DESCRIPTION

Title of Invention

PRESSURE-SENSITIVE ADHESIVE TAPE FOR SEMICONDUCTOR SUBSTRATE FABRICATION AND METHOD FOR MANUFACTURING SEMICONDUCTOR DEVICE

Technical Field

[0001]

The present invention relates to a pressure-sensitive adhesive tape for semiconductor substrate fabrication and a method for manufacturing a semiconductor device.

Background Art

[0002]

In recent years, as electronic instruments have been improved functionally and become more widely used in mobile devices, a demand for semiconductor devices that have higher density and are more highly integrated has become strong, and hence the capacity and density of IC packages have been continuously increased.

[0003]

Examples of the semiconductor devices include a semiconductor device obtained by mounting semiconductor elements on a substrate and organizing them into modules. Further, as a method for manufacturing such a semiconductor

device, for example, the following method has been proposed.

[0004]

That is, first, a plurality of semiconductor elements are loaded on a substrate, and then sealing is performed using a sealing portion formed of a sealing material such that the semiconductor elements loaded on the substrate are covered, thereby obtaining a sealed semiconductor connection (semiconductor substrate).

[0005]

Then, a pressure-sensitive adhesive tape for semiconductor substrate fabrication is attached to the sealing portion side of the obtained sealed semiconductor connection, and the periphery of the sealed semiconductor connection is fixed using a wafer ring. While maintaining this state, the sealed semiconductor connection is cut (diced) using a dicing blade in a thickness direction for each of the semiconductor elements included in the sealed semiconductor connection and is cut and split (singulated). As a result, a plurality of semiconductor sealing bodies are formed on the pressure-sensitive adhesive tape for semiconductor substrate fabrication. In this way, the plurality of semiconductor sealing bodies are manufactured on the pressure-sensitive adhesive tape for semiconductor substrate fabrication at a time.

[0006]

Thereafter, an expanding step of expanding the

pressure-sensitive adhesive tape for semiconductor substrate fabrication in a plane direction is performed, and then the semiconductor sealing bodies obtained by singulating the sealed semiconductor connection are picked up. Subsequently, bumps are formed on a bottom surface side of the substrate such that the bumps are electrically connected to an electrode included in each of the semiconductor elements through conductor posts, which are formed in advance on the substrate included in each of the semiconductor sealing bodies, thereby obtaining a semiconductor device.

[0007]

Regarding the pressure-sensitive adhesive tape for semiconductor substrate fabrication used for manufacturing the semiconductor device, various investigations have been conducted in recent years (for example, see Patent Literature 1).

[0008]

Generally, the pressure-sensitive adhesive tape for semiconductor substrate fabrication has a base material (film base material) and a pressure-sensitive adhesive layer formed on the base material. The sealed semiconductor connection is fixed to the pressure-sensitive adhesive tape for semiconductor substrate fabrication such that the pressure-sensitive adhesive layer and the sealing portion are in contact with each other. Furthermore, in order that the semiconductor sealing bodies

formed after a dicing step of the sealed semiconductor connection can be easily picked up, the pressure-sensitive adhesive layer is usually constituted with a resin composition containing a base resin having pressure-sensitive adhesiveness, a photocurable resin, and the like. In a case where energy is applied to the pressure-sensitive adhesive layer after the dicing step, the resin composition is cured, and hence the pressure-sensitive adhesiveness of the pressure-sensitive adhesive layer is reduced. Then, the semiconductor sealing bodies are picked up by peeling the semiconductor sealing bodies from the pressure-sensitive adhesive layer.

[0009]

Here, as described above, in the method of manufacturing a semiconductor device, the sealed semiconductor connection is required to be more firmly fixed to the pressure-sensitive adhesive tape for semiconductor substrate fabrication at the time of performing the dicing step. Furthermore, after energy is applied to the pressure-sensitive adhesive layer after the dicing step, it is required that the semiconductor sealing bodies obtained by cutting the sealed semiconductor connection are easily peeled from the pressure-sensitive adhesive tape for semiconductor substrate fabrication, that is, the semiconductor sealing bodies are easily picked up.

[0010]

However, depending on the combination of the sealing

material of the sealing portion included in the sealed semiconductor connection and the resin composition constituting the pressure-sensitive adhesive layer included in the pressure-sensitive adhesive tape for semiconductor substrate fabrication, even though energy was applied to the pressure-sensitive adhesive layer after the dicing step, the pressure-sensitive adhesiveness of the pressure-sensitive adhesive layer with respect to the sealing portion cannot be sufficiently reduced. For this reason, unfortunately, the semiconductor sealing bodies cannot be easily picked up from the pressure-sensitive adhesive tape for semiconductor substrate fabrication.

Citation List

Patent Literature

[0011]

[PTL 1] Japanese Unexamined Patent Application, First Publication No. 2009-245989

Summary of Invention

Technical Problem

[0012]

An object of the present invention is to provide a pressure-sensitive adhesive tape for semiconductor substrate fabrication that can obtain a plurality of semiconductor sealing

bodies by cutting a sealed semiconductor connection in a thickness direction thereof in a state where the sealed semiconductor connection is firmly fixed in a dicing step, and can easily pick up the semiconductor sealing bodies by applying energy to a pressure-sensitive adhesive layer after the dicing step. Another object of the present invention is to provide a method for manufacturing a semiconductor device using the pressure-sensitive adhesive tape for the semiconductor substrate fabrication.

Solution to Problem

[0013]

The aforementioned objects are achieved by the present invention described in the following (1) to (11).

(1) A pressure-sensitive adhesive tape for semiconductor substrate fabrication, including a base material and a pressure-sensitive adhesive layer laminated on one surface of the base material, the pressure-sensitive adhesive tape being used for temporarily fixing a sealed semiconductor connection to the base material through the pressure-sensitive adhesive layer when the sealed semiconductor connection including a substrate, a plurality of semiconductor elements disposed on the substrate, and a sealing portion sealing the plurality of semiconductor elements is cut in a thickness direction thereof to obtain a plurality of semiconductor sealing bodies,

in which the pressure-sensitive adhesive layer contains a peeling agent for reducing adhesiveness to the sealing portion when the semiconductor sealing bodies are peeled from the pressure-sensitive adhesive tape for semiconductor substrate fabrication,

in which the sealing portion is formed of a sealing material containing an epoxy group-containing compound,

in which the epoxy group-containing compound has a double bond in a molecular structure thereof, and

in which the peeling agent is a silicone-based oil or a fluorine-based surfactant.

[0014]

(2) The pressure-sensitive adhesive tape for semiconductor substrate fabrication described in (1), in which the peeling agent is the silicone-based oil, and the silicone-based oil is a modified silicone oil.

[0015]

(3) The pressure-sensitive adhesive tape for semiconductor substrate fabrication described in (1) or (2), in which the pressure-sensitive adhesive layer further contains a base resin having pressure-sensitive adhesiveness.

[0016]

(4) The pressure-sensitive adhesive tape for semiconductor substrate fabrication described in (3), in which a glass transition point of the base resin is equal to or lower

than -30°C.

[0017]

(5) The pressure-sensitive adhesive tape for semiconductor substrate fabrication described in (3) or (4), in which a weight-average molecular weight of the base resin is 300,000 to 1,800,000.

[0018]

(6) The pressure-sensitive adhesive tape for semiconductor substrate fabrication described in any one of (3) to (5), in which the pressure-sensitive adhesive layer further contains a curable resin to be cured by application of energy.

[0019]

(7) The pressure-sensitive adhesive tape for semiconductor substrate fabrication described in (6), in which a contact angle of a surface of the pressure-sensitive adhesive layer to hexadecane is equal to or higher than 20° before the application of energy.

[0020]

(8) The pressure-sensitive adhesive tape for semiconductor substrate fabrication described in (6) or (7), in which a contact angle of a surface of the pressure-sensitive adhesive layer to hexadecane is equal to or higher than 10° after the application of energy.

[0021]

(9) The pressure-sensitive adhesive tape for

semiconductor substrate fabrication described in any one of (1) to (8), in which a thickness of the pressure-sensitive adhesive layer is 1 μm to 30 μm.

[0022]

(10) The pressure-sensitive adhesive tape for semiconductor substrate fabrication described in any one of (6) to (9), in which an adhesive force between the pressure-sensitive adhesive layer and the sealing portion before the application of energy is equal to or higher than 70 cN/25 mm and less than 1000 cN/25 mm, and the adhesive force between the pressure-sensitive adhesive layer and the sealing portion after the application of energy is equal to or higher than 60 cN/25 mm and less than 90 cN/25 mm.

[0023]

(11) A method for manufacturing a semiconductor device using the pressure-sensitive adhesive tape for semiconductor substrate fabrication according to any one of (1) to (10), including:

a sealed semiconductor connection forming step of obtaining the sealed semiconductor connection by sealing the plurality of semiconductor elements loaded on the substrate so as to be covered with the sealing portion,

an attaching step of attaching the pressure-sensitive adhesive tape for semiconductor substrate fabrication to the sealed semiconductor connection such that the sealing portion

and the pressure-sensitive adhesive layer are in contact with each other,

a dicing step of forming the plurality of semiconductor sealing bodies on the pressure-sensitive adhesive tape for semiconductor substrate fabrication by dicing and singulating the sealed semiconductor connection in a thickness direction for each of the semiconductor elements included in the sealed semiconductor connection,

a peeling step of peeling each of the semiconductor sealing bodies from the pressure-sensitive adhesive tape for semiconductor substrate fabrication after energy is applied to the pressure-sensitive adhesive layer, and

a bump connecting step of forming each of bumps on a side of the substrate opposite to the semiconductor element such that each bump is electrically connected to an electrode included in the semiconductor element through a conductor post, which is formed in advance on the substrate included in each semiconductor sealing body.

Advantageous Effects of Invention

[0024]

According to the present invention, the sealing material forming the sealing portion contains an epoxy group-containing compound having a double bond in a molecular structure thereof, and a low stress property of the sealing portion is improved.

Due to the low stress property of the sealing portion, adhesiveness between the sealing portion and the pressure-sensitive adhesive layer is improved. As a result, a plurality of semiconductor sealing bodies can be obtained by cutting (dicing) the sealed semiconductor connection in the thickness direction thereof in a state where the sealed semiconductor connection is firmly fixed to the pressure-sensitive adhesive tape for semiconductor substrate fabrication in the dicing step. In addition, the pressure-sensitive adhesive layer contains a predetermined peeling agent, and accordingly, when energy is applied to the pressure-sensitive adhesive layer after the dicing step, the pressure-sensitive adhesiveness of the pressure-sensitive adhesive layer can be reliably reduced also with respect to the sealing portion formed of the sealing material containing the epoxy group-containing compound having the double bond in the molecular structure. For this reason, the semiconductor sealing bodies can be easily picked up from the pressure-sensitive adhesive tape for semiconductor substrate fabrication.

[0025]

Accordingly, a semiconductor device manufactured by applying the method for manufacturing a semiconductor device using the pressure-sensitive adhesive tape for semiconductor substrate fabrication has excellent reliability.

Brief Description of Drawings

[0026]

FIG. 1 is a vertical cross-sectional view showing an example of a semiconductor device manufactured using a pressure-sensitive adhesive tape for semiconductor substrate fabrication of the present invention.

FIG. 2 is a vertical cross-sectional view for illustrating a method for manufacturing the semiconductor device shown in FIG. 1 by using the pressure-sensitive adhesive tape for semiconductor substrate fabrication of the present invention.

FIG. 3 is a vertical cross-sectional view for illustrating the method for manufacturing the semiconductor device shown in FIG. 1 by using the pressure-sensitive adhesive tape for semiconductor substrate fabrication of the present invention.

FIG. 4 is a vertical cross-sectional view showing an embodiment of the pressure-sensitive adhesive tape for semiconductor substrate fabrication of the present invention.

FIG. 5 is a vertical cross-sectional view for illustrating a method for manufacturing the pressure-sensitive adhesive tape for semiconductor substrate fabrication shown in FIG. 4.

Description of Embodiments

[0027]

Hereinafter, a pressure-sensitive adhesive tape for

semiconductor substrate fabrication and a method for manufacturing a semiconductor device of the present invention will be specifically described.

[0028]

First, before the pressure-sensitive adhesive tape for semiconductor substrate fabrication of the present invention is described, a semiconductor device manufactured using the pressure-sensitive adhesive tape for semiconductor substrate fabrication of the present invention, that is, a semiconductor device manufactured by applying the method for manufacturing a semiconductor device of the present invention will be described.

[0029]

<Semiconductor device>

FIG. 1 is a vertical cross-sectional view showing an example of a semiconductor device manufactured using the pressure-sensitive adhesive tape for semiconductor substrate fabrication of the present invention. In the following description, the upper side and the lower side in FIG. 1 will be referred to as “top” and “bottom” respectively.

[0030]

A semiconductor device 20 shown in FIG. 1 has an interposer 25 (substrate) including conductor posts (not shown in the drawing) disposed to penetrate the interposer in a thickness direction, a semiconductor element 26 disposed on the interposer

25, a sealing portion 27 (mold portion) formed of a sealing material sealing the semiconductor element 26, wiring 23 electrically connected to the conductor post, bumps 21 electrically connected to the wiring 23, and a coating portion 22 provided to coat the wiring 23 and expose the bumps 21.

[0031]

The interposer 25 is a substrate supporting the semiconductor element 26. Generally, in a case where the interposer 25 is seen in a plan view, the interposer 25 is found to have a quadrangular shape such as a square shape or a rectangular shape. In the interposer 25, a plurality of through-holes (not shown in the drawing) penetrating the interposer 25 in the thickness direction are formed, the conductor posts corresponding to the through-holes are provided.

[0032]

The bottom surface side of the semiconductor element 26 is provided with an electrode pad. The semiconductor element 26 is disposed on the interposer 25 such that the electrode pad corresponds to the conductor post. The number of semiconductor elements 26 disposed is not particularly limited, but is one in the present embodiment.

[0033]

In a state where the semiconductor element 26 is disposed in the aforementioned position, the sealing portion 27 formed

of the sealing material is formed to cover the top surface side of the semiconductor element 26 and the interposer 25.

[0034]

The conductor posts formed to correspond to the through-holes in the interposer 25 are electrically connected to the electrode pad included in the semiconductor element 26 at the top end of the conductor posts.

[0035]

The bottom surface of the interposer 25 is provided with the wiring 23 formed in a predetermined shape and a portion of the wiring 23 is electrically connected to the bottom end of the conductor posts.

[0036]

The bumps 21 having a spherical shape is electrically connected to the bottom surface of the wiring 23, and accordingly, the semiconductor element 26 and the bumps 21 are electrically connected to each other through the electrode pad, the conductor posts, and the wiring 23. Furthermore, the coating portion 22, which includes an opening portion 221 for exposing the bumps 21 from the bottom side of the coating portion 22, is provided on the bottom surface side of the interposer 25 to cover the wiring 23.

[0037]

In the present embodiment, the semiconductor device 20 includes one semiconductor element 26, but the present invention

is not limited to this constitution. For example, the semiconductor device may include two or more semiconductor elements 26, or may further include an electronic part different from the semiconductor element 26.

[0038]

The semiconductor device constituted as above is manufactured, for example, by the following manufacturing method (method for manufacturing semiconductor device of the present invention) using the pressure-sensitive adhesive tape for semiconductor substrate fabrication of the present invention.

[0039]

<Method for manufacturing semiconductor device>

FIG. 2 and FIG. 3 are vertical cross-sectional views for illustrating a method for manufacturing the semiconductor device shown in FIG. 1 by using the pressure-sensitive adhesive tape for semiconductor substrate fabrication of the present invention. In the following description, the upper side and the lower side in FIG. 2 will be referred to as “top” and “bottom” respectively.

[0040]

[1] First, a sheet material 25’ in the form of a flat plate as shown in (a) of FIG. 2 is prepared, and then a plurality of semiconductor elements 26 are disposed (loaded) on the sheet material 25’ (see (b) of FIG. 2; disposition step).

[0041]

The sheet material 25′ (substrate) includes a plurality of through-holes (not shown in the drawing) formed in advance and conductor posts (not shown in the drawing) embedded to correspond to the through-holes. The conductor posts are formed in positions to which the electrode pads (terminals) included in the semiconductor elements 26 correspond in a case where the semiconductor elements 26 are formed on the sheet material 25′. That is, the number of conductor posts provided to correspond to the through-holes in the sheet material 25′ becomes equal to the total number of electrode pads included in the plurality of semiconductor elements 26 disposed on the sheet material 25′.

[0042]

Furthermore, the sheet material 25′ is singulated by being cut (diced) in the thickness direction thereof, and as a result, the sheet material 25′ becomes the interposer 25 (substrate) included in the semiconductor device 20 and functions to support the semiconductor element 26.

[0043]

The sheet material 25′ is not particularly limited as long as the sheet material 25′ is hard enough to support the semiconductor element 26. For example, the sheet material 25′ may be any of a core substrate constituted with a core material, a rigid substrate such as a build-up substrate constituted with a build-up material, and a flexible substrate. Among these, the

build-up substrate is particularly preferable. The build-up substrate is particularly preferably used because it has excellent processability.

[0044]

The build-up substrate is not particularly limited, and is mainly constituted with, for example, a cured material of a resin composition or the like which contains a thermosetting resin such as a phenol resin, a urea resin, a melamine resin, or an epoxy resin, a curing agent, and an inorganic filler.

[0045]

The core substrate is not particularly limited, and is mainly constituted with, for example, a thermosetting resin such as a cyanate resin, an epoxy resin, or a bismaleimide-triazine resin, and the like.

[0046]

The flexible substrate is constituted with a thermoplastic resin such as polyimide, polyethylene terephthalate (PET), polyethylene naphthalate (PEN), polyether sulfone (PES), polytetrafluoroethylene (PTFE), polyimidobenzoxazole (PIBO), or a liquid crystal polymer, and the like.

[0047]

At the time of disposing the semiconductor elements 26 on the sheet material 25', the semiconductor elements 26 are disposed on the sheet material 25' such that the electrode pads included in the semiconductor elements 26 correspond to the

positions of the conductor posts included in the sheet material 25′. By this disposition, the semiconductor element 26 is disposed in a desired position (the position in which the semiconductor element 26 included in the semiconductor device 20 supposed to be formed is supposed to be disposed) on the sheet material 25′.

