 49 (ref: FIG. 2 (c)) to be described later and to be specific, are the same as those of the first peeling layer 33.

[0093]

The encapsulating sheet 4 includes the supporting layer 43 that supports the encapsulating sheet 4.

[0094]

The supporting layer 43 forms the rear surface of the encapsulating sheet 4 before encapsulation of the semiconductor elements 2. To be specific, the supporting layer 43 is laminated on the entire lower surface of the second peeling layer 34. The supporting material

that forms the supporting layer 43 is not particularly limited as long as it is a material that supports the second peeling layer 34. Examples thereof include polymer sheets such as polyethylene sheet, polyester sheet (PET and the like), polystyrene sheet, polycarbonate sheet, and polyimide sheet; ceramic sheets; and metal foils. The supporting layer 43 has a thickness of, for example, 15 μm or more, or preferably 25 μm or more, and, for example, 125 μm or less, or preferably 75 μm or less.

[0095]

The ambient temperature/humidity controlling device of the preparing device 11 is activated and the temperature and/or humidity of the ambience of the preparing device 11 (that is, the ambience of the encapsulating sheet 4) inside the case are/is controlled in advance. To be specific, the temperature is controlled to, for example, 15 to 40°C and the humidity is controlled to, for example, 25 to 60 %RH (ambient temperature/humidity controlling step).

[0096]

Furthermore, the conveying heater 16 in the absorbing device 39 shown in FIG. 2, the disposing heater 61, the heaters in the first pressing plate 27 and the second pressing plate 28 shown in FIG. 3, and the supporting heater 62 are set at a predetermined temperature in advance. To be specific, the conveying heater 16 is heated at a temperature corresponding to the first removing device 17, for example, 40 to 100°C. The disposing heater 61 is heated at, for example, 50 to 90°C. The heaters in the first pressing plate 27 and the second pressing plate 28 are, when the encapsulating material is a thermosetting resin, for example, heated at or more than a temperature at which the thermosetting resin completely cures (is brought into a C-stage state) as needed. Also, the heaters in the first pressing plate 27 and the second pressing plate 28 are set at a temperature higher than that of the disposing heater 61, to be specific, set higher than the temperature of the disposing heater 61 by, for example, 10°C or more, or preferably 20°C or more, and, for example, 120°C or less, or preferably 80°C or less. The heaters in the first pressing plate 27 and the second pressing plate 28 are heated at, for example, 60 to 210°C. The supporting heater 62 is heated at a temperature capable of preventing warping of the encapsulating layer 31, for example, set at a temperature different from that of the first pressing plate 27 and the second pressing plate 28, for example, set lower than the temperature thereof by, for example, 10°C or more, or preferably 20°C or more, and, for example, 20°C or less, or preferably 10°C or less. To be specific, the supporting heater 62 is heated at 50 to 200°C.

[0097]

The conveying heater 16 is, in the first removing device 17 and the first peeling device 49 (and the disposing device 51) in the preparing device 11, controlled to a temperature corresponding to each of the devices (steps) of the producing device 10.

[0098]

Next, as shown by arrows in FIGS. 2 (a) and 4, the encapsulating sheet 4 is transmitted from the transmitting roll 29 in the transmitting device 8 forwardly.

[0099]

Next, as shown in FIGS. 2 (b) and 4, in the first removing device 17, the encapsulating sheet 4 is first divided into the encapsulating portions 55 that are subjected to encapsulation of the plurality of semiconductor elements 2 and the margin portion 36 that surrounds the encapsulating portions 55 with the pre-cutters 44. The encapsulating portions 55 are, for example, formed into generally circular shapes in plane view and are, in the long-length encapsulating sheet 4, disposed in alignment at spaced intervals to each other in the front-rear direction. The encapsulating portions 55 are set so as to have the same shape and the same size as those of the outer shape of the substrate 3. The margin portion 36 is integrally formed from both end portions in the widthwise direction of both sides in the right-left direction of each of the encapsulating portions 55 and a connecting portion that connects the above-described both end portions in the widthwise direction between the encapsulating portions 55 that are adjacent to each other in the front-rear direction. The pre-cutters 44 fail to cut the supporting layer 43 in the thickness direction, while cutting the encapsulating layer 31 and the peeling layers 32 in the thickness direction.

[0100]

Next, as shown by a dashed line arrow in FIG. 2 (b), in the preparing device 11, the margin portion 36 is peeled from the supporting layer 43 with a margin portion peeling device that is not shown. In this manner, the margin portion 36 in the encapsulating sheet 4 is removed (first removing/shaping step as a shaping step that is the removing step in the preparing step).

