

DESCRIPTION

Title of Invention: ADHESIVE TAPE FOR SEMICONDUCTOR,
METHOD FOR MANUFACTURING SEMICONDUCTOR CHIP
5 WITH ADHESIVE LAYER, AND METHOD FOR
MANUFACTURING SEMICONDUCTOR DEVICE

Technical Field

[0001] The present disclosure relates to an adhesive tape for
semiconductor, a method for manufacturing a semiconductor chip with an
10 adhesive layer, and a method for manufacturing a semiconductor device.

Background Art

[0002] Conventionally, a wire bonding method using fine metal wires such
as gold wires has been widely applied to connect a semiconductor chip
and a substrate. On the other hand, to meet demands for higher
15 functionality, higher integration, and higher speed for semiconductor
devices, a flip-chip connection method (FC connection method) is
becoming widespread, in which conductive protrusions called bumps are
formed on a semiconductor chip or a substrate to directly connect the
semiconductor chip and the substrate.

20 [0003] For example, regarding the connection between a semiconductor
chip and a substrate, a COB (Chip On Board) type connection method
used for BGA (Ball Grid Array), CSP (Chip Size Package), and the like
also corresponds to the FC connection method. The FC connection method
is also widely used for a COC (Chip On Chip) type connection method in
25 which connection parts (for example, bumps and wiring) are formed on a
semiconductor chip to connect semiconductor chips to each other.

[0004] Recently, as one of the high-density mounting technologies, a method has been studied in which a wafer to which a film-like adhesive is attached (a semiconductor wafer with an adhesive layer) is prepared, and a semiconductor chip with an adhesive layer obtained from this wafer is used. Among them, Patent Literature 1 proposes an adhesive tape for semiconductor in which a back-grinding tape and an adhesive are laminated together for the purpose of simplifying the process.

Citation List

Patent Literature

[0005] Patent Literature 1: Japanese Unexamined Patent Publication No. 2009-239138

Summary of Invention

Technical Problem

[0006] In recent years, with strong demands for further miniaturization, thinning, and higher functionality of packages, chip stack packages, POP (Package On Package), TSV (Through-Silicon Via), and the like, in which semiconductor chips are stacked and multi-stacked using the connection methods described above, are also beginning to become widespread. Such stacking and multi-stacking technologies can make packages smaller compared to methods of arranging semiconductor chips and the like two-dimensionally, because they arrange semiconductor chips and the like three-dimensionally. In addition, stacking and multi-stacking technologies are attracting attention as next-generation semiconductor wiring technologies because they are also effective for improving semiconductor performance, reducing noise, reducing mounting area, and saving power.

[0007] When manufacturing the above-mentioned multi-stacked packages,

from the viewpoint of production efficiency, it is common to set the stacking conditions for the semiconductor chips of each layer to be the same. Therefore, the adhesive used for manufacturing multi-stacked packages is required to have little variation in melting and curing characteristics so that semiconductor chips can be stacked under the same conditions. In particular, if the viscosity of the adhesive used for each layer is different, when semiconductor chips are stacked under the same conditions, variations may occur in the distance between the semiconductor chips (gap height), leading to a decrease in package quality. Therefore, it is desirable to minimize the variation in viscosity between adhesives as much as possible.

[0008] On the other hand, as a result of studies by the inventors of the present disclosure, it has become clear that in an adhesive tape for semiconductor integrated with a pressure-sensitive adhesive tape such as a back-grinding tape (hereinafter referred to as "pressure-sensitive adhesive tape-integrated adhesive tape for semiconductor"), the viscosity of the film-like adhesive tends to increase over time. The storage period from the manufacture to the use of the adhesive tape used for manufacturing a package is not necessarily the same, and it is possible that adhesive tapes manufactured at different times are used in the manufacture of a single package. Therefore, in order to use the pressure-sensitive adhesive tape-integrated adhesive tape for semiconductor for manufacturing multi-stacked packages, it is important to suppress the viscosity increase over time as described above.

[0009] Therefore, an object of one aspect of the present disclosure is to provide an adhesive tape for semiconductor that is of a pressure-sensitive

adhesive tape-integrated type, yet in which the adhesive is less likely to cause a viscosity increase over time.

Solution to Problem

[0010] The inventors of the present disclosure conducted intensive studies to elucidate the cause of the thickening of the adhesive in the pressure-sensitive adhesive tape-integrated adhesive tape for semiconductor. As a result, in the component analysis of the pressure-sensitive adhesive tape, they confirmed that the liquid epoxy resin, which is used in the adhesive from the viewpoint of film-formability and the like, is included in the pressure-sensitive adhesive tape, and further confirmed that the amount of the liquid epoxy resin in the pressure-sensitive adhesive tape changes before and after the viscosity increase. Based on this finding, the inventors of the present disclosure conducted further studies and found that by using a specific liquid epoxy resin, the increase in the amount of the liquid epoxy resin in the pressure-sensitive adhesive tape is suppressed, and as a result, the thickening of the adhesive is also suppressed, leading to the present disclosure.

[0011] The present disclosure provides the following [1] to [13].