[0048]

Although the semiconductor element 26 may or may not be fixed on the sheet material 25′, it is more preferable that the semiconductor element 26 is fixed by an adhesive (underfill material) such as an epoxy-based adhesive. In a case where the semiconductor element 26 is fixed in this way, it is possible to effectively prevent the occurrence of positional deviation of the semiconductor element 26 at the time of sealing the semiconductor elements 26 with the sealing portion 27 in the following step [2].

[0049]

[2] Then, on the top surface side of the sheet material 25′, that is, side on which the plurality of semiconductor elements 26 are disposed, the sealing portion 27 is formed such that the sheet material 25′ and the semiconductor elements 26 are covered (see (c) of FIG. 2; sealing portion forming step).

[0050]

In this way, a sealed semiconductor connection 270 (semiconductor substrate) is obtained in which the plurality

of semiconductor elements 26 disposed on the sheet material 25′ (substrate) are sealed with the sealing portion 27 formed of the sealing material on the top surface side of the sheet material 25′.

[0051]

The method for forming the sealing portion 27 is not particularly limited, and examples of the method include a method in which a thermosetting resin composition such as a granular epoxy resin composition is prepared as a sealing material, the thermosetting resin composition is applied to the top surface of the sheet material 25′ such that the sheet material 25′ and the semiconductor elements 26 are covered in a state where the thermosetting resin composition is molten, and then the thermosetting resin composition in the molten state is subjected to compression molding. According to this method, it is possible to easily seal the semiconductor elements 26 with the sealing portion 27 at high density on the sheet material 25′.

[0052]

According to the step [1] and the present step [2], a sealed semiconductor connection forming step is configured in which a plurality of semiconductor elements are loaded on a substrate, and then sealing is performed using a sealing portion formed of a sealing material such that the semiconductor elements loaded on the substrate are covered, thereby obtaining a sealed semiconductor connection.

[0053]

Here, constituent materials of the sealing material will be specifically described. The sealing material is a thermosetting resin composition (for example, granular epoxy resin composition) and contains an epoxy group-containing compound having a double bond in a molecular structure thereof. Specifically, the constituent material of the granular epoxy resin composition contains an epoxy resin and an epoxy group-containing compound having a double bond in a molecular structure thereof unlike the epoxy resin. As a result, the low stress property, high moisture resistance, and quick curability of the sealing portion 27 can be improved.

[0054]

The epoxy resin is generally, for example, a monomer, an oligomer, and a polymer having two or more epoxy groups in one molecule, and the molecular weight and molecular structure thereof are not particularly limited. Specific examples of the epoxy resin include a crystalline epoxy resin such as a biphenyl type epoxy resin, a bisphenol A type epoxy resin, a bisphenol F type epoxy resin, a stilbene type epoxy resin, or a hydroquinone type epoxy resin; a novolac type epoxy resin such as a cresol novolac type epoxy resin, a phenol novolac type epoxy resin, or a naphthol novolac type epoxy resin; a phenol aralkyl type epoxy resin such as a phenylene skeleton-containing phenol aralkyl type epoxy resin, a biphenylene skeleton-containing

phenol aralkyl type epoxy resin, or a phenylene skeleton-containing naphthol aralkyl type epoxy resin; a trifunctional resin such as a triphenolmethane type epoxy resin or an alkyl-modified triphenolmethane type epoxy resin; a modified phenolic epoxy resin such as a dicyclopentadiene-modified phenolic epoxy resin or a terpene-modified phenolic epoxy resin; a heterocyclic ring-containing epoxy resin such as a triazine nucleus-containing epoxy resin; and the like. One kind of the above resin can be used, or two or more kinds of the above resins can be used in combination.

[0055]

The constituent material of the epoxy resin composition contains an epoxy group-containing compound different from the epoxy resin described above.

[0056]

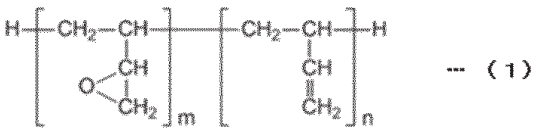
The epoxy group-containing compound has a double bond in a molecular structure thereof and one or more epoxy groups in one molecule. Examples of the epoxy group-containing compound include epoxy group-containing polybutadiene (epoxidized polybutadiene), an epoxy group-containing styrene-butadiene block copolymer, an epoxy group-containing acrylic resin, an epoxy group-containing silane coupling agent, and the like. One kind of the above compound can be used, or two or more kinds of the above compounds can be used in combination. Among these,

the epoxy group-containing compound having an olefin double bond (ethylene bond) is preferable, and the epoxy group-containing polybutadiene is more preferable. As a result, the low stress property, high moisture resistance, and quick curability of the sealing portion 27 can be improved.

[0057]

The epoxy group-containing polybutadiene is represented, for example, by the following General Formula (1).

[0058]



... (1)

[In General Formula (1), m and n each independently represent an integer of 2 or more.]

[0059]

In General Formula (1), m and n may each independently be an integer of 2 or more, but it is preferable that m is 4 to 11 and m + n is 16 to 43, and it is more preferable that m is 8 to 11 and m + n is 35 to 43.

[0060]

Furthermore, the constituent material of the epoxy resin composition preferably contains a curing agent.

[0061]

The curing agent is not particularly limited as long as it can be cured by reacting with the epoxy resin. Examples of

the curing agent include aminos such as linear aliphatic diamine having 2 to 20 carbon atoms such as ethylene diamine, trimethylene diamine, tetramethylene diamine, or hexamethylene diamine, metaphenylene diamine, paraphenylene diamine, paraxylene diamine, 4,4'-diaminodiphenylmethane, 4,4'-diaminodiphenylpropane, 4,4'-diaminodiphenylether, 4,4'-diaminodiphenylsulfone, 4,4'-diaminodicyclohexane, bis(4-aminophenyl)phenylmethane, 1,5-diaminonaphthalene, metaxylenediamine, paraxylenediamine, 1,1-bis(4-aminophenyl)cyclohexane, or dicyanodiamide; a resole type phenol resin such as an aniline-modified resole resin or a dimethyl ether resole resin; a novolac type phenol resin such as a phenol novolac resin, a cresol novolac resin, a tert-butylphenol novolac resin, or a nonylphenol novolac resin; a phenol aralkyl resin such as a phenylene skeleton-containing phenol aralkyl resin or a biphenylene skeleton-containing phenol aralkyl resin; a phenol resin having a condensed polycyclic structure such as a naphthalene skeleton or an anthracene skeleton; polyoxystyrene such as polyparaoxystyrene; acid anhydride including alicyclic acid anhydride such as hexahydrophthalic anhydride (HHPA) or methyltetrahydrophthalic anhydride (MTHPA) and aromatic acid anhydride such as trimellitic anhydride (TMA), pyromellitic anhydride (PMDA), or benzophenone tetracarboxylic acid (BTDA); a polymercaptan compound such as polysulfide, thioester, or

thioether; an isocyanate compound such as isocyanate prepolymer or blocked isocyanate; organic acids such as a carboxylic acid-containing polyester resin; and the like. One kind of the above compound can be used, or two or more kinds of the above compounds can be used in combination.

[0062]

Furthermore, the constituent material of the epoxy resin composition may contain an inorganic filler.

[0063]

The inorganic filler is not particularly limited, and examples thereof include silica such as fused and crushed silica, fused spherical silica, crystalline silica, or secondary aggregation silica; alumina; titanium white; aluminum hydroxide; talc; clay; mica; glass fiber; and the like. One kind of the above curing agent can be used, or two or more kinds of the above curing agents can be used in combination. Among these, fused spherical silica is particularly preferably used. In addition, it is preferable that the particle shape is spherical without limit.

[0064]

The constituent material of the epoxy resin composition preferably contains a curing accelerator.

[0065]

The curing accelerator is not particularly limited, and examples thereof include diazabicycloalkene such as

1,8-diazabicyclo(5,4,0)undecene-7 and derivatives thereof; an amine compound such as tributylamine or benzyldimethylamine; an imidazole compound such as 2-methylimidazole; organic phosphines such as triphenylphosphine or methyl diphenylphosphine; tetra-substituted phosphonium tetra-substituted borate such as tetraphenylphosphonium tetraphenylborate, tetraphenylphosphonium tetrabenzoic acid borate, tetraphenylphosphonium tetranaphthoic acid borate, tetraphenylphosphonium tetranaphthoyl oxyborate, or tetraphenyl phosphonium tetranaphthyl oxyborate; triphenylphosphine adducted with benzoquinone; and the like. One kind of the above curing agent can be used, or two or more kinds of the above curing agents can be used in combination.

[0066]

Furthermore, in addition to the above-mentioned constituent materials, the epoxy resin composition may, if necessary, contain a coupling agent such as γ-glycidoxypropyltrimethoxysilane; a colorant such as carbon black; a release agent such as a natural wax, a synthetic wax, higher fatty acid or metal salt thereof, paraffin, or polyethylene oxide; a low stress agent such as silicone oil or silicone rubber; an ion scavenger such as hydrotalcite; a flame retardant such as aluminum hydroxide; various additives such as an antioxidant.

[0067]

[3] Next, a pressure-sensitive adhesive tape 100 for semiconductor substrate fabrication (hereinafter, also simply referred to as "pressure-sensitive adhesive tape 100") having the base material 4 and the pressure-sensitive adhesive layer 2 laminated on the base material 4 is prepared. Then, as shown in (d) of FIG. 2, the sealed semiconductor connection 270 (semiconductor substrate) is laminated (attached) on the pressure-sensitive adhesive tape 100 in a state where the sealed semiconductor connection 270 is inverted and the sealing portion 27 side, which is formed of the sealing material, of the sealed semiconductor connection 270 faces the pressure-sensitive adhesive layer 2 side of the pressure-sensitive adhesive tape 100 (attaching step). That is, the sealed semiconductor connection 270 is attached to the pressure-sensitive adhesive tape 100 such that the sealing portion 27 and the pressure-sensitive adhesive layer 2 are in contact with each other.

[0068]

The attaching of the pressure-sensitive adhesive tape 100 to the sealed semiconductor connection 270 is performed, for example, in a manner in which the pressure-sensitive adhesive tape 100 is installed on the dicing table not shown in the drawing, a surface of the sealing portion 27 side of the sealed semiconductor connection 270 is placed on the pressure-sensitive adhesive layer 2, and then the sealed

semiconductor connection 270 is gently pressed. The sealed semiconductor connection 270 may be attached in advance to the pressure-sensitive adhesive tape 100 and then installed on the dicing table.

[0069]

The pressure-sensitive adhesive tape 100 (dicing tape) attached to the sealed semiconductor connection 270 has a function of supporting the sealed semiconductor connection 270 by the base material 4 through the pressure-sensitive adhesive layer 2 and reducing the pressure-sensitive adhesiveness of the pressure-sensitive adhesive layer 2 with respect to the sealed semiconductor connection 270 by applying energy to the pressure-sensitive adhesive layer 2.

[0070]

[4] Then, the sealed semiconductor connection 270 to which the pressure-sensitive adhesive tape 100 is attached is fixed using, for example, wafer rings. Thereafter, by using a dicing blade (dicing saw), the sealed semiconductor connection 270 is cut (diced) in the thickness direction for each of the semiconductor elements 26 included in the sealed semiconductor connection 270, thereby forming depressions 62 (cutting step (dicing step); see (e) of FIG. 2). That is, in the sealed semiconductor connection 270, a portion (position) corresponding to each semiconductor device 20 to be formed is diced, and the depression 62 is formed at the position.

[0071]

In this way, the sealed semiconductor connection 270 is singulated for each of the semiconductor elements 26, and as a result, a plurality of semiconductor sealing bodies 290 are formed in a state of being attached on the pressure-sensitive adhesive tape 100.

[0072]

Because the plurality of semiconductor sealing bodies 290 are formed on the pressure-sensitive adhesive tape 100 at a time, it is possible to improve the productivity of the semiconductor device 20 obtained from the semiconductor sealing body 290 through the following steps.

[0073]

At this time, for the purpose of preventing the scattering of cutting chips (dust) generated at the time of cutting the sealed semiconductor connection 270 and for the purpose of inhibiting the sealed semiconductor connection 270 (semiconductor element 26) from being unnecessarily heated, the sealed semiconductor connection 270 is cut while cutting water is being supplied to the sealed semiconductor connection 270.

[0074]

Furthermore, at this time, the pressure-sensitive adhesive tape 100 absorbs shock and functions to prevent cracking, chipping, or the like at the time of cutting the sealed semiconductor connection 270.

[0075]

In the present embodiment, the cutting of the sealed semiconductor connection 270 by using the blade is performed such that the cut reaches the middle of the base material 4 in a thickness direction of the base material 4 as shown in (e) of FIG. 2. In this way, the singulation of the sealed semiconductor connection 270, that is, the formation of the semiconductor sealing body 290 can be reliably performed.

[0076]

[5] Thereafter, by applying energy to the pressure-sensitive adhesive layer 2 included in the pressure-sensitive adhesive tape 100, the pressure-sensitive adhesiveness of the pressure-sensitive adhesive layer 2 with respect to the semiconductor sealing body 290 is reduced.

[0077]

As a result, peeling occurs between the pressure-sensitive adhesive layer 2 and semiconductor sealing body 290 in the following step [6].

[0078]

The method for applying energy to the pressure-sensitive adhesive layer 2 is not particularly limited, and examples thereof include a method of irradiating the pressure-sensitive adhesive layer 2 with energy rays, a method of heating the pressure-sensitive adhesive layer 2, and the like. Among these, a method of irradiating the pressure-sensitive adhesive layer

2 with energy rays is preferable, and particularly, a method of irradiating the pressure-sensitive adhesive layer 2 with energy rays from the base material 4 side of the pressure-sensitive adhesive tape 100 is preferable.

[0079]

The aforementioned method is suitably used as the method for applying energy, because this method prevents the semiconductor element 26 from experiencing an unnecessary thermal history and can efficiently apply energy to the pressure-sensitive adhesive layer 2 in a relatively simple manner.

[0080]

Examples of the energy rays include ultraviolet rays, electron beams, particle beams such as ion beams, and a combination of two or more kinds of the energy rays described above may be used. Among these, ultraviolet rays are particularly preferably used. In a case where the ultraviolet rays are used, the pressure-sensitive adhesiveness of the pressure-sensitive adhesive layer 2 with respect to the semiconductor device 20 can be efficiently reduced.

[0081]

[6] Subsequently, the pressure-sensitive adhesive tape 100 is peeled from the semiconductor sealing body 290. The peeling of the pressure-sensitive adhesive tape 100 is performed, for example, in a manner in which the pressure-sensitive adhesive

tape 100 is radially stretched by using an expander not shown in the drawing to open the semiconductor sealing body 290 obtained by the singulation at a certain interval (expanding step; see (f) of FIG. 2). Thereafter, the semiconductor sealing body 290 is raised up by using a needle or the like, and in this state, the semiconductor sealing body is picked up by being absorbed onto a vacuum collet or air tweezers (pickup step; see (a) of FIG. 3). The peeling occurs between the pressure-sensitive adhesive layer 2 included in the pressure-sensitive adhesive tape 100 and the sealing portion 27 which is formed of the sealing material and included in the semiconductor sealing body 290.

[0082]

By using the pressure-sensitive adhesive tape for semiconductor substrate fabrication of the present invention as the pressure-sensitive adhesive tape 100 at the time of pickup of the semiconductor sealing body 290 in the present step [6], the following effects can be exhibited. That is, as described above, the sealing material forming the sealing portion 27 contains an epoxy group-containing compound having a double bond in a molecular structure thereof, and a low stress property of the sealing portion 27 is improved. Due to the low stress property of the sealing portion 27, an adhesiveness between the sealing portion 27 and the pressure-sensitive adhesive layer 2 is improved. On the other hand, the pressure-sensitive

adhesive layer 2 contains, as described below, a peeling agent (oil repellent) which is a silicone-based oil or a fluorine-based surfactant. Therefore, the pressure-sensitive adhesiveness of the pressure-sensitive adhesive tape 100 to the semiconductor sealing body 290 by application of energy to the pressure-sensitive adhesive layer 2 in the step [5], that is, the adhesiveness between the sealing portion 27 included in the semiconductor sealing body 290 and pressure-sensitive adhesive layer 2 included in the pressure-sensitive adhesive tape 100 can be reliably reduced. As a result, in the present step [6], the pressure-sensitive adhesive tape 100 can be easily peeled from the semiconductor sealing body 290 without causing contamination and adhesive residue on the sealing portion 27, but the detailed description will be given later.

[0083]

According to the step [5] and the present step [6], a peeling step is configured in which the pressure-sensitive adhesive tape for semiconductor substrate fabrication is peeled from the semiconductor sealing body after energy is applied to the pressure-sensitive adhesive layer.

[0084]

[7] Next, as shown in (b) of FIG. 3, the wiring 23 is formed on the interposer 25 side of the semiconductor sealing body 290 (wiring formation step). That is, on a surface side (bottom surface side), which is opposite to the semiconductor element

26, of the interposer 25, the wiring 23 patterned in a predetermined shape is formed such that the wiring 23 is electrically connected to the conductor posts (wiring formation step).

[0085]

The method for forming the wiring 23 is not particularly limited, and examples thereof include I: a method of forming the wiring 23 by using a plating method such as an electroplating method or an electroless plating method, II: a method of forming the wiring 23 by supplying a liquid material containing a conductive material to a surface, which faces the interposer 25 side, of the semiconductor sealing body 290 and drying×solidifying the liquid material, and the like. Among these, the method I is preferable, and particularly, the method of forming the wiring 23 by using an electroplating method is preferable. According to the electroplating method, it is possible to easily and reliably form the wiring 23 which exhibits excellent adhesiveness with respect to the conductor posts.

[0086]

The formation of the wiring 23 in the present step [7] can be omitted depending on the configuration of the semiconductor device to be formed.

[0087]

[8] Thereafter, as shown in (c) of FIG. 3, on the interposer 25 side of the semiconductor sealing body 290, that is, on a

surface side (bottom surface side), which is opposite to the semiconductor element 26, of the interposer 25, a coating portion 22 including opening portions 221 is formed such that a portion of the wiring 23 is exposed (coating portion forming step).