[0101]

Next, as referred to FIG. 2 (b), the lower end portion of the arm 37 extends, that is, the lower end portion of the arm 37 is lowered, so that the lower end surface of the absorbing device 39 is brought into contact with the upper surface of the encapsulating sheet 4 (first peeling layer 33 in the encapsulating portion 55). Subsequently, the sheet-shaped encapsulating sheet 4 is absorbed by an absorbing function of the absorbing device 39. That is, the encapsulating sheet

4 is absorbed to the lower end portion of the arm 37.

[0102]

Next, as shown by the arrow and the phantom lines in FIG. 2 (b), the lower end portion of the arm 37 is shortened, that is, the lower end portion of the arm 37 is raised, so that the encapsulating sheet 4, to be specific, the encapsulating layer 31 and the peeling layers 32 are peeled from the supporting layer 43. In this manner, the encapsulating portion 55 in the encapsulating sheet 4 is separated from the supporting layer 43. That is, the encapsulating portion 55 in the sheet-shaped encapsulating sheet 4 is lifted up from the supporting layer 43.

[0103]

The supporting layer 43 from which the encapsulating portion 55 is peeled is received by a receiving roll that is not shown in the first removing device 17.

[0104]

Subsequently, as referred to FIG. 1, the arm 37 is moved forwardly along the rail 38 and the sheet-shaped encapsulating sheet 4 is conveyed to the first peeling device 49.

[0105]

As shown in FIG. 2 (c), in the first peeling device 49, the second peeling layer 34 is peeled from the encapsulating layer 31 by the peeling structure (first peeling step as a peeling step in the preparing step).

[0106]

In the first peeling step, the temperature of the conveying heater 16 can be controlled to a temperature corresponding to the peeling of the second peeling layer 34 by the peeling structure.

[0107]

Subsequently, the arm 37 is moved forwardly along the rail 38 and the sheet-shaped encapsulating sheet 4 is conveyed to the disposing device 51.

[0108]

In the substrate preparing device 24 shown in FIG. 1, the sheet-shaped substrate 3 on which the plurality of semiconductor elements 2 are mounted is separately prepared.

[0109]

The substrate 3 is not particularly limited as long as it is a mounting substrate that is mounted with the semiconductor elements 2. The substrate 3 is formed of, for example, an insulating substrate such as a laminated substrate obtained by laminating an insulating layer on a silicon substrate, a ceramic substrate, a polyimide resin substrate, or a metal substrate. The

outer shape of the substrate 3, that is, the shape in plane view thereof, is formed into substantially the same as that of the semiconductor device 1 to be obtained and for example, is formed as a sheet-shaped flat plate in a generally circular shape in plane view. The size of the substrate 3 is appropriately set in accordance with the intended use and purpose of the semiconductor device 1. The substrate 3 has a size of, for example, 50 mm or more, or preferably 100 mm or more, and, for example, 1500 mm or less, or preferably 700 mm or less.

[0110]

The plurality of semiconductor elements 2 are provided with respect to one substrate 3. The plurality of semiconductor elements 2 are disposed in alignment at spaced intervals to each other in the front-rear and right-left directions. Each of the semiconductor elements 2 is mounted on the surface of the substrate 3 by, for example, wire-bonding connection or flip-chip mounting. Each of the semiconductor elements 2 is formed into a generally rectangular shape in sectional view with its thickness (length in the up-down direction) shorter than the maximum length thereof in a plane direction (direction along the front-rear and right-left directions).

[0111]

Examples of the semiconductor elements 2 include optical semiconductor elements and electronic elements.

[0112]

Examples of the optical semiconductor elements include LED (light emitting diode elements) and LD (laser diode elements). They are semiconductor elements that convert electrical energy to light energy.

[0113]

Electronic elements are semiconductor elements that convert electrical energy to energy other than light, to be specific, to signal energy or the like. Specific examples thereof include transistors and diodes.

[0114]

The size and the arrangement of the semiconductor elements 2 are appropriately set in accordance with the intended use and purpose of the semiconductor device 1. Each of the semiconductor elements 2 has a thickness of, for example, 50 μm or more, or preferably 100 μm or more, and, for example, 1000 μm or less, or preferably 700 μm or less. Each of the semiconductor elements 2 has a maximum length in the plane direction of, for example, 1 mm or more, or preferably 3 mm or more, and, for example, 50 mm or less, or preferably 30 mm or less.