[0012] [1]

An adhesive tape for semiconductor, including: a film-like adhesive; and a pressure-sensitive adhesive tape laminated to the film-like adhesive, wherein

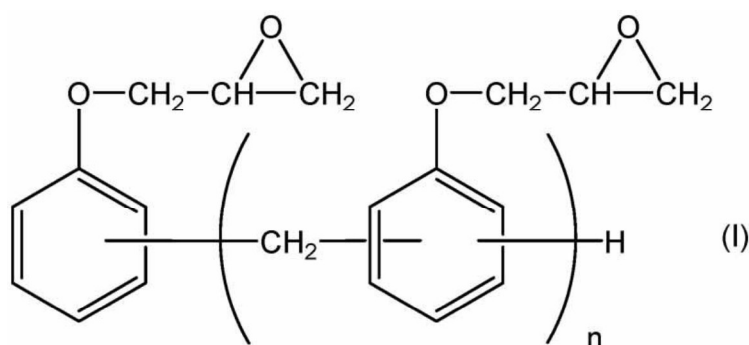
the film-like adhesive contains an epoxy resin and a curing agent, the epoxy resin includes an epoxy resin that is liquid at 25 °C, and

a number-average molecular weight of the epoxy resin that is liquid at 25 °C is 350 or more.

[0013] [2]

The adhesive tape for semiconductor according to [1], wherein the epoxy resin that is liquid at 25 °C includes a compound represented by the following formula (I).

5 [Chem. 1]



[In formula (I), n represents an integer of 1 or more.]

[0014] [3]

10 The adhesive tape for semiconductor according to [1] or [2], wherein a content of a compound having a molecular weight of 350 or more included in the epoxy resin that is liquid at 25 °C is 50 mass% or more based on a total mass of the epoxy resin that is liquid at 25 °C.

[0015] [4]

15 The adhesive tape for semiconductor according to any one of [1] to [3], wherein a content of the epoxy resin that is liquid at 25 °C is 1 to 30 mass% based on a total mass of the film-like adhesive.

[0016] [5]

20 The adhesive tape for semiconductor according to any one of [1] to [4], wherein the epoxy resin includes an epoxy resin that is solid at 25 °C.

[0017] [6]

The adhesive tape for semiconductor according to any one of [1] to [5], wherein the curing agent includes an imidazole-based curing agent.
[0018] [7]

5 The adhesive tape for semiconductor according to any one of [1] to [6], wherein the film-like adhesive further contains a flux compound.
[0019] [8]

The adhesive tape for semiconductor according to any one of [1] to [7], wherein the film-like adhesive further contains a macromolecular component having a weight-average molecular weight of 10,000 or more.
10 [0020] [9]

The adhesive tape for semiconductor according to any one of [1] to [8], wherein the film-like adhesive further contains a filler.
[0021] [10]

15 The adhesive tape for semiconductor according to any one of [1] to [9], wherein a viscosity of the film-like adhesive at 80 °C is 3,000 to 10,000 Pa·s.
[0022] [11]

The adhesive tape for semiconductor according to any one of [1] to [10], wherein a pressure-sensitive adhesive layer forming a contact
20 surface with the film-like adhesive in the pressure-sensitive adhesive tape includes a (meth)acrylic resin.
[0023] [12]

A method for manufacturing a semiconductor chip with an adhesive layer, including:

25 laminating the adhesive tape for semiconductor according to any one of [1] to [11] to a semiconductor wafer from the film-like adhesive

side; and

singulating the semiconductor wafer to which the adhesive tape is laminated to obtain a semiconductor chip with an adhesive layer.

[0024] [13]

5 A method for manufacturing a semiconductor device in which semiconductor chips are stacked, including:

placing a first semiconductor chip with an adhesive layer obtained by the method according to [12] on a substrate from the adhesive layer side and performing compression bonding while heating to obtain a stacked body; and

10 placing a second semiconductor chip with an adhesive layer obtained by the method according to [12] on the stacked body from the adhesive layer side and performing compression bonding while heating.

Advantageous Effects of Invention

15 [0025] According to one aspect of the present disclosure, it is possible to provide an adhesive tape for semiconductor that is of a pressure-sensitive adhesive tape-integrated type, yet in which the adhesive is less likely to cause a viscosity increase over time.

Brief Description of Drawings

20 [0026] FIG. 1 is a schematic cross-sectional view showing one embodiment of the adhesive tape for semiconductor of the present disclosure.

FIG. 2 is a process cross-sectional view schematically showing one embodiment of the method for manufacturing a semiconductor chip with an adhesive layer of the present disclosure.

FIG. 3 is a process cross-sectional view schematically showing

one embodiment of the method for manufacturing a semiconductor chip with an adhesive layer of the present disclosure.

FIG. 4 is a process cross-sectional view schematically showing one embodiment of the method for manufacturing a semiconductor chip with an adhesive layer of the present disclosure.

FIG. 5 is a process cross-sectional view schematically showing one embodiment of the method for manufacturing a semiconductor device of the present disclosure.

FIG. 6 is a process cross-sectional view schematically showing one embodiment of the method for manufacturing a semiconductor device of the present disclosure.

Description of Embodiments

[0027] In this specification, "(meth)acryl" means at least one of acryl and the corresponding methacryl. The same applies to other similar expressions such as "(meth)acryloyl" and "(meth)acrylate". A numerical range indicated using "to" indicates a range including the numbers described before and after "to" as the minimum and maximum values, respectively. Unless specifically stated otherwise, the units of the numerical values described before and after "to" are the same. In the numerical ranges described in this specification, the upper limit value or the lower limit value of the numerical range may be replaced with the value shown in the examples. The individually described upper and lower limit values can be arbitrarily combined. The materials exemplified below may be used alone as one type or in a combination of two or more types, unless otherwise specified. The content of each component in a composition means the total amount of the plurality of substances

corresponding to each component present in the composition, unless otherwise specified.

[0028] Hereinafter, embodiments of the present disclosure will be described in detail with reference to the drawings as appropriate. In the drawings, the same or corresponding parts are denoted by the same reference numerals, and redundant descriptions are omitted. Positional relationships such as up, down, left, and right are based on the positional relationships shown in the drawings, unless otherwise specified. Furthermore, the dimensional ratios in the drawings are not limited to the illustrated ratios.