[0088]

The opening portions 221 are formed to correspond to the positions in which the bumps 21 will be formed in the following step [9].

[0089]

The coating layer is generally constituted with a laminate in which a top layer mainly constituted with Au is laminated on a bottom layer mainly constituted with Ni. The coating layer is formed, for example, using an electroless plating method.

[0090]

The formation of the coating portion 22 in the present step [8] can be omitted depending on the configuration of the semiconductor device to be formed.

[0091]

[9] Thereafter, as shown in (d) of FIG. 3, the bumps 21 are formed to be electrically connected to the wiring 23 exposed from the opening portions 221 (bump connecting step).

[0092]

The bumps 21 electrically connected to the electrode pad included in the semiconductor element 26 through the conductor posts and the wiring 23 is formed in a bottom surface side of

the interposer 25.

[0093]

In a case where a constitution is adopted in which the electrode and the bumps 21 are connected to each other through the conductor posts and the wiring 23, as described above, by interposing the wiring 23 therebetween, the bumps 21 can be disposed in positions different from the positions of the conductor posts in the plane direction of the interposer 25. In other words, it is possible to dispose the bumps 21 such that the central portion of each of the bumps 21 and the central portion of each of the conductor posts do not overlap each other. Accordingly, the bumps 21 can be formed in positions on the bottom surface of the semiconductor device 20 to be obtained.

[0094]

The method for joining the bump 21 to the wiring 23 is not particularly limited, and performed, for example, by interposing a viscous flux between the bumps 21 and the wiring 23.

[0095]

Examples of the material constituting the bump 21 include a brazing material such as a solder, a silver solder, a copper solder, or a phosphor copper solder, and the like. Through the steps described above, the semiconductor device 20 is manufactured.

[0096]

According to the aforementioned method for manufacturing the semiconductor device 20, from one sealed semiconductor connection 270 obtained in the step [2], a plurality of semiconductor sealing bodies 290 can be manufactured at a time on the pressure-sensitive adhesive tape 100 through the steps [3] and [4], and by repeatedly performing the steps [5] to [9], a plurality of semiconductor devices 20 can be manufactured from one sealed semiconductor connection 270. As a result, the productivity of the semiconductor device 20 obtained from the sealed semiconductor connection 270 can be improved.

[0097]

Hereinafter, the pressure-sensitive adhesive tape 100 for semiconductor substrate fabrication (pressure-sensitive adhesive tape for semiconductor substrate fabrication of the present invention) used in the method for manufacturing the semiconductor device 20 will be described.

[0098]

<Pressure-sensitive adhesive tape for semiconductor substrate fabrication>

FIG. 4 is a vertical cross-sectional view showing an embodiment of the pressure-sensitive adhesive tape for semiconductor substrate fabrication of the present invention. In the following description, the upper side and the lower side in FIG. 4 will be referred to as “top” and “bottom” respectively.

[0099]

The pressure-sensitive adhesive tape 100 for semiconductor substrate fabrication, as shown in FIG. 4, includes the base material 4 and the pressure-sensitive adhesive layer 2 laminated on the top surface (one surface) of the base material 4. The pressure-sensitive adhesive tape is used for a process of performing fabrication in which when the sealed semiconductor connection 270 in which the plurality of semiconductor elements 26 disposed on the interposer 25 are sealed with the sealing portion 27 formed of the sealing material containing the epoxy group-containing compound having a double bond in a molecular structure thereof is cut in the thickness direction to obtain the plurality of semiconductor sealing bodies 290, the sealed semiconductor connection 270 is temporarily fixed to the base material 4 through the pressure-sensitive adhesive layer 2. The pressure-sensitive adhesive layer 2 contains the peeling agent for reducing the adhesiveness (that is, the adhesiveness between the sealing portion 27 and the pressure-sensitive adhesive layer 2) between the semiconductor sealing body 290 and the pressure-sensitive adhesive tape 100 when the semiconductor sealing body 290 is peeled from the pressure-sensitive adhesive tape 100. The peeling agent is a silicone-based oil or a fluorine-based surfactant.

[0100]

As described above, the pressure-sensitive adhesive layer

2 included in the pressure-sensitive adhesive tape 100 contains a predetermined peeling agent (oil repellent). Therefore, the pressure-sensitive adhesiveness of the pressure-sensitive adhesive tape 100 to the semiconductor sealing body 290 by application of energy to the pressure-sensitive adhesive layer 2 in the step [5], that is, the adhesiveness between the sealing portion 27 included in the semiconductor sealing body 290 and pressure-sensitive adhesive layer 2 included in the pressure-sensitive adhesive tape 100 can be reliably reduced. As a result, in the step [6], the pressure-sensitive adhesive tape 100 can be easily peeled from the semiconductor sealing body 290 without causing contamination and adhesive residue on the sealing portion 27 when the semiconductor sealing body 290 is picked up.

[0101]

Hereinafter, the base material 4 and the pressure-sensitive adhesive layer 2 included in the pressure-sensitive adhesive tape 100 (dicing tape) will be specifically described.

[0102]

The pressure-sensitive adhesive tape 100 has a function of reducing the pressure-sensitive adhesiveness of the pressure-sensitive adhesive layer 2 with respect to the sealed semiconductor connection 270 (sealing portion 27) by applying energy to the pressure-sensitive adhesive layer 2. Examples of

the method for applying energy to the pressure-sensitive adhesive layer 2 include a method of irradiating the pressure-sensitive adhesive layer 2 with energy rays, a method of heating the pressure-sensitive adhesive layer 2, and the like. Among these, since the semiconductor element 26 does not have to experience an unnecessary thermal history, a method of irradiating the pressure-sensitive adhesive layer 2 with energy rays is suitably used. Therefore, in the following section, as the pressure-sensitive adhesive layer 2, a case where pressure-sensitive adhesiveness is reduced due to the irradiation of energy rays will be representatively described.

[0103]

<Base material 4>

In the present embodiment, the base material 4 is constituted with a laminate including a notched layer 41 positioned on the top surface side and an expansion layer 42 laminated on the bottom surface of the notched layer 41, and has a function of supporting the pressure-sensitive adhesive layer 2 provided on the base material 4.

[0104]

In this way, by using the laminate including the notched layer 41 and the expansion layer 42 as the base material 4, it is possible to suppress the occurrence of cutting chips at the time of cutting the base material 4 by using a dicing blade in the step [4], and to provide the base material 4 having excellent

expandability at the time of expanding the pressure-sensitive adhesive tape 100 by using an expander in the step [6].

[0105]

Therefore, in the following section, a case where the base material 4 is constituted with the laminate including the notched layer 41 and the expansion layer 42 will be representatively described.

[0106]

<<Notched layer 41>>

In the laminate including the notched layer 41 and the expansion layer 42, the notched layer 41 is a layer in which a notch reaching the middle of the notched layer is cut in the thickness direction by using a dicing blade in the step [4].

[0107]

Therefore, it is required for the notched layer 41 to less generate cutting chips at the time of cutting the notch.

[0108]

That is, in a case where the sealed semiconductor connection 270 is cut in the step (dicing step) [4], frictional heat occurs between a dicing blade and the pressure-sensitive adhesive tape 100. Consequently, the portion contacting the dicing blade is exposed to a high temperature, and hence the base material 4 becomes in a molten state. As a result, the molten resin sticks to a surface of the dicing blade and causes clogging. Therefore, normal dicing is hindered, or the molten

and softened base material 4 is stretched by being pulled due to the rotation of the dicing blade. The aforementioned phenomenon is considered to be a cause of the occurrence of whiskers of the base material in the step [4]. Therefore, it is required for the notched layer 41 in which a notch is cut by the dicing blade to have high melt viscosity, prevent the resin from sticking to the dicing blade even in a state where frictional heat occurs at the time of dicing, and markedly suppress the occurrence of cutting chips.

[0109]

Furthermore, the notched layer 41 is radially expanded in the step [6] by using an expander. Therefore, it is required for the notched layer 41 to exhibit expandability in the plane direction of the base material 4.

[0110]

For the reasons described above, it is preferable that the notched layer 41 contains a resin material having high melt viscosity and expandability. Even though frictional heat occurs at the time of dicing in the step [4], it is possible to reliably inhibit or prevent the resin from sticking to the dicing blade. Therefore, the occurrence of cutting chips can be markedly reduced, and the notched layer 41 can become relatively flexible at room temperature. As a result, expandability of the notched layer 41 can be improved in a case where the pressure-sensitive adhesive tape 100 is radially

expanded in the step [6] by using an expander.

[0111]

Examples of the resin material having high melt viscosity and expandability include an ionomer resin, an ethylene-(meth)acrylic acid ester copolymer such as an ethylene-methyl methacrylate copolymer (EMMA), an ethylene-methyl acrylate copolymer (EMA), or an ethylene-ethyl acrylate copolymer (EEA), an ethylene-vinyl acetate copolymer (EVA), and the like. One kind of the above resin can be used, or two or more kinds of the above resins can be used in combination. Among these, the ionomer resin is preferable. In a case where the ionomer resin is used, it is possible to reliably inhibit or prevent the occurrence of cutting chips and whiskers of the base material at the time of cutting a notch in the notched layer 41 by using the dicing blade. Furthermore, expandability of the notched layer 41 can be improved in a case where the pressure-sensitive adhesive tape 100 is radially expanded by an expander, and visible light transmissivity of the notched layer 41 can be further improved.

[0112]

In the present specification, the ionomer resin is a resin obtained by cross-linking a binary copolymer, which contains ethylene and (meth)acrylic acid as constituent components of the polymer, or a ternary copolymer, which contains ethylene, (meth)acrylic acid, and a (meth)acrylic acid ester as

constituent components of the polymer, by using a metal ion. One kind of the above resin can be used, or two or more kinds of the above resins can be used in combination.

[0113]

Examples of the metal ion include a potassium ion (K^+), a sodium ion (Na^+), a lithium ion (Li^+), a magnesium ion (Mg^{++}), a zinc ion (Zn^{++}), and the like. Among these, the zinc ion (Zn^{++}) is preferable as the metal ion because this ion stabilizes the cross-linked structure in the ionomer resin, and hence dicing residues are not easily generated. Furthermore, because the zinc ion has high water resistance, it is possible to reliably prevent the notched layer 41 from swelling due to the cutting water at the time of dicing.

[0114]

In a carboxyl group of the binary copolymer which contains ethylene and (meth)acrylic acid as constituent components of the polymer or the ternary copolymer which contains ethylene, (meth)acrylic acid, and a (meth)acrylic acid ester as constituent components of the polymer, a degree of neutralization by a cation (metal ion) is preferably equal to or higher than 40 mol% and equal to or lower than 75 mol%. As the aforementioned ionomer resin, those obtained by synthesis may be used, and commercially available ionomer resins can also be used.

[0115]

Among the above resins, as the ionomer resin, a resin is preferable which is obtained by cross-linking the ternary copolymer, which contains ethylene, (meth)acrylic acid, and a (meth)acrylic acid alkyl ester as constituent components of the polymer, by using a metal ion. That is, it is preferable that the ionomer resin contains the (meth)acrylic acid alkyl ester as a constituent component of the polymer. In a case where the ionomer resin contains such a component, it is possible to impart appropriate flexibility and excellent processability to the notched layer 41. Furthermore, the visible light transmissivity of the notched layer 41 can be further improved.

[0116]

It is preferable that the ionomer resin has a melting point equal to or higher than 80°C. In a case where the resin has a melting point equal to or higher than 80°C, the heat resistance of the notched layer 41 can be improved. The upper limit of the melting point of the ionomer resin is not particularly limited, but is practically about 100°C.

[0117]

In addition, it is preferable that the ionomer resin has a melt flow rate (MFR) equal to or lower than 3 g/10 min which is measured by the testing method described in JIS K 7210 "Testing Method for Melt Flow Rate of Thermoplastics" at a testing temperature of 190°C under a testing load of 21.18 N. In a case the MFR is as described above, the melt viscosity of the notched

layer 41 can be improved. As a result, it is possible to reliably inhibit the occurrence of cutting chips of the notched layer 41 in the pressure-sensitive adhesive tape 100. The lower limit of the MFR of the ionomer resin is not particularly limited, but is practically 0.8 g/10 min.

[0118]

In a case where the notched layer 41 contains the ionomer resin, the notched layer 41 may further contain other resin materials different from the ionomer resin.

[0119]

The resin materials are not particularly limited, and examples thereof include polyethylene such as low-density polyethylene, linear polyethylene, medium-density polyethylene, high-density polyethylene, or ultra-low-density polyethylene, polypropylene such as random copolymer polypropylene, block copolymer polypropylene, or homopolypropylene, a polyolefin-based resin such as polyvinyl chloride, polybutene, polybutadiene, or polymethylpentene, an olefin-based copolymer such as an ethylene-vinyl acetate copolymer, an ethylene-(meth)acrylic acid copolymer, an ethylene-(meth)acrylic acid ester (random or alternating) copolymer, an ethylene-propylene copolymer, an ethylene-butene copolymer, or an ethylene-hexene copolymer, a polyester-based resin such as polyethylene terephthalate, polyethylene naphthalate, polybutylene terephthalate, or polybutylene

naphthalate, polyurethane, polyimide, polyamide, polyether ketone such as polyether ether ketone, polyether sulfone, polystyrene, a fluororesin, a silicone resin, a cellulose-based resin, a thermoplastic resin such as a styrene-based thermoplastic elastomer, an olefin-based thermoplastic elastomer like a polypropylene-based thermoplastic elastomer, an acrylic resin, a polyester-based thermoplastic elastomer, polyvinyl isoprene, and polycarbonate or a mixture of these thermoplastic resins. One kind of the above resin can be used, or two or more kinds of the above resins can be used in combination.

[0120]

The notched layer 41 may further contain additives such as an antioxidant and filler, in addition to the aforementioned resin materials.

[0121]

The content rate of the ionomer resin in the notched layer 41 is preferably equal to or higher than 60% by weight and equal to or lower than 100% by weight, and more preferably equal to or higher than 80% by weight and equal to or lower than 100% by weight. In a case where the content rate of the ionomer resin is equal to or higher than the lower limit described above, the notched layer 41 can reliably perform the function described above.

[0122]

The elongation at break at 80°C of the notched layer 41 measured based on JIS K 7127 is preferably equal to or higher than 50% and equal to or lower than 350%, and more preferably equal to or higher than 100% and equal to or lower than 200%. In a case where the elongation at break at 80°C of the notched layer 41 is within the above range, it can be said that the notched layer 41 is a layer which has high melt viscosity and less generates cutting chips at the time of cutting a notch in the notched layer 41 by using a dicing blade.

[0123]

Furthermore, a tensile modulus of the notched layer 41 measured based on IPCTM-6502.4.19 is preferably equal to or higher than 70 MPa and equal to or lower than 400 MPa, and more preferably equal to or higher than 100 MPa and equal to or lower than 300 MPa. In a case where the tensile modulus of the notched layer 41 is within the above range, the notched layer 41 is a layer which has excellent expandability and breaks less at the time of radially stretching the pressure-sensitive adhesive tape 100 by using an expander.

[0124]

It is preferable that the thickness of the notched layer 41 is larger than the depth of a notch (hereinafter, referred to as "notching amount" as well) cut in the notched layer 41 by using a dicing blade. Specifically, the thickness of the notched layer 41 is preferably equal to or greater than 10 μm

and equal to or smaller than 140 μm, and more preferably equal to or greater than 20 μm and equal to or smaller than 120 μm. In a case where the thickness of the notched layer 41 is within the above range, even though a cut reaching the middle of the base material 4 is made at the time of cutting the sealed semiconductor connection 270 in the step [4], the notched layer 41 can be individually cut at this time, and accordingly, the cutting chips generated by the cutting can be reduced. In this case, the thickness of the notched layer 41 is set such that the ratio of the thickness of the notched layer 41 to the total thickness of the pressure-sensitive adhesive tape 100 preferably becomes equal to or higher than 60% and equal to or lower than 90%, and more preferably becomes equal to or higher than 60% and equal to or lower than 80%.

[0125]

It is preferable that a functional group such as a hydroxyl group or an amino group, which is reactive with the constituent material contained in the pressure-sensitive adhesive layer 2, is exposed on the surface of the notched layer 41.

[0126]

In addition, the notched layer 41 may be constituted with a laminate (multilayer substance) in which a plurality of layers constituted with different resin materials described above are laminated. Furthermore, the notched layer 41 may be constituted with a blend film obtained by dry blending the resin materials.

[0127]

<<Expansion layer 42>>

In the laminate including the notched layer 41 and the expansion layer 42, the expansion layer 42 is a layer in which a notch made by a dicing blade is not cut in the step [4] and which is radially expanded in the step [6] by using an expander.

[0128]

It is required for the expansion layer 42 to exhibit excellent expandability in the plane direction of the base material 4. Consequently, in the expansion layer 42, a resin material having expandability is preferably used.

[0129]

Examples of the resin material having expandability include a polyethylene-based resin such as low-density polyethylene or medium-density polyethylene, an ethylene-(meth)acrylic acid ester copolymer such as an ethylene-methyl methacrylate copolymer (EMMA), an ethylene-methyl acrylate copolymer (EMA), or an ethylene-ethyl acrylate copolymer (EEA), an ethylene-vinyl acetate copolymer (EVA), various elastomers such as an olefin-based elastomer or a styrene-based elastomer, and the like. One kind of the above resin can be used, or two or more kinds of the above resins can be used in combination. Among these, the polyethylene-based resin is preferable. In a case where the polyethylene-based resin is used, the expandability of the expansion layer 42 can

be further improved at the time of radially expanding the pressure-sensitive adhesive tape 100 by using an expander.