An interval (interval in the front-rear direction or in the right-left direction) between the semiconductor elements 2 that are adjacent to each other is, for example, 0.01 mm or more, or preferably 0.05 mm or more, and, for example, 30 mm or less, or preferably 10 mm or less.

[0115]

Thereafter, the substrate 3 on which the plurality of semiconductor elements 2 are mounted is supplied (conveyed) from the substrate preparing device 24 to the disposing device 51 with, for example, a known supply device (conveying device) such as a belt conveyor.

[0116]

Thereafter, as shown in FIG. 2 (d), in the disposing device 51, the encapsulating sheet 4 is disposed on the substrate 3 on which the plurality of semiconductor elements 2 are mounted.

[0117]

To be specific, as shown by the arrow in FIG. 2 (d), the lower end portion of the arm 37 is lowered and the lower surface of the encapsulating layer 31 in the encapsulating sheet 4 is brought into contact with the upper surfaces of the plurality of semiconductor elements 2. Subsequently, the encapsulating sheet 4 is detached (pulled apart) from the lower end portion of the arm 37 by the termination of the absorbing function of the absorbing device 39.

[0118]

In this manner, the encapsulating sheet 4 is disposed on the upper surfaces of the plurality of semiconductor elements 2.

[0119]

At this time, the position of the encapsulating sheet 4 with respect to the plurality of semiconductor elements 2 is detected with a camera in the positioning device that is not shown. The position of the lower end portion of the arm 37 in the front-rear and right-left directions is adjusted based on the position of the encapsulating sheet 4 detected with the camera (positioning step). To be specific, the encapsulating sheet 4 is positioned with respect to the substrate 3 so that the circumferential end portion of the encapsulating sheet 4 is, in plane view, at the same position as that of the substrate 3.

[0120]

In this manner, the substrate 3, the plurality of semiconductor elements 2, and the encapsulating sheet 4 are prepared (preparing step).

[0121]

Along with the above-described disposition, a part of the encapsulating step is started.

[0122]

To be specific, a preliminary heating step in the encapsulating step is performed in the disposing device 51.

[0123]

In the disposing device 51, the temperature of the conveying heater 16 can be controlled to a temperature different from that set in the first peeling device 49.

[0124]

In the disposing device 51, the disposing heater 61 is heated at the above-described temperature, so that the encapsulating sheet 4 is heated in advance, that is, heated before the subsequent main heating in the hot pressing device 26. That is, in the preliminary heating step, the encapsulating sheet 4 is preliminarily heated. By the preliminary heating step, the encapsulating layer 31 in the encapsulating sheet 4 becomes flexible.

[0125]

Next, as referred to FIG. 1, the substrate 3 on which the encapsulating sheet 4 is disposed is conveyed from the disposing device 51 to the encapsulating device 12 by the second conveying device that is not shown. To be specific, as shown in FIG. 3 (e), the substrate 3 is disposed on the upper surface of the first pressing plate 27.

[0126]

Subsequently, in the encapsulating device 12, the substrate 3, the semiconductor elements 2, and the encapsulating sheet 4 (including the first peeling layer 33) are hot-pressed with the hot pressing device 26 (main heating step).

[0127]

To be specific, the encapsulating sheet 4 that is sandwiched between the first pressing plate 27 and the second pressing plate 28 is hot-pressed. To be more specific, the second pressing plate 28 is pushed into (subjected to thermocompression bonding to) the first pressing plate 27 so that the flexible encapsulating layer 31 in the encapsulating sheet 4 is capable of surely covering the entire surfaces (upper and side surfaces) of the semiconductor elements 2 and the encapsulating layer 31 fills a space between the semiconductor elements 2 that are adjacent to each other. In the thermocompression bonding, the encapsulating layer 31 fills the above-described space so as not to cause a void in the above-described space.

[0128]

By the above-described hot pressing, the circumferential end portions (both end portions in

the front-rear direction and both end portions in the right-left direction) of the encapsulating layer 31 protrude from the circumferential end portions (both end portions in the front-rear direction and both end portions in the right-left direction) of the first peeling layer 33 and the encapsulating sheet 4 outwardly (toward both outer sides in the front-rear direction and both outer sides in the right-left direction, that is, a direction orthogonal to a pressing direction of the hot pressing device 26). That is, while the encapsulating sheet 4 is hot-pressed, the excess portion 35 in the encapsulating sheet 4 occurs (excess portion occurring step).

[0129]

The pressing pressure in the hot pressing is, for example, 0.01 MPa or more, preferably 0.1 MPa or more, or more preferably 1 MPa or more, and, for example, 10 MPa or less.