[0029] < Adhesive Tape for Semiconductor >

FIG. 1 is a schematic cross-sectional view showing one embodiment of the adhesive tape for semiconductor of the present disclosure. In this specification, "for semiconductor" means that it is used for manufacturing a semiconductor device. The adhesive tape for semiconductor is used, for example, to bond a semiconductor chip to a member to be bonded (a substrate such as a wiring circuit board or another semiconductor chip) and to seal a gap between the semiconductor chip and the substrate.

[0030] The adhesive tape for semiconductor 10 shown in FIG. 1 (hereinafter, simply referred to as "adhesive tape 10") includes a support substrate 1, a film-like adhesive 2, and a pressure-sensitive adhesive tape 5. However, the support substrate 1 is not essential.

[0031] The pressure-sensitive adhesive tape 5 includes a pressure-sensitive adhesive layer 3 and a base material 4, and is laminated to the film-like adhesive 2 from the pressure-sensitive adhesive layer 3 side. That is, the pressure-sensitive adhesive layer 3 forms a contact surface with the

film-like adhesive 2 in the pressure-sensitive adhesive tape 5. The pressure-sensitive adhesive tape 5 is, for example, a back-grinding tape, a dicing tape, a protective tape (for example, a film to be peeled off after lamination of the film-like adhesive 2 to an adherend), or the like.

[0032] The film-like adhesive 2 contains an epoxy resin and a curing agent. The epoxy resin includes an epoxy resin that is liquid at 25 °C (hereinafter, also referred to as "liquid epoxy resin"). The number-average molecular weight of the liquid epoxy resin is 350 or more.

[0033] Here, "liquid at 25 °C" means that the viscosity at 25 °C measured with an E-type viscometer is 400 Pa·s or less. The number-average molecular weight means a value in terms of standard polystyrene, measured using GPC (Gel Permeation Chromatography). The unit of molecular weight is g/mol.

[0034] Although the adhesive tape 10 is of a pressure-sensitive adhesive tape-integrated type, it has a characteristic that the film-like adhesive 2 is less likely to cause a viscosity increase over time. The reason for this is not clear, but it is presumed as follows. First, it is presumed that the cause of the viscosity increase is that the composition of the adhesive changes as the liquid epoxy resin included in the adhesive migrates (penetrates) into the pressure-sensitive adhesive layer of the pressure-sensitive adhesive tape over time. In contrast, in the adhesive tape 10, since the number-average molecular weight of the liquid epoxy resin included in the film-like adhesive 2 is 350 or more, it is considered that the migration (penetration) of the liquid epoxy resin into the pressure-sensitive adhesive layer is less likely to occur. Therefore, it is presumed that the composition of the adhesive is less likely to change, and as a result, the adhesive is less

likely to cause a viscosity increase.

[0035] Hereinafter, the film-like adhesive 2 and the pressure-sensitive adhesive tape 5 will be described in detail.

[0036] (Film-like Adhesive)

5 The film-like adhesive 2 is composed of, for example, an adhesive composition. The adhesive composition (film-like adhesive) contains an epoxy resin (hereinafter, also referred to as "component (a)" in some cases) and a curing agent (hereinafter, also referred to as "component (b)" in some cases). The adhesive composition may contain a flux compound
10 (hereinafter, also referred to as "component (c)" in some cases) as necessary, may contain a macromolecular component having a weight-average molecular weight of 10,000 or more (hereinafter, also referred to as "component (d)" in some cases), and may contain a filler (hereinafter, also referred to as "component (e)" in some cases).

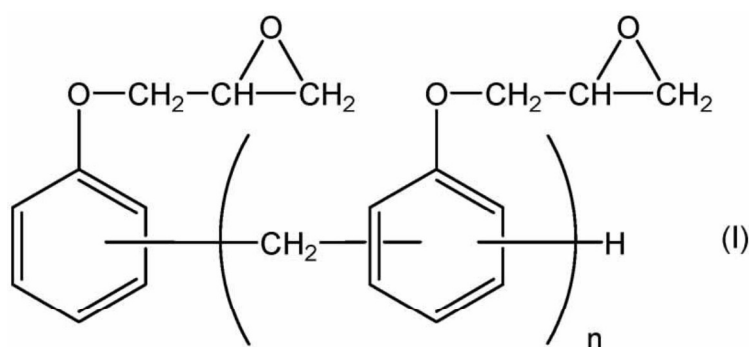
15 [0037] Component (a): Epoxy Resin

The epoxy resin consists of a compound having two or more epoxy groups in the molecule. Component (a) includes at least a liquid epoxy resin having a number-average molecular weight of 350 or more. Examples of the liquid epoxy resin include bisphenol A type glycidyl ether, bisphenol
20 AD type glycidyl ether, bisphenol S type glycidyl ether, bisphenol F type glycidyl ether, hydrogenated bisphenol A type glycidyl ether, ethylene oxide adduct bisphenol A type glycidyl ether, propylene oxide adduct bisphenol A type glycidyl ether, glycidyl ether of naphthalene resin, trifunctional or tetrafunctional glycidyl amine, and the like. The liquid
25 epoxy resin may include one of these alone, or may include a mixture of two or more.

[0038] The liquid epoxy resin may include a compound having a molecular weight of less than 350, but the lower the content of the compound having a molecular weight of less than 350, the more easily the viscosity increase of the adhesive over time is suppressed. The content of compound having a molecular weight of 350 or more included in the liquid epoxy resin may be 50 mass% or more, and may be 70 mass% or more, 90 mass% or more, 95 mass% or more, 99 mass% or more, or 100 mass%, based on the total mass of the liquid epoxy resin, from the viewpoint of further suppressing the viscosity increase of the adhesive over time.