[0130]

In the present specification, the low-density polyethylene refers to polyethylene having a density equal to or higher than 0.880 g/cm^3 and less than 0.940 g/cm^3. The low-density polyethylene is not limited as long as the density thereof is within the above range. However, the density of the low-density polyethylene is particularly preferably equal to or higher than 0.910 g/cm^3 and equal to or lower than 0.930 g/cm^3. The low-density polyethylene is defined as a generic term of the long-chain branched polyethylene (the chain length of a branch is not particularly limited) obtained by polymerizing an ethylene monomer by a high-pressure method, polyethylene referred to as so-called “low-density polyethylene” or “ultra-low-density polyethylene”, polyethylene referred to as “linear low-density polyethylene” obtained by polymerizing ethylene and an α-olefin monomer having 3 to 8 carbon atoms by a low-pressure method (in this case, the length of a short chain branch consists of 1 to 6 carbon atoms), and an “ethylene-α-olefin copolymer elastomer” having a density that falls into the range described above. The density of the low-density polyethylene can be measured based on JIS K 7112.

[0131]

The melting point of the low-density polyethylene is

preferably equal to or higher than 90°C and equal to or lower than 140°C, and more preferably equal to or higher than 110°C and equal to or lower than 130°C. In a case where the melting point of the low-density polyethylene is within the above range, the expansion layer 42 can have heat resistance, and the rigidity of the expansion layer 42 at room temperature can be reduced. Accordingly, the expansion layer 42 having the expandability can be provided.

[0132]

The ionomer resin contained in the notched layer 41 is a resin obtained by cross-linking a binary copolymer, which contains ethylene and (meth)acrylic acid as constituent components of the polymer, or a ternary copolymer, which contains ethylene, (meth)acrylic acid, and a (meth)acrylic acid ester as constituent components of the polymer, by using a metal ion. The ionomer resin contains ethylene as a monomer component.

[0133]

It is preferable that the low-density polyethylene contained in the expansion layer 42 contains ethylene as a monomer component.

[0134]

In a case where the notched layer 41 contains an ionomer resin and the expansion layer 42 contains a low-density polyethylene as described above, both the notched layer 41 and the expansion layer 42 contain ethylene as a monomer component.

Accordingly, in the pressure-sensitive adhesive tape 100, by the effect of the intermolecular interaction between the notched layer 41 and the expansion layer 42, the adhesiveness between the notched layer 41 and the expansion layer 42 can be improved, and it is possible to reliably inhibit or prevent the occurrence of interlaminar peeling between the notched layer 41 and the expansion layer 42.

[0135]

In addition, in a case where the expansion layer 42 contains a low-density polyethylene, the expansion layer 42 may contain other resin materials different from the low-density polyethylene.

[0136]

The resin materials are not particularly limited, and examples thereof include polyethylene such as linear polyethylene, medium-density polyethylene, high-density polyethylene, or ultra-low-density polyethylene, polypropylene such as random copolymer polypropylene, block copolymer polypropylene, or homopolypropylene, a polyolefin-based resin such as polyvinyl chloride, polybutene, polybutadiene, or polymethylpentene, an ionomer such as an ethylene-vinyl acetate copolymer, a zinc ion cross-linked substance, or a soium ion cross-linked substance, an olefin-based copolymer such as an ethylene-(meth)acrylic acid copolymer, an ethylene-(meth)acrylic acid ester (random or alternating)

copolymer, an ethylene-propylene copolymer, an ethylene-butene copolymer, or an ethylene-hexene copolymer, a polyester-based resin such as polyethylene terephthalate, polyethylene naphthalate, polybutylene terephthalate, or polybutylene naphthalate, polyurethane, polyimide, polyamide, polyether ketone such as polyether ether ketone, polyether sulfone, polystyrene, a fluororesin, a silicone resin, a cellulose-based resin, a thermoplastic resin such as a styrene-based thermoplastic elastomer, an olefin-based thermoplastic elastomer like a polypropylene-based thermoplastic elastomer, an acrylic resin, a polyester-based thermoplastic elastomer, polyvinyl isoprene, and polycarbonate or a mixture of these thermoplastic resins. One kind of the above resin can be used, or two or more kinds of the above resins can be used in combination.

[0137]

The expansion layer 42 may contain additives such as an antioxidant, filler, and the like in addition to the aforementioned resin materials.

[0138]

The expansion layer 42 preferably contains an antistatic agent. In a case where the expansion layer 42 contains an antistatic agent, it is possible to reliably inhibit or prevent the occurrence of static electricity in the semiconductor element 26 included in the semiconductor device 20 in the step

(attaching (tape mounting) step) [3], the step (dicing step) [4], and the step (pickup step) [6].

[0139]

The antistatic agent is not particularly limited, and examples thereof include a surfactant, an inherently dissipative polymer (IDP), a metal material, a metal oxide material, a carbonaceous material, and the like. One kind of the above compound can be used, or two or more kinds of the above compounds can be used in combination.

[0140]

Among these, examples of the surfactant include an anionic surfactant, a cationic surfactant, a nonionic surfactant, an amphoteric surfactant, and the like.

[0141]

As the inherently dissipative polymer (IDP), for examples, it is possible to use all IDPs such as a polyester amide-based IDP, polyester amide, polyether ester amide, and a polyurethane-based IDP.

[0142]

Examples of the metal material include gold, silver, copper, silver-coated copper, nickel, and the like, and powder of these metals is preferably used.

[0143]

Examples of the metal oxide material include indium tin oxide (ITO), indium oxide (IO), antimony tin oxide (ATO), indium

zinc oxide (IZO), tin oxide (SnO_2), and the like, and powder of these metal oxides is preferably used.

[0144]

Examples of the carbonaceous material include carbon black, carbon nanotubes such as single-layer carbon nanotubes and multilayer carbon nanotubes, carbon nanofiber, CN nanotubes, CN nanofiber, BCN nanotubes, BCN nanofiber, graphene, and the like.

[0145]

Among these, as the antistatic agent, at least one kind among the surfactant, the inherently dissipative polymer (IDP), the metal oxide material, and carbon black is preferable. These antistatic agents have low temperature dependence of resistivity. Therefore, even though the base material 4 is heated at the time of dicing the sealed semiconductor connection 270, the change of a value of surface resistance of the expansion layer 42 can be reduced.

[0146]

In a case where the expansion layer 42 contains an antistatic agent, the content rate of the antistatic agent in the expansion layer 42 is preferably equal to or higher than 5% by weight and equal to or lower than 40% by weight, and more preferably equal to or higher than 15% by weight and equal to or lower than 30% by weight. In a case where the content of the antistatic agent is less than the lower limit described above,

depending on the type of the antistatic agent, antistatic performance may not be able to be sufficiently imparted to the expansion layer 42. Furthermore, in a case where the content of the antistatic agent is larger than the upper limit described above, it is difficult to impart additional antistatic performance to the expansion layer 42 and it may also affect the cost increase.

[0147]

The content rate of the low-density polyethylene in the expansion layer 42 is preferably equal to or higher than 40% by weight and equal to or lower than 100% by weight, and more preferably equal to or higher than 60% by weight and equal to or lower than 100% by weight. In a case where the content rate of the low-density polyethylene is equal to or higher than the lower limit described above, the expansion layer 42 can reliably perform the function thereof described above. Furthermore, the expansion layer 42 excellent in the adhesiveness with respect to the notched layer 41 can be provided.

[0148]

The tensile modulus of the expansion layer 42 measured based on IPCTM-6502.4.19 is preferably equal to or higher than 30 MPa and equal to or lower than 300 MPa, and more preferably equal to or higher than 100 MPa and equal to or lower than 200 MPa. In a case where the tensile modulus of the expansion layer 42 is within the above range, it can be said that the expansion

layer 42 is a layer which exhibits excellent expandability and breaks less at the time of radially stretching the pressure-sensitive adhesive tape 100 by using an expander.

[0149]

The thickness of the expansion layer 42 is preferably equal to or greater than 7 μm and equal to or smaller than 95 μm, and more preferably equal to or greater than 15 μm and equal to or smaller than 80 μm. In a case where the thickness of the expansion layer 42 is within the above range, the strength, which is high enough for the expansion layer 42 not break at the time of stretching the pressure-sensitive adhesive tape 100 in the step [6], can be reliably imparted to the expansion layer 42. In this case, the ratio of the thickness of the expansion layer 42 to the total thickness of the pressure-sensitive adhesive tape 100 is preferably equal to or higher than 40% and equal to or lower than 95%, and more preferably equal to or higher than 60% and equal to or lower than 80%.

[0150]

The expansion layer 42 may be constituted with a laminate (multilayer substance) in which a plurality of layers constituted with different resin materials described above are laminated.

[0151]

The total light transmittance of the base material 4 constituted as above based on the method specified in JIS K 7361-1

by using a D65 standard light source is preferably equal to or higher than 85% and equal to or lower than 98%, particularly preferably equal to or higher than 90% and equal to or lower than 98%, and more preferably equal to or higher than 95% and equal to or lower than 98%. In a case where the total light transmittance of the base material 4 is within the above range, the pressure-sensitive adhesive tape 100 having excellent light transmitting properties can be provided. Accordingly, in the semiconductor sealing bodies 290 formed by singulating the sealed semiconductor connection 270 in the step [4], even though defective is generated, the defective can be reliably prevented from moving onto the step [6] and the following steps.

[0152]

The thickness of the base material 4 is, for example, preferably equal to or greater than 20 μm and equal to or smaller than 220 μm, and more preferably equal to or greater than 40 μm and equal to or smaller than 200 μm. In a case where the thickness of the base material 4 is within the above range, it is possible to protect (cushion) the sealed semiconductor connection 270 from impact at the time of dicing the sealed semiconductor connection 270 and to dice the sealed semiconductor connection 270 with excellent workability.

[0153]

The base material 4 is not limited to the laminate of the notched layer 41 and the expansion layer 42 as described in the

present embodiment, and for example, may be a single layer body in which any one of the notched layer 41 and the expansion layer 42 is omitted.

[0154]

<Pressure-sensitive adhesive layer>

The pressure-sensitive adhesive layer 2 has a function of supporting the sealed semiconductor connection 270 by allowing the sealed semiconductor connection 270 to adhere thereto at the time of dicing the sealed semiconductor connection 270 in the step [4]. Further, as described above, the pressure-sensitive adhesiveness of the pressure-sensitive adhesive layer 2 with respect to the sealing portion 27 of the sealed semiconductor connection 270 reliably reduces by the application of energy. As a result, in the step [6], the semiconductor sealing body 290 can be easily peeled from the pressure-sensitive adhesive layer 2, that is, the pressure-sensitive adhesive tape 100, and occurrence of contamination and adhesive residue on the sealing portion 27 can be prevented.

[0155]

In particular, in the present invention, the pressure-sensitive adhesive layer 2 contains, a peeling agent which is a silicone-based oil or a fluorine-based surfactant. In this way, the pressure-sensitive adhesive layer 2 can markedly perform the function of reducing the adhesiveness (the

adhesiveness between the sealing portion 27 and the pressure-sensitive adhesive layer 2) between the semiconductor sealing body 290 and the pressure-sensitive adhesive tape 100 when the semiconductor sealing body 290 is peeled from the pressure-sensitive adhesive tape 100 in the step [6].

[0156]

The pressure-sensitive adhesive layer 2 having the aforementioned function is constituted with a resin composition containing, as main materials, (1) base resin having pressure-sensitive adhesiveness, (2) curable resin curing the pressure-sensitive adhesive layer 2, and (5) peeling agent for reducing adhesiveness between the semiconductor sealing body 290 and the pressure-sensitive adhesive tape 100 in the step [6].

[0157]

Hereinafter, each of the components contained in the resin composition will be sequentially described.

(1) Base resin

The base resin has pressure-sensitive adhesiveness and is contained in the resin composition such that the pressure-sensitive adhesiveness with respect to the sealed semiconductor connection 270 is imparted to the pressure-sensitive adhesive layer 2 to firmly fix the sealed semiconductor connection 270 to the pressure-sensitive adhesive tape 100 before the pressure-sensitive adhesive layer 2 is

irradiated with energy rays.

[0158]

Examples of the base resin include known base resins used as components of a pressure-sensitive adhesive layer, such as an acrylic resin (pressure-sensitive adhesive), a silicone-based resin (pressure-sensitive adhesive), a polyester-based resin (pressure-sensitive adhesive), a polyvinyl acetate-based resin (pressure-sensitive adhesive), a polyvinyl ether-based resin (pressure-sensitive adhesive), a styrene-based elastomer resin (pressure-sensitive adhesive), a polyisoprene-based resin (pressure-sensitive adhesive), a polyisobutylene-based resin (pressure-sensitive adhesive), and a urethane-based resin (pressure-sensitive adhesive). Among these, an acrylic resin is preferably used. The acrylic resin has excellent heat resistance and can be relatively easily obtained at low costs. Therefore, the acrylic resin is preferably used as the base resin.

[0159]

A base polymer of the acrylic resin is a polymer (homopolymer or copolymer) containing a (meth)acrylic acid ester as a main monomer component.

[0160]

The (meth)acrylic acid ester is not particularly limited, and examples thereof include a (meth)acrylic acid alkyl ester such as methyl (meth)acrylate, ethyl (meth)acrylate, propyl

(meth)acrylate, isopropyl (meth)acrylate, butyl (meth)acrylate, isobutyl (meth)acrylate, s-butyl (meth)acrylate, t-butyl (meth)acrylate, pentyl (meth)acrylate, hexyl (meth)acrylate, heptyl (meth)acrylate, octyl (meth)acrylate, isooctyl (meth)acrylate, 2-ethylhexyl (meth)acrylate, nonyl (meth)acrylate, isononyl (meth)acrylate, decyl (meth)acrylate, isodecyl (meth)acrylate, undecyl (meth)acrylate, dodecyl (meth)acrylate, tridecyl (meth)acrylate, tetradecyl (meth)acrylate, pentadecyl (meth)acrylate, hexadecyl (meth)acrylate, heptadecyl (meth)acrylate, or octadecyl (meth)acrylate, a (meth)acrylic acid cycloalkyl ester such as cyclohexyl (meth)acrylate, a (meth)acrylic acid aryl ester such as phenyl (meth)acrylate, and the like. One kind of the above resin can be used, or two or more kinds of the above resins can be used in combination. It is preferable that the acrylic resin contains at least one kind of compound among methyl (meth)acrylate, butyl (meth)acrylate, and 2-ethylhexyl (meth)acrylate as a (meth)acrylic acid alkyl ester. Particularly, the (meth)acrylic acid alkyl ester has excellent heat resistance and can be relatively easily obtained at low costs.

[0161]

For the purpose of improving cohesive force, heat resistance, and the like, if necessary, an acrylic resin contains a copolymerizable monomer as a monomer component constituting

the polymer in addition to the aforementioned (meth)acrylic acid ester.

[0162]

The aforementioned copolymerizable monomer is not particularly limited, and examples thereof include a hydroxyl group-containing monomer such as 2-hydroxyethyl (meth)acrylate, 2-hydroxypropyl (meth)acrylate, 4-hydroxybutyl (meth)acrylate, or 6-hydroxyhexyl (meth)acrylate, an epoxy group-containing monomer such as glycidyl (meth)acrylate, a carboxyl group-containing monomer such as (meth)acrylic acid, itaconic acid, maleic acid, fumaric acid, crotonic acid, or isocrotonic acid, an acid anhydride group-containing monomer such as maleic anhydride or itaconic anhydride, an amide-based monomer such as (meth)acrylamide, N,N-dimethyl (meth)acrylamide, N-butyl (meth)acrylamide, N-methylol (meth)acrylamide, N-methylolpropane (meth)acrylamide, N-methoxymethyl (meth)acrylamide, or N-butoxymethyl (meth)acrylamide, an amino group-containing monomer such as aminoethyl (meth)acrylate, N,N-dimethylaminoethyl (meth)acrylate, or t-butylaminoethyl (meth)acrylate, a cyano group-containing monomer such as (meth)acrylonitrile, an olefin-based monomer such as ethylene, propylene, isoprene, butadiene, or isobutylene, a styrene-based monomer such as styrene, α-methylstyrene, or vinyl toluene, a vinyl ester-based monomer such as vinyl acetate or vinyl propionate, a vinyl ether-based monomer such as methyl vinyl

ether or ethyl vinyl ether, a halogen atom-containing monomer such as vinyl chloride or vinylidene chloride, an alkoxy group-containing monomer such as methoxyethyl (meth)acrylate or ethoxyethyl (meth)acrylate, a monomer having a nitrogen atom-containing ring such as N-vinyl-2-pyrrolidone, N-methylvinylpyrrolidone, N-vinylpyridine, N-vinylpiperidone, N-vinylpyrimidine, N-vinylpiperazine, N-vinylpirazine, N-vinylpyrrole, N-vinylimidazole, N-vinyloxazole, N-vinylmorpholine, N-vinylcaprolactam, or N-(meth)acryloylmorpholine, and the like. One kind of the above resin can be used, or two or more kinds of the above resins can be used in combination.

[0163]

The content of these copolymerizable monomers with respect to all of the monomer components constituting the acrylic resin is preferably equal to or less than 40% by weight, and more preferably equal to or less than 10% by weight.

[0164]

In the polymer constituting the acrylic resin, the copolymerizable monomer may be contained in the terminal of a main chain, in the middle of the main chain, or in both of the terminal of the main chain and the middle of the main chain.

[0165]

For the purpose of cross-linking the polymers, the copolymerizable monomer may contain a polyfunctional monomer.

[0166]

Examples of the polyfunctional monomer include 1,6-hexanediol (meth)acrylate, (poly)ethylene glycol di(meth)acrylate, (poly)propylene glycol di(meth)acrylate, neopentyl glycol di(meth)acrylate, pentaerythritol di(meth)acrylate, trimethylolpropane tri(meth)acrylate, pentaerythritol tri(meth)acrylate, dipentaerythritol hexa(meth)acrylate, glycerin di(meth)acrylate, epoxy (meth)acrylate, polyester (meth)acrylate, urethane (meth)acrylate, divinyl benzene, butyl di(meth)acrylate, hexyl di(meth)acrylate, and the like. One kind of the above resin can be used, or two or more kinds of the above resins can be used in combination.

[0167]

Furthermore, an ethylene-vinyl acetate copolymer, a vinyl acetate polymer, and the like can be used as the copolymerizable monomer component.

[0168]

The aforementioned acrylic resin (polymer) can be generated by polymerizing a single monomer component or a mixture of two or more kinds of monomer components. The monomer component can be polymerized by, for example, a polymerization method such as a solution polymerization method, an emulsification polymerization method, a bulk polymerization method, or a suspension polymerization method.