[0130]

The hot pressing device 26 is controlled so that a degree of parallelization of the second pressing plate 28 to the first pressing plate 27 is 100 μm or less.

[0131]

Furthermore, the hot pressing device 26 is controlled so that a distribution of the pressing pressure of the first pressing plate 27 and the second pressing plate 28 is within 10 %.

[0132]

Moreover, the hot pressing device 26 is controlled so that a temperature distribution of the first pressing plate 27 and the second pressing plate 28 is within 10°C.

[0133]

By the above-described hot pressing, when the encapsulating material is a thermosetting resin, the encapsulating layer 31 in the encapsulating sheet 4 can be allowed to completely cure (brought into a C-stage state). Alternatively, in the producing device 10 of the semiconductor device, the semiconductor device 1 to be described next is taken out from the producing device 10 of the semiconductor device without completely curing the encapsulating layer 31 in the encapsulating sheet 4 (without bringing it into a C-stage state). Thereafter, the encapsulating layer 31 in the encapsulating sheet 4 can be also allowed to completely cure (brought into a C-stage state) with, for example, an oven or the like.

[0134]

Accordingly, the plurality of semiconductor elements 2 are encapsulated by the encapsulating sheet 4. In this manner, the semiconductor device 1 is obtained.

[0135]

Thereafter, the collecting step is performed with the collecting device 13.

[0136]

That is, as referred to FIG. 1, first, the semiconductor device 1 is conveyed to the second peeling device 50 by the first conveying device 14 in the encapsulating device 12. To be specific, as referred to FIG. 3 (e), the lower end portion of the arm 37 extends, that is, the lower end portion of the arm 37 is lowered, so that the lower end surface of the absorbing device 39 is brought into contact with the upper surface of the first peeling layer 33 of the semiconductor device 1. Subsequently, the semiconductor device 1 is absorbed by an absorbing function of the absorbing device 39. That is, the semiconductor device 1 is absorbed to the lower end portion of the arm 37.

[0137]

Subsequently, the lower end portion of the arm 37 is shortened, that is, the lower end portion of the arm 37 is raised, so that the semiconductor device 1 is lifted up from the first pressing plate 27.

[0138]

Thereafter, the arm 37 of the first conveying device 14 is moved forwardly along the rail 38 and the semiconductor device 1 is conveyed to the second peeling device 50.

[0139]

In conveyance of the semiconductor device 1 by the first conveying device 14, the conveying heater 16 can be controlled to a temperature capable of suppressing deformation such as warping of the encapsulating layer 31 that encapsulates the plurality of semiconductor elements 2 (encapsulating sheet temperature controlling step in the collecting step).

[0140]

In the second peeling device 50, the first peeling layer 33 is peeled from the encapsulating layer 31 by the peeling structure (second peeling step as the peeling step in the collecting step).

[0141]

In the second peeling step, the conveying heater 16 is heated to a temperature capable of suppressing deformation such as warping of the encapsulating layer 31, to be specific, can be controlled to a temperature different from that of the first pressing plate 27 and the second pressing plate 28.

[0142]

Next, the semiconductor device 1 from which the first peeling layer 33 is peeled is

conveyed from the second peeling device 50 to the second removing device 18 by the third conveying device that is not shown. To be specific, the semiconductor device 1 is housed in the case 22. To be more specific, by the third conveying device that is not shown, the substrate 3 of the semiconductor device 1 is scooped up from the lower side thereof to be conveyed forwardly. Then, as shown in FIG. 3 (g), the substrate 3 of the semiconductor device 1 is disposed on the upper surface of the bottom wall of the case 22.

[0143]

Next, in the second removing device 18, the excess portion 35 is cut by the cutting member 45 and the outer shape of the encapsulating sheet 4 is shaped (second removing/shaping step as the shaping step that is the removing step in the collecting step).

[0144]

In the second removing/shaping step, the excess portion 35 is cut by the cutting member 45 that moves circumferentially around the semiconductor device 1 and the outer shape of the encapsulating layer 31 in the encapsulating sheet 4 is shaped. To be specific, the main axis of the cutting member 45 is moved circumferentially around the semiconductor device 1 and the rotary blade is rotated around the main axis, so that the excess portion 35 is cut and removed.

[0145]

Also, for example, gas such as the air is sprayed to the semiconductor device 1 from the spray port that is not shown and the suction device connected to the suction port 23 is activated.

[0146]

Cutting chips caused by cutting of the excess portion 35 are blown off from the semiconductor device 1 by the gas sprayed from the spray port to be absorbed into the suction port 23, so that they are discharged from the case 22.