[0039] In one embodiment, the liquid epoxy resin may include a compound represented by the following formula (I) from the viewpoint of enabling further suppression of the viscosity increase of the adhesive over time by suppressing the motion (molecular motion) of the resin.

[Chem. 2]



[In formula (I), n represents an integer of 1 or more.]

[0040] From the viewpoint of suppressing the molecular motion of the resin, the liquid epoxy resin may include a compound in which n in formula (I) is 1. From the viewpoint of further suppressing the molecular motion of the resin, the liquid epoxy resin may include both a compound

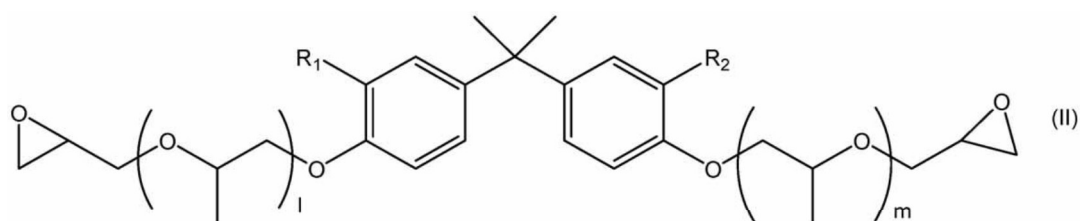
in which n in formula (I) is 1 and a compound in which n in formula (I) is 2 or more.

[0041] The content of the compound in which n in formula (I) is 1 may be 30 to 100 mass%, and may be 40 mass% or more or 50 mass% or more, and may be 75 mass% or less, 65 mass% or less, or 55 mass% or less, and may be 40 to 75 mass%, 50 to 65 mass%, or 50 to 55 mass%, based on the total mass of the liquid epoxy resin.

[0042] The content of the compound represented by formula (I) may be 70 mass% or more, and may be 80 mass% or more or 90 mass% or more, based on the total mass of the liquid epoxy resin. The liquid epoxy resin may consist only of the compound represented by formula (I).

[0043] In one embodiment, the liquid epoxy resin may include a compound represented by the following formula (II). In this case, the molecular motion of the liquid epoxy resin tends to be suppressed by steric hindrance, and as a result, the viscosity increase of the adhesive over time tends to be further suppressed.

[Chem. 3]



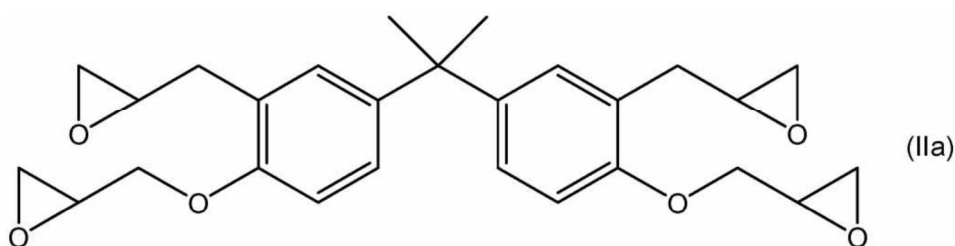
[In formula (II), R^1 and R^2 each independently represent a hydrogen atom or a glycidyl group, and l and m represent an integer of 0 or more.]

[0044] In formula (II), l and m may be, for example, an integer of 0 to 10. The sum of l and m may be, for example, an integer of 0 to 20. When R^1 and R^2 are hydrogen atoms, at least one of l and m may be 1 or more.

[0045] The compound represented by formula (II) included in the liquid epoxy resin may be one type or a plurality of types.

[0046] From the viewpoints of suppressing the molecular motion of the liquid epoxy resin and heat resistance after film curing, the compound represented by formula (II) may be a compound represented by the following formula (IIa).

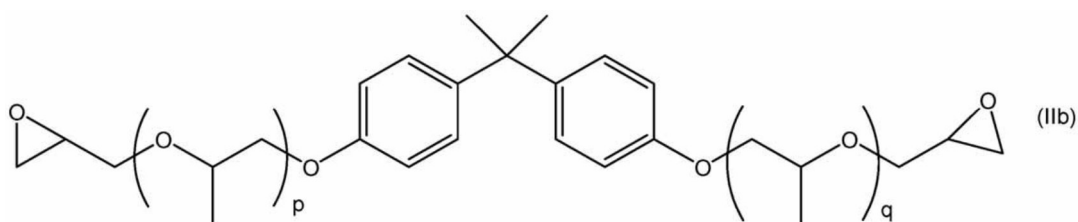
[Chem. 4]



[0047] The content of the compound represented by formula (IIa) may be 70 mass% or more, and may be 80 mass% or more or 90 mass% or more, based on the total mass of the liquid epoxy resin. The liquid epoxy resin may consist only of the compound represented by formula (IIa).

[0048] The compound represented by formula (II) may be a compound represented by the following formula (IIb).

[Chem. 5]



[In formula (IIb), p and q represent an integer of 0 or more, and the sum of p and q is 1 or more.]

[0049] From the viewpoint of suppressing the molecular motion of the resin, the liquid epoxy resin may include a compound in which the sum of

p and q in formula (IIb) is 1 or 2, and may include both of these. From the same viewpoint, the liquid epoxy resin may include a compound in which the sum of p and q in formula (IIb) is 3 or more, in addition to the compound in which the sum of p and q in formula (IIb) is 1 or 2.