[0169]

The acrylic resin obtained by polymerizing the monomer component described above is preferably an acrylic resin (referred to as a "double bond introduction-type acrylic resin" in some cases) having a carbon-carbon double bond in a side chain, in the middle of a main chain, or in the terminal of a main chain. In a case where the acrylic resin is a double bond introduction-type acrylic resin, even though a curable resin which will be described later is not added, the obtained pressure-sensitive adhesive layer 2 can function as the pressure-sensitive adhesive layer 2 described above.

[0170]

The aforementioned double bond introduction-type acrylic resin is preferably a double bond introduction-type acrylic resin (referred to as a "double bond side chain introduction-type acrylic resin" in some cases) in which 1/100 or more of side chains among the side chains in the polymer constituting the acrylic resin each have one carbon-carbon double bond. The introduction of the carbon-carbon double bond into the side chain of the acrylic resin is advantageous as well in terms of molecular design. The double bond side chain introduction-type acrylic resin may also have the carbon-carbon double bond in the middle of a main chain or in the terminal of a main chain.

[0171]

The method for synthesizing the double bond

introduction-type acrylic resin (that is, the method for introducing the carbon-carbon double bond into the acrylic resin) is not particularly limited, and examples thereof include the following method. First, an acrylic resin containing a functional group (referred to as a "functional group-containing acrylic resin" in some cases) is synthesized by copolymerizing a functional group-containing monomer as a copolymerizable monomer. Then, a functional group which can react with the functional group in the functional group-containing acrylic resin and a compound having a carbon-carbon double bond (referred to as a "carbon-carbon double bond-containing reactive compound" in some cases) are subjected to a condensation reaction or an addition reaction in a state where the carbon-carbon double bond in the functional group-containing acrylic resin is being allowed to maintain energy ray curability (energy ray polymerizing properties). In this way, a double bond introduction-type acrylic resin can be synthesized.

[0172]

Examples of control means at the time of introducing the carbon-carbon double bond into 1/100 or more of side chains among all of the side chains in the acrylic resin include a method of appropriately regulating the content of the carbon-carbon double bond-containing reactive compound which is a compound subjected to the condensation reaction or the addition reaction together with the functional group-containing acrylic resin.

[0173]

At the time of causing the condensation reaction or the addition reaction between the functional group-containing acrylic resin and the carbon-carbon double bond-containing reactive compound, by using a catalyst, the aforementioned reaction can be effectively carried out. The catalyst is not particularly limited, but a tin-based catalyst such as dibutyltin dilaurate is preferably used. The content of the tin-based catalyst is not particularly limited, but is preferably, for example, equal to or greater than 0.05 parts by weight and equal to or less than 1 part by weight with respect to 100 parts by weight of the functional group-containing acrylic resin.

[0174]

Examples of a functional group A in the functional group-containing acrylic resin and a functional group B in the carbon-carbon double bond-containing reactive compound include a carboxyl group, an acid anhydride group, a hydroxyl group, an amino group, an epoxy group, an isocyanate group, an aziridine group, and the like. Examples of a combination of the functional group A in the functional group-containing acrylic resin and the functional group B in the carbon-carbon double bond-containing reactive compound include various combinations such as a combination of a carboxylic acid group (carboxyl group) and an epoxy group, a combination of a carboxylic acid group

and an aziridyl group, a combination of a hydroxyl group and an isocyanate group, and a combination of a hydroxyl group and a carboxyl group. Among these, a combination of a hydroxyl group and an isocyanate group is preferable. In a case where the aforementioned combination is used, it is possible to easily track the reaction between the functional groups A and B.

[0175]

In the combination of the functional groups A and B, any of the functional groups may be the functional group A of the functional group-containing acrylic resin or the functional group B of the carbon-carbon double bond-containing reactive compound. For example, in a case where a combination of a hydroxyl group and an isocyanate group is used, the hydroxyl group is preferably the functional group A in the functional group-containing acrylic resin, and the isocyanate group is preferably the functional group B in the carbon-carbon double bond-containing reactive compound.

[0176]

In this case, examples of the monomer having the functional group A constituting the functional group-containing acrylic resin include a carboxyl group-containing monomer such as acrylic acid, methacrylic acid, carboxyethyl acrylate, carboxypentyl acrylate, itaconic acid, maleic acid, fumaric acid, or crotonic acid, an acid anhydride group-containing monomer such as maleic anhydride or itaconic anhydride, a

hydroxyl group-containing monomer such as 2-hydroxyethyl (meth)acrylate, 2-hydroxypropyl (meth)acrylate, 4-hydroxybutyl (meth)acrylate, 6-hydroxyhexyl (meth)acrylate, 8-hydroxyoctyl (meth)acrylate, 10-hydroxydecyl (meth)acrylate, 12-hydroxylauryl (meth)acrylate, (4-hydroxymetylcyclohexyl)methyl (meth)acrylate, vinyl alcohol, allyl alcohol, 2-hydroxyethyl vinyl ether, 2-hydroxypropyl vinyl ether, 4-hydroxybutyl vinyl ether, ethylene glycol monovinyl ether, diethylene glycol monovinyl ether, propylene glycol monovinyl ether, or dipropylene glycol monovinyl ether, an epoxy group-containing monomer such as glycidyl (meth)acrylate or allyl glycidyl ether, and the like.

[0177]

Examples of the carbon-carbon double bond-containing reactive compound having the functional group B include a carbon-carbon double bond-containing reactive compound having an isocyanate group such as (meth)acryloyl isocyanate, (meth)acryloyloxymethyl isocyanate, 2-(meth)acryloyloxyethyl isocyanate, 2-(meth)acryloyloxypropyl isocyanate, 3-(meth)acryloyloxypropyl isocyanate, 4-(meth)acryloyloxybutyl isocyanate, m-propenyl-α,α-dimethylbenzyl isocyanate, and the like, a carbon-carbon double bond-containing reactive compound having an epoxy group such as glycidyl (meth)acrylate, and the like.

[0178]

It is preferable that the acrylic resin has a functional group (reactive functional group) such as a hydroxyl group or a carboxyl group (particularly, a hydroxyl group) exhibiting reactivity to a cross-linking agent or a photopolymerization initiator. In a case where the acrylic resin has such a functional group, the cross-linking agent or the photopolymerization initiator is linked to the acrylic resin which is a monomer component. Accordingly, it is possible to accurately inhibit or prevent the cross-linking agent or the photopolymerization initiator from leaking out of the pressure-sensitive adhesive layer 2. As a result, by the energy ray irradiation performed in the step [5], the pressure-sensitive adhesiveness of the pressure-sensitive adhesive layer 2 with respect to the sealed semiconductor connection 270 is more reliably reduced.

[0179]

The glass transition point of the base resin is preferably equal to or lower than -20°C, and more preferably lower than -50°C. In the present invention, after irradiating the pressure-sensitive adhesive layer 2 with energy rays, the pressure-sensitive adhesive layer 2 contains a predetermined peeling agent in order to reduce the adhesiveness between the semiconductor sealing body 290 and the pressure-sensitive adhesive tape 100 when the semiconductor sealing body 290 is peeled from the pressure-sensitive adhesive tape 100 in the step

[6]. As described above, even though the pressure-sensitive adhesive layer 2 contains a peeling agent, the pressure-sensitive adhesive layer 2 exhibits excellent pressure-sensitive adhesiveness before the pressure-sensitive adhesive layer 2 is irradiated with energy rays because the glass transition point of the base resin has the above upper limit. Accordingly, the sealed semiconductor connection 270 can be more reliably fixed to the pressure-sensitive adhesive tape 100 at the time of dicing the sealed semiconductor connection 270 in the step [4].

[0180]

In this case, the weight-average molecular weight of the base resin is preferably set to be 300,000 to 1,800,000, more preferably set to be 400,000 to 1,600,000, and even more preferably set to be 500,000 to 1,200,000. As described above, even though the pressure-sensitive adhesive layer 2 contains a peeling agent, the pressure-sensitive adhesive layer 2 exhibits excellent pressure-sensitive adhesiveness before the pressure-sensitive adhesive layer 2 is irradiated with energy rays because the weight-average molecular weight of the base resin is set in the above range. Furthermore, the sealed semiconductor connection 270 or the like can be reliably inhibited or prevented from being contaminated at the time of dicing the sealed semiconductor connection 270 in the step [4].

[0181]

(2) Curable resin

The curable resin has, for example, curing properties of being cured by being irradiated with energy rays. As a result of incorporating the base resin into the cross-linked structure of the curable resin by curing, the adhesive force (pressure-sensitive adhesiveness) of the pressure-sensitive adhesive layer 2 is reduced.

[0182]

Furthermore, in the present invention, the pressure-sensitive adhesive layer 2 contains the peeling agent and the base resin is incorporated into the cross-linked structure of the curable resin by curing of the curable resin, and accordingly, the peeling agent leaks out to the surface of the pressure-sensitive adhesive layer 2. From this viewpoint as well, the adhesive force of the pressure-sensitive adhesive layer 2 can be reduced.

[0183]

As the curable resin, for example, a low-molecular weight compound is used which has, as a functional group, a polymerizable carbon-carbon double bond being able to be three-dimensionally cross-linked by being irradiated with energy rays such as ultraviolet rays or electron beams in at least two or more molecules. Specific examples of the curable resin include an esterified substance of (meth)acrylic acid and a polyhydric alcohol such as trimethylolpropane

tri(meth)acrylate, pentaerythritol tri(meth)acrylate, pentaerythritol tetra(meth)acrylate, tetramethylolmethane tetra(meth)acrylate, tetraethylene glycol di(meth)acrylate, 1,6-hexanediol di(meth)acrylate, neopentyl glycol di(meth)acrylate, dipentaerythritol hexa(meth)acrylate, dipentaerythritol monohydroxypenta(meth)acrylate, 1,4-butylene glycol di(meth)acrylate, polyethylene glycol di(meth)acrylate, or glycerin di(meth)acrylate, an ester acrylate oligomer, a cyanurate-based compound having a carbon-carbon double bond-containing group such as 2-propenyl-di-3-butenyl cyanurate, an isocyanurate-based compound having a carbon-carbon double bond-containing group such as tris(2-acryloxyethyl)isocyanurate, tris(2-methacryloxyethyl)isocyanurate, 2-hydroxyethyl bis(2-acryloxyethyl)isocyanurate, bis(2-acryloxyethyl) 2-[(5-acryloxyhexyl)-oxy]ethyl isocyanurate, tris(1,3-diacryloxy-2-propyl-oxycarbonylamino-n-hexyl)isocyanurate, tris(1-acryloxyethyl-3-methacryloxy-2-propyl-oxycarbonylamino-n-hexyl)isocyanurate, or tris(4-acryloxy-n-butyl)isocyanurate, commercially available oligoester acrylate, aromatic urethane acrylate, aliphatic urethane acrylate, and the like. One kind of the above resin can be used, or two or more kinds of the above resins can be used in combination. The resin composition preferably contains

an oligomer having 6 or more functional groups among the above, and more preferably contains an oligomer having 15 or more functional groups. In a case where the resin composition contains the above oligomer, the curable resin can be more reliably cured by being irradiated with energy rays. The curable resin is preferably urethane acrylate. In a case where urethane acrylate is used, appropriate flexibility can be imparted to the pressure-sensitive adhesive layer 2, and as a result, an effect is obtained which makes it possible to inhibit the cracking of the adhesive at the time of pickup.

[0184]

The aforementioned urethane acrylate is not particularly limited and is obtained by reacting hydroxyl group-containing (meth)acrylate (for example, 2-hydroxyethyl (meth)acrylate, 2-hydroxypropyl (meth)acrylate, or polyethylene glycol (meth)acrylate) with an isocyanate-terminated urethane prepolymer which is obtained by reacting a polyester-type or polyether-type polyol compound with a polyvalent isocyanate compound (for example, 2,4-tolylene diisocyanate, 2,6-tolylene diisocyanate, 1,3-xylylene diisocyanate, 1,4-xylylene diisocyanate, or diphenylmethane 4,4-diisocyanate).

[0185]

The curable resin is not particularly limited, but is preferably obtained by mixing two or more curable resins having different weight-average molecular weights. In a case where

such a curable resin is used, a degree of cross-linking of the resin cured by energy ray irradiation can be easily controlled, and a pressure-sensitive adhesive tape 100 can be provided in which the pickup properties of semiconductor sealing body 290 (semiconductor element 26) in the step [6] are improved. As the curable resin, for example, a mixture of a first curable resin and a second curable resin which has a weight-average molecular weight greater than that of the first curable resin may be used.

[0186]

In a case where the mixture of the first curable resin and the second curable resin is used as the curable resin, the weight-average molecular weight of the first curable resin is preferably about 100 to 1,000, and more preferably about 200 to 500. The weight-average molecular weight of the second curable resin is preferably about 1,000 to 30,000, more preferably about 1,000 to 10,000, and even more preferably about 2,000 to 5,000. Furthermore, the first curable resin preferably has 1 to 5 functional groups, and the second curable resin preferably has 6 or more functional groups. In a case where the curable resin satisfies the aforementioned relationship, the effects described above can be more markedly exhibited.

[0187]

The amount of the curable resin formulated with respect to 100 parts by weight of the base resin is preferably equal to or greater than 5 parts by weight and equal to or less than

500 parts by weight, more preferably equal to or greater than 10 parts by weight and equal to or less than 300 parts by weight, and even more preferably equal to or greater than 20 parts by weight and equal to or less than 200 parts by weight. In a case where the amount of the curable resin formulated is adjusted as described above, a pressure-sensitive adhesive tape 100 can be provided which exhibits excellent pickup properties of the semiconductor sealing body 290 (semiconductor element 26) in the step [6].

[0188]

In a case where a double bond introduction-type acrylic resin is used as the aforementioned acrylic resin, that is, in a case where an acrylic resin having a carbon-carbon double bond in a side chain, in the middle of a main chain, or in the terminal of a main chain is used, the curable resin may not be added to the resin composition, for the following reason. In a case where the acrylic resin is a double bond introduction-type acrylic resin, by the irradiation of energy rays, the pressure-sensitive adhesive layer 2 is cured due to the function of the carbon-carbon double bond included in the double bond introduction-type acrylic resin, and accordingly, the adhesive force of the pressure-sensitive adhesive layer 2 is reduced.

[0189]

(3) Photopolymerization initiator

By the irradiation of energy rays, the pressure-sensitive

adhesiveness of the pressure-sensitive adhesive layer 2 with respect to the sealed semiconductor connection 270 is reduced. In a case where ultraviolet rays and the like are used as the energy rays, it is preferable that the curable resin contains a photopolymerization initiator for facilitating the initiation of the polymerization of the curable resin.

[0190]

Examples of the photopolymerization initiator include 2,2-dimethoxy-1,2-diphenylethan-1-one, 1-[4-(2-hydroxyethoxy)-phenyl]-2-hydroxy-2-methyl-1-propan-1-one, 2-hydroxy-1-{4-[4-(2-hydroxy-2-methyl-propionyl)-benzyl]phenyl}-2-methyl-propan-1-one, benzyl diphenyl sulfide, tetramethylthiuram monosulfide, 4-(2-hydroxyethoxy)phenyl(2-hydroxy-2-propyl)ketone, α-hydroxy-α,α′-dimethylacetophenone, 2-methyl-2-hydroxypropiophenone, 1-hydroxycyclohexyl phenylketone, Michler's ketone, acetophenone, methoxyacetophenone, 2,2-dimethoxy-2-phenyl acetophenone, 2,2-diethoxyacetophenone, 2-methyl-1-[4-(methylthio)-phenyl]-2-morpholinopropane-1-one, benzoin methyl ether, benzoin ethyl ether, benzoin propyl ether, benzoin isopropyl ether, benzoin isobutyl ether, benzyl, benzoin, dibenzyl, α-hydroxycyclohexyl phenyl ketone, benzyl dimethyl ketal, 2-hydroxymethyl phenyl propane,

2-naphthalenesulfonyl chloride,
1-phenone-1,1-propanedione-2-(o-ethoxycarbonyl)oxime,
benzophenone, benzoyl benzoate,
4,4'-dimethylaminobenzophenone,
4,4'-diethylaminobenzophenone, 4,4'-dichlorobenzophenone,
3,3'-dimethyl-4-methoxybenzophenone, o-acryloxybenzophenone,
p-acryloxybenzophenone, o-methacryloxybenzophenone,
p-methacryloxybenzophenone,
p-(meth)acryloxyethoxybenzophenone, a
benzophenone-4-carboxylic acid ester of acrylate such as
1,4-butanediol mono(meth)acrylate, 1,2-ethanediol
mono(meth)acrylate, or 1,8-octanediol mono(meth)acrylate,
thioxanthone, 2-chlorothioxanthone, 2-methylthioxanthone,
2,4-dimethylthioxanthone, isopropylthioxanthone,
2,4-dichlorothioxanthone, 2,4-diethylthioxanthone,
2,4-diisopropylthioxanthone, azobisisobutyronitrile,
β-chloroanthraquinone, camphorquinone, halogenated ketone,
acylphosphine oxide, acyl phosphonate, polyvinyl benzophenone,
chlorothioxanthone, dodecyl thioxanthone, dimethyl
thioxanthone, diethyl thioxanthone, 2-ethylanthraquinone,
t-butylanthraquinone, a 2,4,5-triarylimidazole dimer, and the
like. One kind of the above resin can be used, or two or more
kinds of the above resins can be used in combination.

[0191]

Among these, a benzophenone derivative and an alkylphenone

derivative are preferable. These compounds contain a hydroxyl group in a molecule as a reactive functional group. Through the reactive functional group, the compounds can be linked to the base resin or the curable resin and can more reliably exhibit the function thereof as a photopolymerization initiator.

[0192]

The amount of the photopolymerization initiator formulated with respect to 100 parts by weight of the base resin is preferably equal to or greater than 0.1 parts by weight and equal to or less than 50 parts by weight, and more preferably equal to or greater than 0.5 parts by weight and equal to or less than 10 parts by weight. By adjusting the amount of the photopolymerization initiator formulated as described above, the pressure-sensitive adhesive tape 100 having suitable pickup properties can be provided.