[0147]

While the excess portion 35 is cut by the cutting member 45, the encapsulating layer 31 in the encapsulating sheet 4 is formed into the same shape as that of the substrate 3 in plane view. In this manner, the outer shape of the semiconductor device 1 is shaped.

[0148]

Thereafter, as shown in FIG. 3 (h), the shaped semiconductor device 1 is conveyed from the second removing device 18 to the semiconductor device-collecting device 40 by the third conveying device.

[0149]

To be specific, in the semiconductor device-collecting device 40, the semiconductor device 1 is housed in a cassette that is not shown by the third conveying device. In this manner, the cassette housing the semiconductor device 1 is collected.

[0150]

According to the producing method of the semiconductor device 1 performed by using the above-described producing device 10, the encapsulating sheet 4 and the plurality of semiconductor elements 2 are prepared; then, the plurality of semiconductor elements 2 are collectively encapsulated by the encapsulating sheet 4; and then, the encapsulating sheet 4 and the plurality of semiconductor elements 2 are collected, so that the semiconductor device 1 that collectively encapsulates the plurality of semiconductor elements 2 and includes them can be easily produced. Thus, the semiconductor device 1 in which the plurality of semiconductor elements 2 are encapsulated by the encapsulating sheet 4 can be used in accordance with various purposes and intended uses.

[0151]

According to the producing method, the margin portion 36 (ref: the dashed lines in FIG. 2 (b), and FIG. 4) and the excess portion 35 (ref: FIG. 3 (g)) in the encapsulating sheet 4 are removed, so that the semiconductor device 1 in a desired shape can be obtained.

[0152]

That is, as shown by the dashed lines in FIG. 2 (b), the margin portion 36 in the encapsulating sheet 4 is removed, so that in the positioning step shown in FIG. 2 (d), the positioning accuracy of the encapsulating portion 55 with respect to the substrate 3 and the plurality of semiconductor elements 2 can be improved.

[0153]

As shown in FIG. 3 (g), by removing the excess portion 35 in the encapsulating layer 31, as shown in FIG. 3 (f), the outer shape of the semiconductor device 1 is shaped, so that the semiconductor device 1 having excellent size accuracy can be obtained.

[0154]

According to the producing method, by the positioning step of positioning with respect to the plurality of semiconductor elements 2 performed by the positioning device that is not shown, the plurality of semiconductor elements 2 can be encapsulated with excellent accuracy. Thus, the semiconductor device 1 can be produced with excellent accuracy.

[0155]

According to the producing method, by the encapsulating sheet temperature controlling step of controlling the temperature of the encapsulating sheet 4 performed by the conveying heater 16 in the encapsulating device 12 and the second peeling device 50 and by the supporting heater 62 in the second peeling device 50, deformation of the encapsulating sheet 4 after encapsulation of the plurality of semiconductor elements 2 can be effectively prevented. Thus, the semiconductor device 1 in a desired shape can be produced.

[0156]

According to the producing method, by the preliminary heating step performed by the conveying heater 16 and the disposing heater 61 in the disposing device 51, the encapsulating sheet 4 becomes flexible and thereafter, by the main heating step performed by the hot pressing device 26, the semiconductor elements 2 can be surely encapsulated. Thus, while the encapsulating sheet 4 is easily shaped into a desired shape, the semiconductor elements 2 can be encapsulated by the encapsulating sheet 4. As a result, the semiconductor device 1 in a desired shape can be produced.

[0157]

According to the producing method, by the ambient temperature/humidity controlling device of the preparing device 11 (not shown), the ambient temperature and/or humidity of the encapsulating sheet 4 in the preparing device 11 can be controlled, so that the condition of the encapsulating sheet 4 before encapsulation of the semiconductor elements 2 is fixed and the semiconductor device 1 can be stored and conveyed, while being retained at constant quality. Thus, the accuracy of encapsulation of the semiconductor elements 2 by the encapsulating sheet 4 can be improved.

[0158]

According to the producing method, in the preparing step performed by the preparing device 11, the excess portion 35 in the encapsulating sheet 4 is removed and the outer shape of the encapsulating sheet 4 is shaped, so that the semiconductor elements 2 can be encapsulated with excellent handleability by the shaped encapsulating sheet 4.