5 [0050] The content of the compound in which the sum of p and q in formula (IIb) is 1 may be 10 to 30 mass%, may be 15 mass% or more or 20 mass% or more, may be 25 mass% or less or 20 mass% or less, and may be 15 to 25 mass%, 20 to 25 mass%, or 10 to 20 mass%, based on the total mass of the liquid epoxy resin.

10 [0051] The content of the compound in which the sum of p and q in formula (IIb) is 2 may be 10 to 90 mass%, may be 30 mass% or more or 50 mass% or more, may be 70 mass% or less or 50 mass% or less, and may be 30 to 70 mass%, 50 to 70 mass%, or 10 to 50 mass%, based on the total mass of the liquid epoxy resin.

15 [0052] The content of the compound in which the sum of p and q in formula (IIb) is 3 or more may be 0 to 90 mass%, may be 30 mass% or more or 50 mass% or more, may be 70 mass% or less or 50 mass% or less, and may be 30 to 70 mass%, 50 to 70 mass%, or 0 to 50 mass%, based on the total mass of the liquid epoxy resin.

20 [0053] The number-average molecular weight of the liquid epoxy resin, from the viewpoint of achieving both the effect of suppressing viscosity increase and the intended effects of the liquid epoxy resin (improvement of film-formability, low viscosity, improvement of laminatability, etc.) at a high level, may be 350 to 800. The number-average molecular weight of
25 the liquid epoxy resin may be 400 or more, 450 or more, or 500 or more, and may be 700 or less, 600 or less, or 500 or less, and may be 400 to 700,

450 to 600, 500 to 600, or 350 to 500.

[0054] The epoxy equivalent weight of the liquid epoxy resin may be 50 to 500 g/eq, and may be 100 to 400 g/eq or 120 to 370 g/eq.

[0055] The content of the liquid epoxy resin, from the viewpoint of achieving both the effect of suppressing viscosity increase and the intended effects of the liquid epoxy resin (improvement of film-formability, low viscosity, improvement of laminatability, etc.) at a high level, may be 1 to 30 mass%, and may be 3 mass% or more or 5 mass% or more, and may be 20 mass% or less or 10 mass% or less, and may be 3 to 20 mass% or 5 to 10 mass%, based on the total mass of the adhesive composition (film-like adhesive).

[0056] Component (a), from the viewpoint of heat resistance after film curing, may include an epoxy resin that is solid (non-liquid) at 25 °C (hereinafter, also referred to as "solid epoxy resin"). Here, "solid at 25 °C" means that the viscosity at 25 °C measured with an E-type viscometer is more than 400 Pa·s.

[0057] As the solid epoxy resin, for example, bisphenol A type epoxy resin, bisphenol F type epoxy resin, naphthalene type epoxy resin, phenol novolac type epoxy resin, cresol novolac type epoxy resin, phenol aralkyl type epoxy resin, biphenyl type epoxy resin, triphenylmethane type epoxy resin, triphenolmethane type epoxy resin, dicyclopentadiene type epoxy resin, and various polyfunctional epoxy resins can be used. These can be used alone or as a mixture of two or more.

[0058] The content of the solid epoxy resin, from the viewpoint of achieving both the effect of suppressing viscosity increase and the intended effects of the liquid epoxy resin (improvement of film-

formability, low viscosity, improvement of laminatability, etc.) at a high level, may be 0 to 90 mass%, and may be 20 mass% or more, 40 mass% or more, or 60 mass% or more, and may be 85 mass% or less or 80 mass% or less, and may be 20 to 85 mass%, 40 to 85 mass%, or 60 to 80 mass%,
5 based on the total mass of component (a).

[0059] Component (b): Curing Agent

Examples of component (b) include phenolic resin-based curing agents, acid anhydride-based curing agents, amine-based curing agents, imidazole-based curing agents, and phosphine-based curing agents.

10 Among these, phenolic resin-based curing agents, acid anhydride-based curing agents, amine-based curing agents, and imidazole-based curing agents exhibit flux activity that suppresses the formation of an oxide film on the connection part, so by using these curing agents, the connection reliability can be improved. Hereinafter, each curing agent will be
15 described.

[0060] (i) Phenolic Resin-Based Curing Agent

The phenolic resin-based curing agent is not particularly limited as long as it has two or more phenolic hydroxyl groups in the molecule, and for example, phenol novolac resin, cresol novolac resin, phenol aralkyl resin, cresol naphthol formaldehyde polycondensate, triphenylmethane type
20 polyfunctional phenolic resin, and various polyfunctional phenolic resins can be used. These can be used alone or as a mixture of two or more.

[0061] (ii) Acid Anhydride-Based Curing Agent

As the acid anhydride-based curing agent, for example, methylcyclohexanetetracarboxylic dianhydride, trimellitic anhydride, pyromellitic anhydride, benzophenonetetracarboxylic dianhydride, and
25

ethylene glycol bis(anhydrotrimellitate) can be used. These can be used alone or as a mixture of two or more.

[0062] (iii) Amine-Based Curing Agent

As the amine-based curing agent, for example, dicyandiamide can be used.