[0193]

(4) Cross-linking agent

The curable resin may further contain a cross-linking agent. In a case where the curable resin contains the cross-linking agent, the curability of the curable resin can be improved.

[0194]

The cross-linking agent is not particularly limited, and examples thereof include an isocyanate-based cross-linking agent, an epoxy-based cross-linking agent, a urea resin-based

cross-linking agent, a methylol-based cross-linking agent, a chelate-based cross-linking agent, an aziridine-based cross-linking agent, a melamine-based cross-linking agent, a polyvalent metal chelate-based cross-linking agent, an acid anhydride-based cross-linking agent, a polyamine-based cross-linking agent, a carboxyl group-containing polymer-based cross-linking agent, and the like. Among these, an isocyanate-based cross-linking agent is preferable.

[0195]

The isocyanate-based cross-linking agent is not particularly limited, and examples thereof include a polyisocyanate compound of polyvalent isocyanate, a trimer of a polyisocyanate compound, a trimer of an isocyanate-terminated compound obtained by reacting a polyisocyanate compound with a polyol compound, a blocked polyisocyanate compound obtained by blocking an isocyanate-terminated urethane prepolymer by using phenol or oximes, and the like.

[0196]

Examples of the polyvalent isocyanate include 2,4-tolylene diisocyanate, 2,6-tolylene diisocyanate, 1,3-xylylene diisocyanate, 1,4-xylylene diisocyanate, diphenylmethane-4,4’-diisocyanate, diphenylmethane-2,4’-diisocyanate, 3-methyldiphenylmethane diisocyanate, hexamethylene diisocyanate, isophorone diisocyanate, dicyclohexylmethane-4,4’-diisocyanate,

dicyclohexylmethane-2,4'-diisocyanate, 4,4'-diphenylether diisocyanate,

4,4'-[2,2-bis(4-phenynoxyphenyl)propane]diisocyanate,

2,2,4-trimethyl-hexamethylene diisocyanate, and the like. One kind of the above resin can be used, or two or more kinds of the above resins can be used in combination. Among these, at least one kind of polyvalent isocyanate is preferable which is selected from the group consisting of 2,4-tolylene diisocyanate, diphenylmethane-4,4'-diisocyanate, and hexamethylene diisocyanate.

[0197]

The amount of the cross-linking agent formulated with respect to 100 parts by weight of the base resin is preferably equal to or greater than 0.01 parts by weight and equal to or less than 50 parts by weight, and more preferably equal to or greater than 5 parts by weight and equal to or less than 50 parts by weight. By adjusting the amount of the cross-linking agent formulated as described above, the pressure-sensitive adhesive tape 100 having suitable pickup properties can be provided.

[0198]

(5) Peeling agent

In the present invention, a resin composition constituting the pressure-sensitive adhesive layer 2 contains, a peeling agent which is a silicone-based oil or a fluorine-based surfactant. Therefore, by irradiating the pressure-sensitive

adhesive layer 2 with energy rays, the adhesiveness between the semiconductor sealing body 290 and the pressure-sensitive adhesive tape 100 can be reduced.

[0199]

The effect of the peeling agent being contained in the pressure-sensitive adhesive layer 2 will be described in detail. In the step [5], by curing of the curable resin caused by the application of energy to the pressure-sensitive adhesive layer 2, the peeling agent leaks out to the surface of the pressure-sensitive adhesive layer 2. Due to the leakage of the peeling agent on the surface of such a pressure-sensitive adhesive layer 2, the interaction is reduced between the constituent materials at the interface between the sealing portion 27 and the pressure-sensitive adhesive layer 2. As a result, the adhesiveness between the semiconductor sealing body 290 and pressure-sensitive adhesive tape 100 is reliably reduced. Therefore, in the step [6], the pressure-sensitive adhesive tape 100 can be easily peeled from the semiconductor sealing body 290 without causing contamination and adhesive residue on the sealing portion 27.

[0200]

As described above, the sealing material forming the sealing portion 27 contains, as an epoxy group-containing compound different from the epoxy resin, an epoxy group-containing compound having a double bond in a molecular

structure thereof. Accordingly, the interaction between the constituent material of the sealing portion 27 and the constituent material of the pressure-sensitive adhesive layer 2 at the interface between the sealing portion 27 and the pressure-sensitive adhesive layer 2 tends to be high. Also with respect to the sealing portion 27 formed of the sealing material containing the epoxy group-containing compound having a double bond in a molecular structure thereof, as described above, the adhesiveness (the adhesive force of the pressure-sensitive adhesive layer 2 with respect to the sealing portion 27) between the semiconductor sealing body 290 and the pressure-sensitive adhesive tape 100 can be reliably reduced after the application of energy to the pressure-sensitive adhesive layer 2 in the step [5] in a case of containing a predetermined peeling agent in the pressure-sensitive adhesive layer 2. Such an effect can be confirmed by the adhesive force of the pressure-sensitive adhesive layer 2 before and after the application of energy with respect to the sealing portion 27 formed of the sealing material containing the epoxy group-containing compound having the double bond in the molecular structure. Specifically, the adhesive force between the pressure-sensitive adhesive layer 2 and the sealing portion 27 before application of energy is preferably equal to or higher than 70 cN/25 mm and less than 1,000 cN/25 mm, and more preferably equal to or higher than 200 cN/25 mm and less than 1,000 cN/25 mm. On the other hand, the

adhesive force between the pressure-sensitive adhesive layer 2 and the sealing portion 27 after application of energy is preferably equal to or higher than 60 cN/25 mm and less than 90 cN/25 mm, and more preferably equal to or higher than 5 cN/25 mm and less than 60 cN/25 mm. A method of measuring the adhesive force will be described in detail by Examples. It is preferable that the adhesive force of the pressure-sensitive adhesive layer 2 before and after application of energy satisfies the following relationship. That is, provided that the adhesive force between the pressure-sensitive adhesive layer 2 and the sealing portion 27 before application of energy is A and the adhesive force between the pressure-sensitive adhesive layer 2 and the sealing portion 27 after application of energy is B, A - B is preferably in a range of 110 cN/25 mm to 940 cN/25 mm, and more preferably in a range of 140 cN/25 mm to 920 cN/25 mm.

[0201]

The peeling agent (oil repellent material) may contain other materials, in addition to a silicone-based oil or a fluorine-based surfactant, within a range not restricting the function thereof (that is, by leaking out to the surface of the pressure-sensitive adhesive layer 2, the interaction is reduced between the constituent materials at the interface between the sealing portion 27 and the pressure-sensitive adhesive layer 2). For example, the peeling agent can include one or two or more kinds of a fluorine-based material, a coupling agent having

a fluorine atom, and the like.

[0202]

Among these, examples of the fluorine-based material include a fluorine-based organic material such as polytetrafluoroethylene (PTFE), an ethylene-tetrafluoroethylene copolymer (ETFE), or an ethylene-chlorotrifluoroethylene copolymer (ECTFE), a fluorine-based inorganic material such as potassium fluorotitanate, potassium silicofluoride, or potassium fluorozirconate, and the like.

[0203]

Examples of the coupling agent having a fluorine atom include tridecafluoro-1, tridecafluoro-1,1,2,2-tetrahydrooctyl trimethoxysilane, trifluoropropyl trimethoxysilane, γ-glycidoxypropyl trimethoxysilane, and the like.

[0204]

Furthermore, the fluorine-based surfactant is preferably perfluoroalkylsulfonic acid ($CF_3(CF_2)_nSO_3H$; n is an integer of 1 or more), perfluoroalkylcarboxylic acid ($CF_3(CF_2)_nCOOH$; n is an integer of 1 or more), or fluorine telomer alcohol ($F(CF_2)_nCH_2CH_2OH$; n is an integer of 1 or more).

[0205]

The silicone-based oil is preferably a linear silicone oil such as a dimethyl silicone oil (polysiloxane), a methylphenyl

silicone oil, or a methyl hydrogen polysiloxane, a modified silicone oil such as an epoxy-modified silicone oil, an amino-modified silicone oil, a carboxyl-modified silicone oil, an alcohol-modified silicone oil, a fluorine-modified silicone oil, an epoxy polyether-modified silicone oil, or a polyether-modified silicone oil, and the like.

[0206]

Among these, as the fluorine-based surfactant, a perfluoroalkylsulfonic acid is preferable. As the silicone-based oil, a modified silicone oil is preferable.

[0207]

By using a silicone-based oil (particularly, a modified silicone oil) as a peeling agent, the base resin is incorporated into the cross-linked structure of the curable resin by the curable resin being cured by the irradiation of energy rays. Accordingly, when the adhesive force of the pressure-sensitive adhesive layer 2 is reduced, the silicone-based oil oozes out from the cross-linked structure. As a result, the peeling agent leaks out to the surface of the pressure-sensitive adhesive layer 2, and due to this, the adhesiveness between the semiconductor sealing body 290 and the pressure-sensitive adhesive tape 100 is more reliably reduced.

[0208]

By using a fluorine-based surfactant as a peeling agent, the adhesive force by the pressure-sensitive adhesive layer 2

is maintained with excellent adhesive strength before the irradiation of energy rays, and the adhesive force can be reliably reduced after the irradiation of energy rays. Therefore, before the irradiation of energy rays, the semiconductor sealing body 290 and the pressure-sensitive adhesive tape 100 are fixed with excellent adhesion, whereas after the irradiation of energy rays, the adhesiveness between the semiconductor sealing body 290 and the pressure-sensitive adhesive tape 100 can be reliably reduced.

[0209]

The content of the peeling agent in the pressure-sensitive adhesive layer 2, that is, in the resin composition slightly varies with the type of the peeling agent. However, the content is, for example, preferably equal to or higher than 0.01% by weight and equal to or lower than 1.0% by weight, and more preferably equal to or higher than 0.05% by weight and equal to or lower than 0.5% by weight. In a case where the content of the peeling agent is less than the lower limit described above, depending on the type of the peeling agent, a sufficient amount of the peeling agent cannot leak out to the surface of the pressure-sensitive adhesive layer 2 when curing the curable resin, and thus the adhesion between the semiconductor sealing body 290 and the pressure-sensitive adhesive tape 100 may not be reduced. In a case where the content of the peeling agent is larger than the upper limit described above, depending on

the type of the peeling agent, the function (specifically, the function as the pressure-sensitive adhesive layer 2 that adheres to the sealing portion 27 before the application of energy rays and can be peeled from the sealing portion 27 after the application of energy rays) of the pressure-sensitive adhesive layer 2 before and after the application of energy may be markedly reduced.

[0210]

(6) Other components

The resin composition constituting the pressure-sensitive adhesive layer 2 may contain, as other components used in addition to the above components (1) to (5), at least one kind among a tackifier, an anti-aging agent, a viscosity adjuster, a filler, a colorant, a flame retardant, a softener, an antioxidant, a plasticizer, and a surfactant.

[0211]

Among these, the tackifier is not particularly limited, and examples thereof include a rosin resin, a terpene resin, a coumarone resin, a phenol resin, an aliphatic petroleum resin, an aromatic petroleum resin, an aliphatic-aromatic copolymer-based petroleum resin, and the like. One kind of the above resin can be used, or two or more kinds of the above resins can be used in combination.

[0212]

A contact angle A of a surface of the pressure-sensitive

adhesive layer 2 with respect to hexadecane is, preferably equal to or higher than 20°, more preferably equal to or higher than 20° and equal to or lower than 50°, and more preferably equal to or higher than 25° and equal to or lower than 40° before the application of energy. In a case where the contact angle in the pressure-sensitive adhesive layer 2 is set to be within the above range, although slightly varies depending on the type of the base resin contained in the pressure-sensitive adhesive layer 2, the sealed semiconductor connection 270 can be reliably fixed to the pressure-sensitive adhesive tape 100 at the time of the step [4].

[0213]

A contact angle B of a surface of the pressure-sensitive adhesive layer 2 with respect to hexadecane is, preferably equal to or higher than 10°, more preferably equal to or higher than 10° and equal to or lower than 45°, and more preferably equal to or higher than 20° and equal to or lower than 30° after the application of energy. In a case where the contact angle in the pressure-sensitive adhesive layer 2 is set to be within the above range, although slightly varies depending on the type of the base resin contained in the pressure-sensitive adhesive layer 2, the adhesive force of the pressure-sensitive adhesive layer 2 with respect to the semiconductor sealing body 290 can be suitably reduced. Therefore, in the step [6], the semiconductor

sealing body 290 can be easily picked up.

[0214]

In a case where the contact angles A and B are within the above ranges, (contact angle A - contact angle B) is preferably equal to or higher than 1° and equal to or lower than 10°, and more preferably equal to or higher than 3° and equal to or lower than 7°. In a case where the contact angle is within the above range, the effects can be markedly exerted.

[0215]

A tack strength of the pressure-sensitive adhesive layer 2 is preferably equal to or higher than 150 kPa and equal to or lower than 400 kPa and more preferably equal to or higher than 250 kPa and equal to or lower than 400 kPa at 25°C before the application of energy. In a case where the tack strength at 25°C of the pressure-sensitive adhesive layer 2 before the application of energy is within the above range, it can be said that the pressure-sensitive adhesive layer 2 has the adhesive force enough to reliably fix a sealed semiconductor connection including a sealing portion formed of a sealing material not containing an epoxy group-containing compound having a double bond in a molecular structure thereof at the time of the step [4].

[0216]

A tack strength of the pressure-sensitive adhesive layer 2 is preferably equal to or higher than 0 kPa and equal to or

lower than 150 kPa and more preferably equal to or higher than 0 kPa and equal to or lower than 100 kPa at 25°C after the application of energy. In a case where the tack strength at 25°C of the pressure-sensitive adhesive layer 2 after the application of energy is within the above range, it can be said that the pressure-sensitive adhesive layer 2 has the adhesive force enough to easily pick up a semiconductor sealing body including a sealing portion formed of a sealing material not containing an epoxy group-containing compound having a double bond in a molecular structure thereof at the time of the step [6].

[0217]

The tack strength of the pressure-sensitive adhesive layer 2 is measured based on JIS Z 0237, for example, in a manner in which the pressure-sensitive adhesive tape 100 is set in a tacking tester TAC-II from RHESCA CO., LTD. such that the pressure-sensitive adhesive layer 2 faces up, and by using Constant Load for continuously controlling the tester such that a probe is pushed into the pressure-sensitive adhesive layer 2 by applying pressure up to the preset value and the preset pressure is maintained until after the preset time, a probe made of SUS304 having a diameter of 5.0 mm is brought into contact with the pressure-sensitive adhesive layer 2 from above. At this time, the probe is brought into contact with the measurement sample at a speed of 10 mm/sec, a contact load is set to be 200 gf, and a contact time is set to be 1 second. Thereafter, the

probe is peeled off upwards at a peeling rate of 10 mm/sec, and the strength required for peeling off the probe is measured as the tack strength. The tack strength at 25°C is measured by setting a probe temperature to be 25°C and a plate temperature to be 25°C.

[0218]

The thickness of the pressure-sensitive adhesive layer 2 is not particularly limited. For example, the thickness of the pressure-sensitive adhesive layer 2 is preferably equal to or greater than 1 μm and equal to or less than 30 μm, more preferably equal to or greater than 5 μm and equal to or less than 30 μm, and even more preferably equal to or greater than 10 μm and equal to or less than 25 μm. In a case where the thickness of the pressure-sensitive adhesive layer 2 is within the above range, an excellent adhesive force is exhibited before energy is applied to the pressure-sensitive adhesive layer 2, and excellent peeling properties are exhibited between the pressure-sensitive adhesive layer 2 and the sealed semiconductor connection 270 after energy is applied to the pressure-sensitive adhesive layer 2. Furthermore, in a case where the thickness of the pressure-sensitive adhesive layer 2 is within the above range, by setting the total light transmittance of the base material 4 measured using a D65 standard light source to be equal to or higher than 85% and equal to or lower than 98%, a

pressure-sensitive adhesive tape 100 having apparently excellent light transmitting properties can be obtained.

[0219]

The pressure-sensitive adhesive layer 2 may be constituted with a laminate (multilayer substance) in which a plurality of layers constituted with different resin compositions described above are laminated.

[0220]

The pressure-sensitive adhesive tape 100 for semiconductor substrate fabrication constituted as above can be manufactured as below, for example.

[0221]

<Method for manufacturing pressure-sensitive adhesive tape for semiconductor substrate fabrication>

FIG. 5 is a vertical cross-sectional view for illustrating a method for manufacturing the pressure-sensitive adhesive tape for semiconductor substrate fabrication shown in FIG. 4. In the following description, the upper side and the lower side in FIG. 5 will be referred to as “top” and “bottom” respectively.

[0222]

[1B] First, the base material 4 in which the notched layer 41 and the expansion layer 42 are laminated in this order is prepared (see (a) of FIG. 5).

[0223]

The base material 4 constituted as above is not

particularly limited, and can be manufactured using a general molding method such as a lamination method for films obtained by an extrusion molding method such as an inflation co-extrusion method or a T-die co-extrusion method, an extrusion molding method such as a calendar method, an inflation extrusion method, a T-die extrusion method, or a cyclic die extrusion method, or a wet casting method. Among these, the T-die co-extrusion method is preferable. By the above method, the layers included in the pressure-sensitive adhesive tape 100 can be formed with an excellent thickness accuracy.

[0224]

Hereinafter, the T-die co-extrusion method (extrusion method using T dies) will be described. First, the resin components constituting the notched layer 41 and the expansion layer 42 are separately subjected to dry blending or melt-kneading, thereby obtaining resin compositions for forming the layers 41 and 42. The resin compositions for forming the layers 41 and 42 are supplied into a screw-type extruder and extruded in the form of a film from a multilayer T die adjusted to have a temperature of 180°C to 240°C, and then the film is cooled and wound while being passed through a cooling roll adjusted to have a temperature of 10°C to 50°C, thereby obtaining the base material 4. Alternatively, the resin compositions for forming the layers 41 and 42 may be obtained in the form of pellets first and then subjected to extrusion molding as described above

so as to obtain the base material 4. The thickness of each of the formed layers 41 and 42 can be adjusted by adjusting the rotation frequency of the screw of the extruder.