[0159]

According to the producing method, the encapsulating sheet 4 can be protected by the peeling layers 32 and in the first peeling step and the second peeling step, the peeling layers 32 that are unnecessary for the encapsulation of the semiconductor elements 2 can be peeled from the encapsulating sheet 4. To be specific, the second peeling layer 34 laminated on the lower

surface of the encapsulating layer 31 can be peeled from the encapsulating layer 31 by the first peeling step performed by the first peeling device 49. Also, the first peeling layer 33 laminated on the upper surface of the encapsulating layer 31 can be peeled from the encapsulating layer 31 by the second peeling step performed by the second peeling device 50.

[0160]

Furthermore, for example, when a concave portion corresponding to the encapsulating sheet 4 and the semiconductor elements 2 after encapsulation is formed in each of the first pressing plate 27 and the second pressing plate 28 in the hot pressing device 26 (when not formed into a flat plate shape), after the substrate 3 on which the encapsulating sheet 4 is disposed is positioned with respect to the position corresponding to the concave portion in the first pressing plate 27, the substrate 3 is required to be fitted into the concave portion.

[0161]

On the contrary, in the embodiment in FIG. 2, the first pressing plate 27 and the second pressing plate 28 in the hot pressing device 26 are formed into flat plate shapes, so that the substrate 3 on which the encapsulating sheet 4 is disposed can be disposed at an arbitrary position on the upper surface of the first pressing plate 27. Thus, the encapsulating step can be quickly and easily performed with less number of steps.

[0162]**<Modified Example>**

In the encapsulating sheet 4, a reference hole (not shown) used in the positioning step of the encapsulating sheet 4 can be also formed in a position (preferably, both side end portions in the right-left direction) corresponding to a portion separated from the semiconductor element 2 in the front-rear direction or the right-left direction. The reference hole is formed in the encapsulating sheet 4 by the pre-cutters 44.

[0163]

Meanwhile, a reference mark corresponding to the reference hole in the encapsulating sheet 4 can be also formed in the substrate 3.

[0164]

In the positioning step using the positioning device, the encapsulating sheet 4 can be also positioned with respect to the substrate 3 on which the semiconductor elements 2 are mounted by confirming overlapping of the position of the reference hole in the encapsulating sheet 4 with that of the reference mark in the substrate 3 in plane view with a camera.

[0165]

The reference hole can be formed so as to pass through the first peeling layer 33, the encapsulating layer 31, and the second peeling layer 34 or can be also formed only in the first peeling layer 33.

[0166]

Also, the disposing plate 56 can have an elevating function of elevating in the up-down direction. In this manner, deformation of the encapsulating layer 31 in the encapsulating sheet 4 by heating can be prevented in the positioning step.

[0167]

In the preliminary heating step performed by the conveying heater 16 and the disposing heater 61 in the disposing device 51, the encapsulating sheet 4 is arranged at the upper side and the substrate 3 is arranged at the lower side. Alternatively, for example, though not shown, the arrangement thereof can be also reversed, that is, the encapsulating sheet 4 can be arranged at the lower side and the substrate 3 can be arranged at the upper side. In this manner, heat sagging of the encapsulating sheet 4, which becomes flexible by the preliminary heating step, caused by preliminary heating is prevented and the encapsulating sheet 4 can be supported from the lower side thereof by, for example, the disposing plate 56 or the like. Thus, the encapsulating sheet 4 and the semiconductor element 2 can be laminated with excellent handleability, while the shape of the encapsulating layer 31 in the encapsulating sheet 4 is retained.

[0168]

In the embodiment in FIG. 4, the encapsulating portion 55 and the substrate 3 (not shown in FIG. 4) are formed into circular shapes. However, the shape of the encapsulating portion 55 and/or the substrate 3 is not particularly limited and the encapsulating portion 55 and/or the substrate 3 can be also formed into appropriate shape(s) such as a generally rectangular shape in plane view (including a generally strip shape in plane view).

[0169]

In the embodiment in FIG. 1, the first removing device 17 and the second removing device 18 are provided in the preparing device 11 and the collecting device 13, respectively and both of the first removing/shaping step and the second removing/shaping step are performed. Alternatively, for example, either one of the first removing/shaping step or the second removing/shaping step can be also performed. In such a case, though not shown, either one of the first removing device 17 or the second removing device 18 can be also provided in the

[0170]

Furthermore, the semiconductor device 1 can be also obtained without performing both of the first removing/shaping step and the second removing/shaping step. In such a case, the preparing device 11 and the collecting device 13 can be also configured without providing the first removing device 17 and the second removing device 18 in the preparing device 11 and the collecting device 13, respectively.