5 [0063] (iv) Imidazole-Based Curing Agent

Examples of the imidazole-based curing agent include 2-phenylimidazole, 2-phenyl-4-methylimidazole, 1-benzyl-2-methylimidazole, 1-benzyl-2-phenylimidazole, 1-cyanoethyl-2-undecylimidazole, 1-cyano-2-phenylimidazole, 1-cyanoethyl-2-undecylimidazole trimellitate, 1-cyanoethyl-2-phenylimidazolium trimellitate, 2,4-diamino-6-[2'-methylimidazolyl-(1')]-ethyl-s-triazine, 2,4-diamino-6-[2'-undecylimidazolyl-(1')]-ethyl-s-triazine, 2,4-diamino-6-[2'-ethyl-4'-methylimidazolyl-(1')]-ethyl-s-triazine, 2,4-diamino-6-[2'-methylimidazolyl-(1')]-ethyl-s-triazine isocyanuric acid adduct, 2-phenylimidazole isocyanuric acid adduct, 2-phenyl-4,5-dihydroxymethylimidazole, 2-phenyl-4-methyl-5-hydroxymethylimidazole, and adducts of epoxy resins and imidazoles.

Among these, from the viewpoints of excellent curability, storage stability, and connection reliability, at least one selected from the group consisting of 1-cyanoethyl-2-undecylimidazole, 1-cyano-2-phenylimidazole, 1-cyanoethyl-2-undecylimidazole trimellitate, 1-cyanoethyl-2-phenylimidazolium trimellitate, 2,4-diamino-6-[2'-methylimidazolyl-(1')]-ethyl-s-triazine, 2,4-diamino-6-[2'-ethyl-4'-methylimidazolyl-(1')]-ethyl-s-triazine, 2,4-diamino-6-[2'-methylimidazolyl-(1')]-ethyl-s-triazine isocyanuric acid adduct, 2-phenylimidazole isocyanuric acid adduct, 2-phenyl-4,5-dihydroxymethylimidazole, and 2-phenyl-4-methyl-5-

hydroxymethylimidazole may be used. These can be used alone or in a combination of two or more. A latent curing agent in which these are microencapsulated may be used.

[0064] (v) Phosphine-Based Curing Agent

5 Examples of the phosphine-based curing agent include triphenylphosphine, tetraphenylphosphonium tetraphenylborate, tetraphenylphosphonium tetra(4-methylphenyl)borate, and tetraphenylphosphonium (4-fluorophenyl)borate.

10 [0065] The phenolic resin-based curing agent, the acid anhydride-based curing agent, and the amine-based curing agent can each be used alone as one type or as a mixture of two or more types. The imidazole-based curing agent and the phosphine-based curing agent may each be used alone, or may be used together with a phenolic resin-based curing agent, an acid anhydride-based curing agent, or an amine-based curing agent.

15 [0066] In one embodiment, a curing agent selected from the group consisting of a phenolic resin-based curing agent, an amine-based curing agent, an imidazole-based curing agent, and a phosphine-based curing agent may be used from the viewpoint that storage stability is further improved and decomposition or deterioration due to moisture absorption is less likely to occur.

20 [0067] In one embodiment, a curing agent selected from the group consisting of a phenolic resin-based curing agent, an amine-based curing agent, and an imidazole-based curing agent may be used from the viewpoint of ease of adjusting the curing speed and from the viewpoint
25 that a fast-curing property enables short-time connection for the purpose of improving productivity. Among them, when an imidazole-based curing

agent is used, the above effects are more easily obtained.

[0068] The content of the curing agent (particularly the content of the imidazole-based curing agent) may be 0.1 to 20 parts by mass or 0.1 to 10 parts by mass per 100 parts by mass of component (a). When the content of the curing agent is 0.1 parts by mass or more, curability tends to improve, and when it is 20 parts by mass or less, the adhesive composition does not cure before the metal joint is formed, and connection failure is less likely to occur.

[0069] Component (c): Flux Compound

Component (c) is a compound having flux activity, and is, for example, a compound having a carboxy group (mono- or polycarboxylic acid). As described above, an imidazole-based curing agent may also have flux activity, but a compound corresponding to an imidazole-based curing agent is not included in the above component (c). Specific examples of component (c) include dicarboxylic acids such as succinic acid, glutaric acid, adipic acid, pimelic acid, suberic acid, azelaic acid, sebacic acid, undecanedioic acid, and dodecanedioic acid, as well as compounds in which an electron-donating group is substituted at the 2-position of these dicarboxylic acids (for example, 2-methylglutaric acid).

[0070] The content of component (c) may be 0.5 to 10 mass% or 0.5 to 5 mass% based on the total amount of the adhesive composition.

[0071] Component (d): Macromolecular Component having a weight-average Molecular Weight of 10,000 or More

Component (d) contributes to the improvement of heat resistance and film-formability. Component (d) is, for example, a thermoplastic resin. Examples of component (d) include phenoxy resin, polyimide resin,

polyamide resin, polycarbodiimide resin, cyanate ester resin, acrylic resin, polyester resin, polyethylene resin, polyethersulfone resin, polyetherimide resin, polyvinyl acetal resin, urethane resin, and acrylic rubber. Among these, when at least one selected from the group consisting of phenoxy resin, polyimide resin, acrylic rubber, cyanate ester resin, and polycarbodiimide resin is used, excellent heat resistance and film-formability are easily obtained, and when at least one selected from the group consisting of phenoxy resin, polyimide resin, and acrylic rubber is used, more excellent heat resistance and film-formability are easily obtained. These thermoplastic resins can also be used alone or as a mixture or copolymer of two or more. Note that component (d) does not include the epoxy resin that is component (a).

[0072] The weight-average molecular weight of component (d) is 10,000 or more, and may be 20,000 or more or 30,000 or more from the viewpoint of further improving the heat resistance and film-formability of the adhesive composition. The weight-average molecular weight of component (d) may be 1,000,000 or less or 500,000 or less from the viewpoint of increasing heat resistance. From the above viewpoints, the weight-average molecular weight of component (d) may be 10,000 to 1,000,000, 20,000 to 500,000, or 30,000 to 500,000. In this specification, the weight-average molecular weight means a value in terms of standard polystyrene, measured using GPC (Gel Permeation Chromatography). An example of the measurement conditions for the GPC method is shown below.