[0225]

In the process of winding the film while cooling the film by passing it through the aforementioned cooling roll, it is preferable to wind the film substantially in a non-stretched state by securing the strength enough for preventing the film from breaking at the time of expansion. In a case where the film is wound in a non-stretched state, the base material 4 having excellent light transmitting properties can be provided. The substantially non-stretched state refers to a state where the film is not actively stretched, and includes a non-stretched state or a state where the film is slightly stretched only to the extent that does not affect the warpage of the base material 4 at the time of dicing. Generally, at the time of winding the film, the film may be pulled such that it does not sag.

[0226]

Furthermore, in a case where the notched layer 41 is manufactured using a lamination method, the notched layer 41 can be used in a non-stretched state or may be, if necessary, subjected to a uniaxial or biaxial stretching treatment. In addition, for the purpose of improving the adhesiveness between the notched layer 41 and the expansion layer 42, a surface treatment such as a corona treatment, a chromic acid treatment,

a matting treatment, a treatment of exposure to ozone, a treatment of exposure to flame, a treatment of exposure to electric shock at high voltage, an ionizing radiation treatment, a primer treatment, or an anchor coating treatment may be performed on a surface (bottom surface) of the notched layer 41.

[0227]

In a case where the expansion layer 42 is manufactured using a lamination method, by thermally laminating a material, which is obtained by melting the resin composition as the constituent material of the expansion layer 42, on the notched layer 41 and then cooling the material, the expansion layer 42 can be formed.

[0228]

[2B] Then, the pressure-sensitive adhesive layer 2 is formed on the top surface of the obtained base material 4 (notched layer 41) (see (b) of FIG. 5).

[0229]

For the purpose of improving the adhesiveness between the base material 4 and the pressure-sensitive adhesive layer 2, a surface treatment such as a corona treatment, a chromic acid treatment, a matting treatment, a treatment of exposure to ozone, a treatment of exposure to flame, a treatment of exposure to electric shock at high voltage, an ionizing radiation treatment, a primer treatment, or an anchor coating treatment may be

performed on a surface (top surface) of the base material 4.

[0230]

The pressure-sensitive adhesive layer 2 can be obtained by applying or spreading a liquid material, which is prepared by dissolving the resin composition as the constituent material of the pressure-sensitive adhesive layer 2 in a solvent so as to make a varnish-like material, on the base material 4 and then volatilizing the solvent such that the pressure-sensitive adhesive layer 2 is formed.

[0231]

The solvent is not particularly limited, and examples thereof include methyl ethyl ketone, acetone, toluene, ethyl acetate, dimethyl formaldehyde, and the like. One kind of the above resin can be used, or two or more kinds of the above resins can be used in combination.

[0232]

The coating or spreading of the liquid material performed on the base material 4 can be carried out by using a method such as die coating, curtain coating, gravure coating, comma coating, bar coating, or lip coating.

[0233]

[3B] Thereafter, for the pressure-sensitive adhesive layer 2 formed on the base material 4, a portion of the pressure-sensitive adhesive layer 2 is annularly removed in a state where the base material 4 is allowed to remain in the

thickness direction of the pressure-sensitive adhesive layer 2 such that the central side and the outer peripheral side are separated, thereby making the pressure-sensitive adhesive layer 2 include a central portion 122 and an outer peripheral portion 121 (see (c) of FIG. 5).

[0234]

Examples of the method of annularly removing a portion of the pressure-sensitive adhesive layer 2 include a method of punching the pressure-sensitive adhesive layer 2 such that the region which should be removed is surrounded and then removing the pressure-sensitive adhesive layer 2 positioned in the punched region.

[0235]

The region which should be removed can be punched by using, for example, a method using a roll-like mold or a method using a press mold. Among these, it is preferable to use the method using a roll-like mold that makes it possible to continuously manufacture the pressure-sensitive adhesive tape 100.

[0236]

In the present process, by punching a portion of the pressure-sensitive adhesive layer 2 in the shape of a ring (circle), the central portion 122 and the outer peripheral portion 121 are formed. However, a portion of the pressure-sensitive adhesive layer 2 may be punched in any shape, as long as the central portion 122 of the pressure-sensitive

adhesive layer 2 can be fixed using a wafer ring in the aforementioned method for manufacturing a semiconductor device. Specifically, examples of the punching shape include, in addition to the aforementioned circular shape, an oval shape, an elliptical shape such as the shape of a straw bag, a polygonal shape such as a quadrangular shape or a pentagonal shape, and the like.

[0237]

[4B] Then, a separator 1 is laminated on the pressure-sensitive adhesive layer 2 formed on the base material 4, thereby obtaining a pressure-sensitive adhesive tape 100 in which the pressure-sensitive adhesive layer 2 is coated with the separator 1 (see (d) of FIG. 5).

[0238]

The method of laminating the separator 1 on the pressure-sensitive adhesive layer 2 is not particularly limited, and for example, it is possible to use a lamination method using a roll or a lamination method using a press. Among these, from the viewpoint of productivity that enables continuous production, the lamination method using a roll is preferable.

[0239]

The separator 1 is not particularly limited, and examples thereof include a polypropylene film, a polyethylene film, a polyethylene terephthalate film, and the like.

[0240]

In order to peel off the separator 1 at the time of using the pressure-sensitive adhesive tape 100, a film with a surface having undergone a release treatment may be used as the separator 1. Examples of the release treatment include a treatment of coating the surface of the separator 1 with a release agent, a treatment of making fine irregularities on the surface of the separator 1, and the like. Examples of the release agent include a silicone-based release agent, an alkyd-based release agent, a fluorine-based release agent, and the like.

[0241]

Through the process described so far, the pressure-sensitive adhesive tape 100 coated with the separator 1 can be formed.

[0242]

The pressure-sensitive adhesive tape 100 coated with the separator 1 that is manufactured in the present embodiment is used after the pressure-sensitive adhesive tape 100 is peeled from the separator 1 in the aforementioned method of manufacturing a semiconductor device using the pressure-sensitive adhesive tape 100.

[0243]

At the time of peeling the separator 1 from the pressure-sensitive adhesive layer 2 coated with the separator 1, it is preferable to peel the separator 1 at an angle equal to or greater than 90° and equal to or less than 180° with respect

to the surface of the pressure-sensitive adhesive layer 2. In a case where the peeling angle of the separator 1 is within the above range, it is possible to reliably prevent peeling from occurring in a region other than the interface between the pressure-sensitive adhesive layer 2 and the separator 1.

[0244]

In the present embodiment, a case has been described in which the semiconductor device 20 is applied to a Quad Flat Package (QFP) and the semiconductor device 20 having such a constitution is manufactured using the pressure-sensitive adhesive tape 100. However, the present invention is not limited to this case, and the pressure-sensitive adhesive tape 100 can be applied to manufacturing of various types of semiconductor packages. For example, the pressure-sensitive adhesive tape 100 can be applied to the manufacturing of memory or logic elements such as a dual in-line package (DIP), a plastic leaded chip carrier (PLCC), a low-profile quad flat package (LQFP), a small outline package (SOP), a small outline J lead package (SOJ), a thin small outline package (TSOP), a thin quad flat package (TQFP), a tape carrier package (TCP), a ball grid array (BGA), a chip size package (CSP), a matrix array package ball grid array (MAPBGA), and a chip stacked chip size package.

[0245]

Hitherto, the pressure-sensitive adhesive tape for semiconductor substrate fabrication of the present invention

and the method of manufacturing a semiconductor device have been described, but the present invention is not limited thereto.

[0246]

For example, optional components which can perform the same function may be added to each of the layers included in the pressure-sensitive adhesive tape for semiconductor substrate fabrication of the present invention. Alternatively, in the base material, a plurality of notched layers 41 and a plurality of expansion layers 42 may be laminated.

[0247]

In addition, the constitution of each of the layers included in the pressure-sensitive adhesive tape for semiconductor substrate fabrication of the present invention may be substituted with any constitution which can perform the same function. Alternatively, a layer of any constitution, for example, an antistatic layer or the like may be added.

[0248]

In the present embodiment, a case has been described where the sealed semiconductor connection (semiconductor substrate) is fixed using the pressure-sensitive adhesive tape for semiconductor substrate fabrication of the present invention, and a semiconductor sealing body as a target which is obtained by dicing the sealed semiconductor connection is picked up from the pressure-sensitive adhesive tape for semiconductor substrate fabrication. However, the present invention is not

limited thereto, and can include a case where a semiconductor wafer (semiconductor substrate) on which a plurality of semiconductor elements are formed is fixed, and semiconductor elements as targets which are obtained by dicing the semiconductor wafer are picked up from the pressure-sensitive adhesive tape for semiconductor substrate fabrication.

Examples

[0249]

Next, specific examples of the present invention will be described. Herein, the present invention is not limited to the description of the examples.

[0250]

1. Preparation of raw materials

First, the raw materials used for preparing the base material film for a dicing film of examples will be shown below.

[0251]

<Raw materials of base material 4>

Ionomer resin “HIMILAN 1855” (manufactured by DU PONT-MITSUI POLYCHEMICALS; metal atom: Zn, MFR: 1.0, melting point: 86°C)

Low-density polyethylene LDPE “F222” (manufactured by UBE-MARUZEN POLYETHYLENE Co., Ltd., melting point: 110°C)

Antistatic agent “PELESTAT 212” (manufactured by Sanyo Chemical Industries, Ltd.; polyether/polyolefin block polymer)

[0252]

<Raw materials of pressure-sensitive adhesive layer 2>

In the pressure-sensitive adhesive layer of each of examples, the following raw materials were used.

[0253]

<Base resin>

At least two kinds of compounds among butyl acrylate (BA), acrylic acid (AA), methyl methacrylate (MA), and 2-ethylhexyl acrylate (2EHA) were mixed together and subjected to solution polymerization in a toluene solvent by a common method, the acryl copolymers 1 to 5 were obtained.

[0254]

In the acryl copolymers 1 to 5, the mixing ratio between at least two kinds of compounds mixed together among MA, BA, 2EHA, and AA was set to be as below.

[0255]

Acryl copolymer 1 (BA/AA = 90/10)

Acryl copolymer 2 (BA/AA = 95/5)

Acryl copolymer 3 (MA/BA/2EHA/AA = 15/45/35/5)

Acryl copolymer 4 (MA/2EHA/AA = 10/85/5)

Acryl copolymer 5 (MA/2EHA/AA = 12/85/3)

[0256]

Furthermore, the glass transition point and the weight-average molecular weight in the acryl copolymers 1 to 5 were set to be as below.

[0257]

Acryl copolymer 1 (glass transition point: -38°C, weight-average molecular weight: 600,000)

Acryl copolymer 2 (glass transition point: -45°C, weight-average molecular weight: 800,000)

Acryl copolymer 3 (glass transition point: -42°C, weight-average molecular weight: 600,000)

Acryl copolymer 4 (glass transition point: -50°C, weight-average molecular weight: 800,000)

Acryl copolymer 5 (glass transition point: -53°C, weight-average molecular weight: 800,000)

[0258]

<UV curable resin>

Urethane acrylate 1 (manufactured by SHIN-NAKAMURA CHEMICAL CO., LTD., trade name: UA-33H): 20 parts by weight

[0259]

<Cross-linking agent>

Polyisocyanate compound (trade name “CORONATE L”, manufactured by Nippon Polyurethane Industry Co., Ltd.)

[0260]

<Photoinitiator>

Benzophenone-based photoinitiator (trade name “IRGACURE 651”, manufactured by Ciba Specialty Chemicals Inc.)

[0261]

<Peeling agent>

Silicone-based oil ("BYK-302", manufactured by BYK Japan

KK)

Fluorine-based surfactant ("RS-75", manufactured by DIC Corporation)

[0262]

2. Preparation of pressure-sensitive adhesive tape for semiconductor substrate fabrication

(Example 1)

<Preparation of base material 4>

As a resin for forming a notched layer, an ionomer resin "HIMILAN 1855" was used.

[0263]

Furthermore, 80.0% by mass of the low-density polyethylene LDPE "F222" and 20.0% by mass of the antistatic agent "PELESTAT 212" were dry-blended, thereby obtaining a resin composition for forming an expansion layer.

[0264]

Each of the obtained resin for forming a notched layer and the resin composition for forming an expansion layer was adjusted to have a temperature of 200°C, supplied into extruders, extruded from a double layer dice with a temperature of 200°C in order of notched layer/expansion layer, cooled and solidified using a cooling roll set to be 20°C, and wound in a substantially non-stretched state, thereby obtaining a base material 4 having a double layer structure.

[0265]

In the obtained base material 4, the thickness of the notched layer 41 was 100 μm, the thickness of the expansion layer 42 was 50 μm, and the total thickness of the base material 4 was 150 μm.

[0266]

<Preparation of pressure-sensitive adhesive tape 100 (dicing film)>

The pressure-sensitive adhesive layer 2 was provided on the notched layer 41 of the base material 4 prepared as above, thereby obtaining the pressure-sensitive adhesive tape 100. Specifically, as raw materials of the pressure-sensitive adhesive layer 2, 50% by mass of the base resin (acryl copolymer 1), 43% by mass of the UV curable resin, 3% by mass of the cross-linking agent, 3% by mass of the photoinitiator, and 1% by mass of the peeling agent were used and dissolved and mixed together in ethyl acetate, thereby obtaining a mixture. Then, the notched layer of the base material 4 was bar-coated with the mixture such that the thickness of the film after drying became 20 μm, and then the film was dried for 10 minutes at 80°C, thereby obtaining the pressure-sensitive adhesive tape 100 of Example 1.

[0267]

(Examples 2 to 6 and Comparative Example 1)

The base materials 4 and the pressure-sensitive adhesive tapes 100 of Examples 2 to 5 and Comparative Example 1 were

prepared in the same manner as in Example 1, except that the type of the raw materials was changed as described in Table 1.

[0268]

3. Evaluation

<Tack strength at 25°C before application of energy>

The tack strength at 25°C of the pressure-sensitive adhesive layer before the application of energy was evaluated as below.

[0269]

First, based on JIS Z 0237, each of the pressure-sensitive adhesive tapes 100 of Examples 1 to 6 and Comparative Example 1 was set in a tacking tester TAC-II from RHESCA CO., LTD. such that the pressure-sensitive adhesive layer faced up, and a probe made of SUS304 having a diameter of 5.0 mm was brought into contact with the pressure-sensitive adhesive layer from above. The probe at this time was brought into contact with the pressure-sensitive adhesive layer at a speed of 10 mm/sec, a contact load was set to be 200 gf, a contact time was set to be 1 second, and a probe temperature and a plate temperature were set to be 25°C. Thereafter, the probe was peeled off upwards at a peeling rate of 10 mm/sec, and the strength required for peeling off the probe was measured as the tack strength. According to the obtained tack strength, the tack strength at 25°C was evaluated based on the following evaluation standards. The results are shown in Table 1.

[0270]

[Evaluation standards]

The tack strength was equal to or higher than 250 kPa and equal to or lower than 400 kPa: A

The tack strength was equal to or higher than 150 kPa and less than 250 kPa: B

The tack strength was less than 150 kPa or higher than 400 kPa: C

[0271]

<Tack strength at 25°C after application of energy>

The tack strength at 25°C of the pressure-sensitive adhesive layer after the application of energy was evaluated as below.

[0272]

First, based on JIS Z 0237, each of the pressure-sensitive adhesive tapes 100 of Examples 1 to 5 and Comparative Examples 1 and 2 was set in a tacking tester TAC-II from RHESCA CO., LTD. such that the pressure-sensitive adhesive layer faced up, and a probe made of SUS304 having a diameter of 5.0 mm was brought into contact with the pressure-sensitive adhesive layer from above. The probe at this time was brought into contact with the pressure-sensitive adhesive layer at a speed of 10 mm/sec, a contact load was set to be 200 gf, a contact time was set to be 1 second, and a probe temperature and a plate temperature were set to be 25°C. Thereafter, after irradiating the

pressure-sensitive adhesive tape with ultraviolet rays from the rear surface side (irradiation time: 20 seconds, irradiation intensity: 500 mJ/cm^2), the probe was peeled off upwards at a peeling rate of 10 mm/sec, and the strength required for peeling off the probe was measured as the tack strength. According to the obtained tack strength, the tack strength at 25°C was evaluated based on the following evaluation standards. The results are shown in Table 1.

[0273]

[Evaluation standards]

The tack strength was equal to or higher than 0 kPa and less than 50 kPa: A

The tack strength was equal to or higher than 50 kPa and equal to or lower than 150 kPa: B

The tack strength was higher than 150 kPa: C

[0274]

<Contact angle before application of energy>

The contact angle of the pressure-sensitive adhesive layer with respect to hexadecane before the application of energy was measured as below.

[0275]

First, for each of the pressure-sensitive adhesive tapes 100 of Examples 1 to 6 and Comparative Example 1, hexadecane was supplied to the pressure-sensitive adhesive layer 2, thereby determining the contact angle of the pressure-sensitive

adhesive layer with respect to hexadecane before the application of energy. The results are shown in Table 1.

[0276]

<Contact angle after application of energy>

The contact angle of the pressure-sensitive adhesive layer with respect to hexadecane after the application of energy was measured as below.

[0277]

First, for each of the pressure-sensitive adhesive tapes 100 of Examples 1 to 6 and Comparative Example 1, after irradiating the pressure-sensitive adhesive tape with ultraviolet rays from the rear surface side (irradiation time: 20 seconds, irradiation intensity: 500 mJ/cm^2), hexadecane was supplied to the pressure-sensitive adhesive layer 2, thereby determining the contact angle of the pressure-sensitive adhesive layer with respect to hexadecane before the application of energy. The results are shown in Table 1.

[0278]

<Tape mounting characteristics>

The tape mounting characteristics were evaluated as below.

[0279]

First, a dummy substrate 1 made of glass epoxy (60 mm x 15 mm x 1.2 mm (thickness)), which will be described in detail in the adhesive force before the application of energy described later, was attached to the pressure-sensitive adhesive tapes

100 of Examples 1 to 6 and Comparative Example 1, and whether or not air bubbles, which entered the space between the pressure-sensitive adhesive layer 2 included in the pressure-sensitive adhesive tape 100 and the dummy substrate, occurred was visually observed. According to the number of air bubbles observed, the tape mounting characteristics were evaluated based on the following evaluation standards. The results are shown in Table 1.