[0171]

The positioning step is performed by providing the positioning device that is not shown in the disposing device 51 in FIG. 1. Alternatively, for example, the encapsulating sheet 4 can be also disposed in the plurality of semiconductor elements 2 without performing the positioning step. In such a case, the disposing device 51 can be also configured without providing the positioning device in the semiconductor device 1.

[0172]

The encapsulating sheet temperature controlling step is performed by providing the conveying heater 16 in the first conveying device 14 in the collecting device 13 in FIGS. 3 (e) and 3 (f). Alternatively, for example, the semiconductor device 1 can be also collected without performing the encapsulating sheet temperature controlling step. In such a case, for example, though not shown, the first conveying device 14 in the collecting device 13 can be also configured without providing the conveying heater 16 in the first conveying device 14 in the collecting device 13.

[0173]

In the embodiment in FIG. 2 (d), the preliminary heating step is performed by providing the disposing heater 61 in the disposing device 51 in the preparing device 11. Alternatively, for example, the main heating step can be also performed without performing the preliminary heating step. In such a case, the disposing device 51 can be also configured without providing the disposing heater 61 in the disposing device 51 in the preparing device 11.

[0174]

In the embodiment in FIG. 1, the ambient temperature/humidity controlling step is performed by providing the ambient temperature/humidity controlling device that is not shown in the preparing device 11. Alternatively, for example, the preparing step can be also performed without performing the ambient temperature/humidity controlling step. In such a case, the

preparing device 11 can be also configured without providing the ambient temperature/humidity controlling device.

[0175]

In the embodiment in FIG. 1, the first removing/shaping step is performed by providing the first removing device 17 in the preparing device 11. Alternatively, for example, the encapsulating sheet 4 can be also prepared without performing the first removing/shaping step. In such a case, the transmitting roll 29 in the transmitting device 8 is not provided in the semiconductor device 1 and the encapsulating sheet 4 that is shaped into a sheet in advance is prepared. Along with this, the plurality of semiconductor elements 2 mounted on the substrate 3 are prepared, so that the preparing step is performed.

[0176]

In the embodiment in FIG. 1, the encapsulating layer 31 is protected by the first peeling layer 33 and the second peeling layer 34. Alternatively, the encapsulating sheet 4 can be also configured without laminating either one of the first peeling layer 33 or the second peeling layer 34 or without laminating both of them in the encapsulating sheet 4.

[0177]

In such a case, the semiconductor device 1 can be also configured without providing either one of the first peeling device 49 or the second peeling device 50 or without providing both of them in the semiconductor device 1.

[0178]

In the embodiment in FIG. 2 (d), the encapsulating sheet 4 is disposed on the substrate 3 on which the semiconductor elements 2 are mounted in the disposing device 51. However, the disposition is not limited to this. Alternatively, for example, the disposing device 51 shown in FIG. 2 (d) also serves as the encapsulating device 12 shown in FIG. 3 (e). In the encapsulating device 12, the substrate 3 on which the semiconductor elements 2 are mounted is provided on the first pressing plate 27 in the hot pressing device 26 and subsequently, the encapsulating sheet 4 can be also disposed on the substrate 3 on which the semiconductor elements 2 are mounted.

[0179]

In the disposition of the encapsulating sheet 4, the ambience (space) in the disposing device 51 and/or the ambience (space) of the case that houses the disposing device 51 can be also brought into a reduced pressure (vacuum) with a decompression device that is not shown. To be specific, the above-described ambience (space) is depressurized in advance and next, the

encapsulating sheet 4 is disposed on the substrate 3 on which the semiconductor elements 2 are mounted.

[0180]

Alternatively, first, the encapsulating sheet 4 is disposed on the substrate 3 on which the semiconductor elements 2 are mounted and thereafter, the above-described ambience (space) can be also depressurized.

[0181]

In the embodiment in FIG. 2 (d), the substrate 3 is described as a flat plate shape having a flat surface. However, the shape of the substrate 3 is not limited to this. Alternatively, for example, a concave portion can be also formed in the upper surface of the substrate 3 or a through hole can be also formed in the substrate 3. The concave portion and the through hole include the above-described reference mark such as a reference concave portion and a reference hole and are formed in, for example, a space between the semiconductor elements 2 that are adjacent to each other. Examples of the concave portion include a V-shape ditch in which the upper portion of the substrate 3 is cut into a generally V-shape and a rectangular ditch in which the upper portion of the substrate 3 is cut into a generally rectangular shape. The through hole is, for example, formed so as to pass through the substrate 3 in the thickness direction. The shapes in plane view of the concave portion and the through hole are formed into appropriate shapes and are not particularly limited.