Apparatus: HCL-8320GPC, UV-8320 (product name, manufactured by Tosoh Corporation), or HPLC-8020 (product name, manufactured by

Tosoh Corporation)

Column: TSKgel superMultiporeHZ-M x 2, or 2 pieces of GMHXL + 1 piece of G-2000XL

Detector: RI or UV detector

5 Column temperature: 25 to 40 °C

Eluent: A solvent in which the macromolecular component dissolves is selected. For example, THF (tetrahydrofuran), DMF (N,N-dimethylformamide), DMA (N,N-dimethylacetamide), NMP (N-methylpyrrolidone), toluene. When a polar solvent is selected, the concentration of phosphoric acid may be adjusted to 0.05 to 0.1 mol/L (typically 0.06 mol/L), and the concentration of LiBr may be adjusted to 0.5 to 1.0 mol/L (typically 0.63 mol/L).

Flow rate: 0.30 to 1.5 mL/min

Standard substance: Polystyrene

15 [0073] When the adhesive composition contains component (d), the ratio C_a/C_d (mass ratio) of the content C_a of component (a) to the content C_d of component (d) may be 0.01 to 5, 0.05 to 3, or 0.1 to 2. By setting the ratio C_a/C_d to 0.01 or more, better curability and adhesive strength can be obtained, and by setting the ratio C_a/C_d to 5 or less, better film-formability can be obtained.

[0074] Component (e): Filler

Component (e) is effective for controlling the viscosity of the adhesive composition, the physical properties of the cured product of the adhesive composition, and the like. As component (e), inorganic fillers such as insulating inorganic fillers and whiskers, and organic fillers such as resin fillers are used. Component (e) may be used alone as one type, or two or

more types may be used in combination. Since inorganic fillers and organic fillers each have advantageous effects, either one may be used depending on the application, or both may be mixed and used to exhibit the functions of both.

5 [0075] Examples of the insulating inorganic filler include glass, silica, alumina, titanium oxide, carbon black, mica, and boron nitride. Among these, when at least one selected from the group consisting of silica, alumina, titanium oxide, and boron nitride is used, reliability is likely to be improved due to their low linear expansion characteristics, and when at
10 least one selected from the group consisting of silica, alumina, and boron nitride is used, it becomes easier to form a film with more stable characteristics.

[0076] Examples of the whisker include aluminum borate, aluminum titanate, zinc oxide, calcium silicate, magnesium sulfate, and boron nitride.

15 [0077] Examples of the resin filler include fillers made of resins such as polyurethane and polyimide. The resin filler contributes to the improvement of connection reliability because its coefficient of thermal expansion is smaller than that of organic components (epoxy resin, curing agent, etc.). The resin filler also makes it possible to easily adjust the
20 viscosity of the adhesive composition. Since the resin filler is superior to the inorganic filler in the function of relaxing stress, the resin filler can also further suppress peeling in reflow tests and the like.

[0078] In one embodiment, an insulating inorganic filler may be used from the viewpoint of insulation reliability (especially HAST resistance).

25 [0079] The shape, particle size, and content of component (e) are not particularly limited. Component (e) may be one whose physical properties

have been appropriately adjusted by surface treatment.

[0080] The content of component (e) may be 10 to 80 mass% or 15 to 60 mass% based on the total amount of the adhesive composition.

[0081] The main components that can be included in the film-like adhesive 2 have been described above, but the film-like adhesive 2 may include components other than the above (other components). For example, the film-like adhesive 2 may further include a thermosetting resin other than an epoxy resin, such as a phenolic resin (except when included as a curing agent) or an acrylic resin. However, from the viewpoint of adhesiveness, the film-like adhesive 2 may include an epoxy resin as a main component of the thermosetting resin. From the above viewpoint, the content of the epoxy resin may be 80 mass% or more, or 90 mass% or more, based on the total amount of the thermosetting resin. The content of the epoxy resin may be 100 mass% based on the total amount of the thermosetting resin.

[0082] The film-like adhesive 2 may further include additives such as an antioxidant, a silane coupling agent, a titanium coupling agent, a leveling agent, and an ion trapping agent. These can be used alone as one type or in a combination of two or more types. The content of these may be appropriately adjusted so that the effect of each additive is exhibited.

[0083] The film-like adhesive 2 can be formed by dissolving or dispersing an adhesive composition containing the above-described components in a solvent to form a varnish, applying this varnish onto the support substrate 1, and removing the solvent by heating. By this method, a film-like adhesive with a support substrate, which includes the support substrate 1 and the film-like adhesive 2, is obtained.

[0084] As the support substrate 1, for example, a polymer film having heat resistance and solvent resistance, such as polyethylene terephthalate, can be used. Examples of commercially available products include a polyethylene terephthalate film such as "A-31" manufactured by Toyobo Co., Ltd. The thickness of the support substrate 1 may be 10 to 100 μm , 30 to 75 μm , or 35 to 50 μm . When the thickness of the support substrate 1 is 10 μm or more, the support substrate 1 tends to be less likely to tear during application, and when it is 100 μm or less, it tends to be excellent in terms of low cost.

[0085] Examples of the method for applying the varnish onto the support substrate 1 include generally known methods such as a knife coating method, a roll coating method, a spray coating method, a gravure coating method, a bar coating method, and a curtain coating method.

[0086] The temperature condition for removing the solvent by heating may be 70 to 150 $^{\circ}\text{C}$.