[0280]

[Evaluation standards]

No air bubble occurred between the pressure-sensitive adhesive layer and the dummy substrate: A

Air bubbles slightly occurred between the pressure-sensitive adhesive layer and the dummy substrate: B

Due to the insufficient tackiness, air bubbles apparently occurred between the pressure-sensitive adhesive layer and the dummy substrate: C

[0281]

<Adhesive force before application of energy>

The adhesive force before the application of energy was measured as below.

[0282]

First, the pressure-sensitive adhesive tapes 100 of Examples 1 to 6 and Comparative Example 1 were adjusted to have a width of 25 mm, and the pressure-sensitive adhesive tapes were

attached to a dummy substrate 1 (60 mm × 15 mm × 1.2 mm (thickness)) made of glass epoxy containing epoxidized polybutadiene and a dummy substrate 2 (60 mm × 15 mm × 1.2 mm (thickness)) made of glass epoxy not containing epoxidized polybutadiene by one reciprocation of a 2 kg roller. Thereafter, based on JIS Z 0237, a peak strength measured when holding one end the pressure-sensitive adhesive tape 100 and peeling off it in a direction of 180° at a speed of 300 mm/min at 25°C was measured as the adhesive force.

[0283]

Each of the dummy substrate 1 made of glass epoxy and the dummy substrate 2 made of glass epoxy was manufactured as follows.

[0284]

That is, 4.13% by weight of a biphenyl type epoxy resin (manufactured by Mitsubishi Chemical Corporation, YX4000K, melting point: 105°C, epoxy equivalent: 185) as an epoxy resin 1; 4.54% by weight of a phenol aralkyl resin (manufactured by MEIWA PLASTIC INDUSTRIES,LTD., MEH7851SS, softening point: 65°C, hydroxyl equivalent: 203) containing a biphenylene skeleton as a phenol resin 1; 0.13% by weight of triphenylphosphine; 90.00% by weight of fused spherical silica (average particle size: 30 μm); 0.50% by weight of an epoxidized polybutadiene compound 1 (manufactured by Nippon Petrochemicals Co., Ltd., E-1800-6.5,

number-average molecular weight: 1,800, viscosity (25°C): 350 Pa·s); 0.20% by weight of γ-glycidyl propyltrimethoxysilane; 0.20% by weight of carnauba wax; and 0.30% by weight of carbon black were mixed with a mixer, and then an obtained mixture was kneaded using two rolls having surface temperatures of 90°C and 45°C and cooled and pulverized to make an epoxy resin composition. A sealing portion was molded on a bismaleimide-triazine resin/a glass cloth substrate having a thickness of 60 mm × 15 mm × 0.56 mm with a mold temperature of 175°C, an injection pressure of 6.9 MPa, and a curing time of 2 minutes by using a transfer molding machine, and post-curing was performed at 175°C for 2 hours to obtain the dummy substrate 1 made of glass epoxy.

[0285]

Furthermore, 4.37% by weight of a biphenyl type epoxy resin (manufactured by Mitsubishi Chemical Corporation, YX4000K, melting point: 105°C, epoxy equivalent: 185) as an epoxy resin 1; 4.80% by weight of a phenol aralkyl resin (manufactured by MEIWA PLASTIC INDUSTRIES,LTD., MEH7851SS, softening point: 65°C, hydroxyl equivalent: 203) containing a biphenylene skeleton as a phenol resin 1; 0.13% by weight of triphenylphosphine; 90.00% by weight of fused spherical silica (average particle size: 30 μm); 0.20% by weight of γ-glycidyl propyltrimethoxysilane; 0.20% by weight of carnauba wax; and 0.30% by weight of carbon black were mixed with a mixer, and then an obtained mixture was kneaded

using two rolls having surface temperatures of 90°C and 45°C and cooled and pulverized, thereby obtaining an epoxy resin composition. The dummy substrate 2 made of glass epoxy was obtained by using a transfer molding machine under the same conditions as the dummy substrate 1 made of glass epoxy.

[0286]

According to the obtained adhesive force, the adhesive force before the application of energy was evaluated based on the following evaluation standards. The results are shown in Table 1.

[0287]

[Evaluation standards]

The adhesive force before the application of energy was equal to or higher than 200 cN/25 mm and less than 1,000 cN/25 mm: A

The adhesive force before the application of energy was equal to or higher than 70 cN/25 mm and less than 200 cN/25 mm: B

The adhesive force before the application of energy was less than 70 cN/ 25 mm or equal to or higher than 1,000 cN/25 mm: C

[0288]

<Adhesive force after application of energy>

The adhesive force after the application of energy was evaluated as below.

[0289]

First, the dummy substrate 1 (60 mm × 15 mm × 1.2 mm (thickness)) made of glass epoxy containing epoxidized polybutadiene and the dummy substrate 2 (60 mm × 15 mm × 1.2 mm (thickness)) made of glass epoxy not containing epoxidized polybutadiene were each attached to the pressure-sensitive adhesive tapes 100 of Examples 1 to 6 and Comparative Example 1. Thereafter, dicing was performed under the following conditions, and the segmented dummy substrates were irradiated with ultraviolet rays from the rear surface side of the pressure-sensitive adhesive tape (irradiation time: 20 seconds, irradiation intensity: 500 mJ/cm^2). Then, the segmented dummy substrates were picked up using a vacuum collet, and the force required for picking up was measured as the adhesive force.

[0290]

According to the obtained adhesive force, the adhesive force after the application of energy was evaluated based on the following evaluation standards. The results are shown in Table 1.

[0291]

[Evaluation standards]

The adhesive force after the application of energy was equal to or higher than 5 cN/25 mm and less than 60 cN/25 mm: A

The adhesive force after the application of energy was

equal to or higher than 60 cN/25 mm and less than 90 cN/25 mm: B

The adhesive force after the application of energy was equal to or higher than 90 cN/25 mm: C

[0292]

<Rear surface contamination and adhesive residue characteristics>

The rear surface contamination and the adhesive residue characteristics were evaluated as below.

[0293]

First, the dummy substrate 1 (60 mm × 15 mm × 1.2 mm (thickness)) made of glass epoxy containing epoxidized polybutadiene and the dummy substrate 2 (60 mm × 15 mm × 1.2 mm (thickness)) made of glass epoxy not containing epoxidized polybutadiene were each attached to the pressure-sensitive adhesive tapes 100 of Examples 1 to 6 and Comparative Example 1, then dicing was performed under the following conditions and the segmented dummy substrates were irradiated with ultraviolet rays from the rear surface side of the pressure-sensitive adhesive tape (irradiation time: 20 seconds, irradiation intensity: 500 mJ/cm^2). Thereafter, by using the vacuum collet, 50 pieces among the segmented dummy substrates were picked up, and whether or not the rear surface contamination in the substrates picked up and whether or not the adhesive residue remained in the substrates picked up were visually observed.

According to the number of dummy substrates in which the rear surface contamination or the adhesive residue was observed, the rear surface contamination and the adhesive residue characteristics were evaluated based on the following evaluation standards. The results are shown in Table 1.

[0294]

[Evaluation standards]

The number of dummy substrates in which the rear surface contamination or the adhesive residue was observed was 0/50: A

The number of dummy substrates in which the rear surface contamination or the adhesive residue was observed was 1 to 3/50: B

The number of dummy substrates in which the rear surface contamination or the adhesive residue was observed was equal to or higher than 4/50: C

[0295]

[Dicing conditions]

Dicing device: “DAD-3350” (trade name, manufactured by DISCO Corporation)

Dicing blade: “P08-SDC220” (trade name, manufactured by DISCO Corporation)

Rotation frequency of blade: 30,000 rpm

Cutting rate: 100 mm/sec

Notching: 100 μm from the surface of the dicing film

(notching amount for the notched layer: 80 μm)

Cut size: 5 mm × 5 mm

Blade cooler: 2 L/min

[0296]

<Cutting chip characteristics>

The cutting chip characteristics were evaluated as below.

[0297]

First, the dummy substrate 1 made of glass epoxy (60 mm × 15 mm × 1.2 mm (thickness)) was attached to the pressure-sensitive adhesive tapes 100 of Examples 1 to 6 and Comparative Example 1, and dicing was performed under the following conditions. Then, the cutting lines were observed, the number of cutting chips having a length of equal to or greater than 100 μm coming out of the cutting lines was counted, and based on the following evaluation standards, the cutting chip characteristics were evaluated. The results are shown in Table 1.

[0298]

[Evaluation standards]

The number of cutting chips was 0 to 5: A

The number of cutting chips was 6 to 10: B

The number of cutting chips was equal to or greater than 11: C

[0299]

[Dicing conditions]

Dicing device: “DAD-3350” (trade name, manufactured by DISCO Corporation)

Dicing blade: “P08-SDC220” (trade name, manufactured by DISCO Corporation)

Rotation frequency of blade: 20,000 rpm

Cutting rate: 125 mm/sec

Notching: 100 μm from the surface of the dicing film (notching amount for the notched layer: 80 μm)

Cut size: 10 mm × 10 mm

Blade cooler: 2 L/min

[0300]

[Table 1]

			Example						Camparative Example
			1	2	3	4	5	6	1
Pressure-sensitive adhesive layer		Acryl copolymer 1 [% by mass]	50					50	50
		Acryl copolymer 2 [% by mass]		50					
		Acryl copolymer 3 [% by mass]			50				
		Acryl copolymer 4 [% by mass]				50			
		Acryl copolymer 5 [% by mass]					50		
		Urethane acrylate 1 [% by mass]	43	43	43	43	43	43	44
		Polyisocyanate compound [% by mass]	3	3	3	3	3	3	3
		Benzophenone-based photoinitiator [% by mass]	3	3	3	3	3	3	3
		Silicone-based oil (peeling agent) [% by mass]	1	1	1	1	1		
		Fluorine-based surfactant (peeling agent) [% by mass]						1	
		Thickness [μm]	20	20	20	20	20	20	20
Base material	Notched layer	HIMILAN 1855 [% by mass]	100.0	100.0	100.0	100.0	100.0	100.0	100.0
		Thickness [μm]	100	100	100	100	100	100	100
	Expansion layer	F222 [% by mass]	80.0	80.0	80.0	80.0	80.0	80.0	80.0
		PELESTAT 212 [% by mass]	20.0	20.0	20.0	20.0	20.0	20.0	20.0
		Thickness [μm]	50	50	50	50	50	50	50
Evaluation		Tack strength at 25°C before application of energy	B	B	B	B	A	A	A
		Tack strength at 25°C after application of energy	A	A	A	A	A	A	B
		Contact angle with respect to hexadecane before application of energy	30	30	35	28	30	24	8
		Contact angle with respect to hexadecane after application of energy	25	22	30	26	26	22	7
		Tape mounting characteristics	B	A	B	A	A	B	B
		Adhesive force before application of energy (dummy substrate 1)	A	B	B	A	A	A	A
		Adhesive force before application of energy (dummy substrate 2)	B	B	A	A	A	A	A
		Adhesive force after application of energy (dummy substrate 1)	B	B	B	B	B	B	C
		Adhesive force after application of energy (dummy substrate 2)	A	A	A	B	B	B	B
		Rear surface contamination and adhesive residue characteristics (dummy substrate 1)	A	B	A	B	B	B	C
		Rear surface contamination and adhesive residue characteristics (dummy substrate 2)	A	A	B	B	B	B	B
		Cutting chip characteristics	A	A	A	A	A	A	A

[0301]

As is evident from the results in Table 1, it was found that in the pressure-sensitive adhesive tapes 100 of Examples 1 to 6, also for a sealing portion formed of a sealing material containing epoxidized polybutadiene, the adhesive force of the pressure-sensitive adhesive tape 100 with respect to the sealing material can be reduced by application of energy due to a peeling agent contained in the pressure-sensitive adhesive layer 2.

[0302]

On the other hand, in the pressure-sensitive adhesive tape of Comparative Example 1, the pressure-sensitive adhesive layer 2 does not contain a peeling agent, and accordingly, the adhesive force of the pressure-sensitive adhesive tape 100 with respect to the sealing material containing epoxidized polybutadiene could not be reduced by application of energy.

Industrial Applicability

[0303]

According to the present invention, it is possible to provide a pressure-sensitive adhesive tape for semiconductor substrate fabrication, including a base material and a pressure-sensitive adhesive layer laminated on one surface of the base material, in which the pressure-sensitive adhesive tape is used for a process of performing fabrication in which when a sealed semiconductor connection including a substrate, a

plurality of semiconductor elements disposed on the substrate, and a sealing portion sealing the plurality of semiconductor elements is cut in a thickness direction thereof to obtain a plurality of semiconductor sealing bodies, the sealed semiconductor connection is temporarily fixed to the base material through the pressure-sensitive adhesive layer, the pressure-sensitive adhesive layer contains a peeling agent for reducing adhesiveness to the sealing portion when the semiconductor sealing bodies are peeled from the pressure-sensitive adhesive tape for semiconductor substrate fabrication, the sealing portion is formed of a sealing material containing an epoxy group-containing compound, the epoxy group-containing compound has a double bond in a molecular structure thereof, and the peeling agent is a silicone-based oil or a fluorine-based surfactant. A semiconductor device manufactured by applying such a pressure-sensitive adhesive tape has excellent reliability. Therefore, the present invention has industrial applicability.

Reference Signs List

[0304]

1 separator

2 pressure-sensitive adhesive layer

4 base material

20 semiconductor device

21 bump

22 coating portion

23 wiring

25 interposer

25′ sheet material

26 semiconductor element

27 sealing portion

41 notched layer

42 expansion layer

62 depression

100 pressure-sensitive adhesive tape for semiconductor substrate fabrication (pressure-sensitive adhesive tape)

121 outer peripheral portion

122 central portion

221 opening portion

270 sealed semiconductor connection

290 semiconductor sealing body

Claims

1. A pressure-sensitive adhesive tape for semiconductor substrate fabrication, comprising:

a base material; and

a pressure-sensitive adhesive layer laminated on one surface of the base material,

the pressure-sensitive adhesive tape being used for temporarily fixing a sealed semiconductor connection to the base material through the pressure-sensitive adhesive layer when the sealed semiconductor connection including a substrate, a plurality of semiconductor elements disposed on the substrate, and a sealing portion sealing the plurality of semiconductor elements is cut in a thickness direction thereof to obtain a plurality of semiconductor sealing bodies, and the temporarily fixing being carried out in a state where the sealing portion and the pressure-sensitive adhesive layer are in contact with each other,

wherein the pressure-sensitive adhesive layer contains a peeling agent for reducing adhesiveness to the sealing portion when the semiconductor sealing bodies are peeled from the pressure-sensitive adhesive tape for semiconductor substrate fabrication,

wherein the sealing portion is formed of a sealing material containing an epoxy group-containing compound,

wherein the epoxy group-containing compound has a double bond in a molecular structure thereof, and

wherein the peeling agent is a silicone-based oil or a fluorine-based surfactant.

2. The pressure-sensitive adhesive tape for semiconductor substrate fabrication according to claim 1,

wherein the peeling agent is the silicone-based oil, and

the silicone-based oil is a modified silicone oil.

3. The pressure-sensitive adhesive tape for semiconductor substrate fabrication according to claim 1 or 2,

wherein the pressure-sensitive adhesive layer further contains a base resin having pressure-sensitive adhesiveness.

4. The pressure-sensitive adhesive tape for semiconductor substrate fabrication according to claim 3,

wherein a glass transition point of the base resin is equal to or lower than -30°C.

5. The pressure-sensitive adhesive tape for semiconductor substrate fabrication according to claim 3 or 4,

wherein a weight-average molecular weight of the base resin is 300,000 to 1,800,000.

6. The pressure-sensitive adhesive tape for semiconductor substrate fabrication according to any one of claims 3 to 5,

wherein the pressure-sensitive adhesive layer further contains a curable resin to be cured by application of energy.

7. The pressure-sensitive adhesive tape for semiconductor substrate fabrication according to claim 6,

wherein a contact angle of a surface of the pressure-sensitive adhesive layer to hexadecane is equal to or higher than 20° before the application of energy.

8. The pressure-sensitive adhesive tape for semiconductor substrate fabrication according to claim 6 or 7,

wherein a contact angle of a surface of the pressure-sensitive adhesive layer to hexadecane is equal to or higher than 10° after the application of energy.

9. The pressure-sensitive adhesive tape for semiconductor substrate fabrication according to any one of claims 1 to 8,

wherein a thickness of the pressure-sensitive adhesive layer is 1 μm to 30 μm.

10. The pressure-sensitive adhesive tape for semiconductor substrate fabrication according to any one of claims 6 to 9,

wherein an adhesive force between the pressure-sensitive adhesive layer and the sealing portion before the application of energy is equal to or higher than 70 cN/25 mm and less than 1000 cN/25 mm, and

the adhesive force between the pressure-sensitive adhesive layer and the sealing portion after the application of energy is equal to or higher than 60 cN/25 mm and less than 90 cN/25 mm.

11. A method for manufacturing a semiconductor device using the pressure-sensitive adhesive tape for semiconductor substrate fabrication according to any one of claims 1 to 10, comprising:

a sealed semiconductor connection forming step of obtaining the sealed semiconductor connection by sealing the plurality of semiconductor elements loaded on the substrate so as to be covered with the sealing portion,

an attaching step of attaching the pressure-sensitive adhesive tape for semiconductor substrate fabrication to the sealed semiconductor connection such that the sealing portion and the pressure-sensitive adhesive layer are in contact with each other;

a dicing step of forming the plurality of semiconductor sealing bodies on the pressure-sensitive adhesive tape for semiconductor substrate fabrication by dicing and singulating

the sealed semiconductor connection in a thickness direction for each of the semiconductor elements included in the sealed semiconductor connection;

a peeling step of peeling each of the semiconductor sealing bodies from the pressure-sensitive adhesive tape for semiconductor substrate fabrication after energy is applied to the pressure-sensitive adhesive layer; and

a bump connecting step of forming each of bumps on a side of the substrate opposite to the semiconductor element such that each bump is electrically connected to an electrode included in the semiconductor element through a conductor post, which is formed in advance on the substrate included in each semiconductor sealing body.