[0182]

While the illustrative embodiments of the present invention are provided in the above description, such is for illustrative purpose only and it is not to be construed as limiting the scope of the present invention. Modification and variation of the present invention that will be obvious to those skilled in the art is to be covered by the following claims.

Industrial Applicability

[0183]

The present invention is used for production of various semiconductor devices.

Description of the Reference Numerals

[0184]

1. Semiconductor device
2. Semiconductor element
3. Substrate

- 4. Encapsulating sheet
- 10. Producing device
- 11. Preparing device
- 12. Encapsulating device
- 13. Collecting device
- 14. Conveying device
- 16. Conveying heater
- 17. First removing device
- 18. Second removing device
- 32. Peeling layer
- 33. First peeling layer
- 34. Second peeling layer
- 35. Excess portion
- 36. Margin portion
- 41. First shaping device
- 43. Supporting layer
- 44. Pre-cutter
- 45. Cutting member
- 49. First peeling device
- 50. Second peeling device
- 61. Disposing heater
- 62. Supporting heater

CLAIMS

1. A method for producing a semiconductor device, obtained by encapsulating a semiconductor element by an encapsulating sheet, comprising the steps of:
 - preparing the encapsulating sheet and the plurality of semiconductor elements;
 - after the preparing step, collectively encapsulating the plurality of semiconductor elements by the encapsulating sheet; and
 - after the encapsulating step, collecting the encapsulating sheet and the plurality of semiconductor elements.
2. The method for producing a semiconductor device according to claim 1 further comprising:
 - a removing step of removing an excess portion in the encapsulating sheet.
3. The method for producing a semiconductor device according to claim 1, wherein the preparing step includes a positioning step of positioning the encapsulating sheet with respect to the plurality of semiconductor elements.
4. The method for producing a semiconductor device according to claim 1, wherein the collecting step includes an encapsulating sheet temperature controlling step of controlling the temperature of the encapsulating sheet.
5. The method for producing a semiconductor device according to claim 1, wherein the encapsulating step includes
 - a preliminary heating step of heating the encapsulating sheet in advance and
 - after the preliminary heating step, a main heating step of heating the encapsulating sheet to encapsulate the plurality of semiconductor elements.
6. The method for producing a semiconductor device according to claim 1, wherein the preparing step includes an ambient temperature/humidity controlling step of controlling an ambient temperature and/or humidity of the encapsulating sheet.

7. The method for producing a semiconductor device according to claim 2, wherein the preparing step includes a shaping step of removing an excess portion in the encapsulating sheet and shaping the outer shape of the encapsulating sheet.
8. The method for producing a semiconductor device according to claim 1, wherein the encapsulating sheet is protected by a protecting member and the preparing step and/or the collecting step include(s) a peeling step of peeling the protecting member from the encapsulating sheet.
9. A producing device of a semiconductor device, encapsulating a semiconductor element by an encapsulating sheet, comprising:
 - a preparing device of preparing the encapsulating sheet and the plurality of semiconductor elements;
 - an encapsulating device of collectively encapsulating the plurality of semiconductor elements by the prepared encapsulating sheet; and
 - a collecting device of collecting the plurality of semiconductor elements encapsulated by the encapsulating sheet.
10. The producing device of a semiconductor device according to claim 9 further comprising:
 - a removing device of removing an excess portion in the encapsulating sheet.
11. The producing device of a semiconductor device according to claim 9, wherein the preparing device includes a positioning device of positioning the encapsulating sheet with respect to the plurality of semiconductor elements.
12. The producing device of a semiconductor device according to claim 9, wherein the collecting device includes an encapsulating sheet temperature controlling device of controlling the temperature of the encapsulating sheet.
13. The producing method of a semiconductor device according to claim 9, wherein the encapsulating device includes

a preliminary heating device of heating the encapsulating sheet in advance and
a main heating device of heating the preliminarily heated encapsulating sheet to
encapsulate the plurality of semiconductor elements.

14. The producing device of a semiconductor device according to claim 9, wherein
the preparing device includes an ambient temperature/humidity controlling device of
controlling an ambient temperature and/or humidity of the encapsulating sheet.
15. The producing device of a semiconductor device according to claim 10, wherein
the preparing device includes a shaping device of removing an excess portion in the
encapsulating sheet and shaping the outer shape of the encapsulating sheet.
16. The producing device of a semiconductor device according to claim 9, wherein
the encapsulating sheet is protected by a protecting member and
the preparing device and/or the collecting device include(s) a peeling device of peeling
the protecting member from the encapsulating sheet.