[0087] The solvent to be used is not particularly limited, but may be determined in consideration of volatility and the like during the formation of the adhesive layer from the boiling point. For example, from the viewpoint that curing of the adhesive layer is less likely to proceed during the formation of the adhesive layer, a solvent with a relatively low boiling point such as methanol, ethanol, 2-methoxyethanol, 2-ethoxyethanol, 2-butoxyethanol, methyl ethyl ketone, acetone, methyl isobutyl ketone, toluene, or xylene may be used. For the purpose of improving coatability, a solvent with a relatively high boiling point such as dimethylacetamide, dimethylformamide, N-methylpyrrolidone, or cyclohexanone may be used. These solvents can be used alone or in a combination of two or more.

[0088] The thickness of the film-like adhesive 2 may be 2 to 50 μm , and may be 5 to 20 μm . The thickness of the film-like adhesive 2 may be 5 to 16 μm from the viewpoint of suppressing resin squeeze-out after mounting. The thickness of the film-like adhesive 2 may be 0.6 to 1.5 times, may be 0.7 to 1.3 times, and may be 0.8 to 1.2 times the height of the electrodes before connection of the semiconductor wafer. The thickness of the film-like adhesive 2 may be less than the height of the electrodes before connection of the semiconductor wafer. When the thickness of the film-like adhesive 2 is 0.6 times or more the height of the electrodes, the occurrence of voids due to insufficient filling of the adhesive can be sufficiently suppressed, and the connection reliability can be further improved. When the thickness of the film-like adhesive 2 is 1.5 times or less, the amount of adhesive pushed out from the chip connection region during connection can be sufficiently suppressed, so that the formation of fillets can be suppressed, and the adhesion of the adhesive to unnecessary parts can be sufficiently prevented.

[0089] The viscosity of the film-like adhesive 2 at 80 °C may be 3,000 to 10,000 Pa·s or 4,000 to 9,000 Pa·s. When the viscosity is in the above range, resin melting during compression bonding becomes easy, and the resin can flow sufficiently, so that voids are less likely to occur around the electrodes and grooves, and furthermore, contact between opposing electrodes can be more reliably achieved as a preliminary step for making a good connection. The viscosity of the film-like adhesive 2 is measured by the procedure described in the Examples.

[0090] The adjustment of the viscosity of the film-like adhesive 2 can be performed, for example, by selecting the macromolecular component,

selecting the filler, and adjusting the blending amounts thereof.

[0091] (Pressure-sensitive Adhesive Tape)

The pressure-sensitive adhesive tape 5 includes a pressure-sensitive adhesive layer 3 and a base material 4. Hereinafter, the pressure-sensitive adhesive layer 3 will be described first, followed by a description of the base material 4.

[0092] The pressure-sensitive adhesive layer 3 has tackiness at room temperature and has the necessary adhesion to an adherend. The pressure-sensitive adhesive layer 3 may have a property of curing (decreasing tackiness) by high-energy rays such as radiation or by heat. The pressure-sensitive adhesive layer 3 may be easily peelable from the adhesive layer without applying high-energy rays such as radiation or heat. The pressure-sensitive adhesive layer 3 may be a pressure-sensitive type adhesive layer. The pressure-sensitive adhesive layer 3 can be formed using, for example, an acrylic resin, various synthetic rubbers, natural rubber, or a polyimide resin. Among these, when the pressure-sensitive adhesive layer 3 includes at least one of an acrylic resin and a methacrylic resin (hereinafter, these are collectively referred to as "(meth)acrylic resin"), an effect of suppressing the viscosity increase of the adhesive over time is expected.

[0093] A pressure-sensitive adhesive layer having a property of curing (decreasing tackiness) by high-energy rays such as radiation may, for example, contain an acrylic copolymer that is a main component, a cross-linking agent, and a photopolymerization initiator. Hereinafter, these components will be described. Note that the "main component" refers to the component with the highest content in the composition constituting the target layer. The content of the main component may be more than 50 parts

by mass per 100 parts by mass of the composition.

[0094] The acrylic copolymer may have at least a radiation-curable carbon-carbon double bond-containing group and a hydroxyl group.

[0095] The (meth)acrylic resin as the acrylic copolymer may be one that contains an unsaturated bond in a side chain and the resin itself has tackiness. Examples of such a resin include a resin having a glass transition temperature of -40 °C or lower, a hydroxyl value of 20 to 150 mgKOH/g, containing 0.3 to 1.5 mmol/g of a chain-polymerizable functional group, in which an acid value is substantially not detected, and having a weight-average molecular weight of 300,000 or more.

[0096] The (meth)acrylic resin having the above characteristics can be obtained by synthesis using a known method. As the known method, for example, solution polymerization, suspension polymerization, emulsion polymerization, bulk polymerization, precipitation polymerization, vapor phase polymerization, plasma polymerization, supercritical polymerization, and the like are used. As the type of polymerization reaction, in addition to radical polymerization, cationic polymerization, anionic polymerization, living radical polymerization, living cationic polymerization, living anionic polymerization, coordination polymerization, immortal polymerization, and the like, techniques such as ATRP or RAFT can also be used. From the viewpoints of good economy, high reaction rate, ease of polymerization control, and the like, as well as the simplicity of blending, such as being able to use the resin solution obtained by polymerization as it is for blending, a method of synthesizing by radical polymerization using a solution polymerization method may be used.

[0097] Here, a method for obtaining a (meth)acrylic resin by radical polymerization using a solution polymerization method will be described in detail as an example.

[0098] The monomer used when synthesizing the (meth)acrylic resin is

5 not particularly limited as long as it has one (meth)acryl group in one molecule. Examples of the monomer include aliphatic (meth)acrylates such as methyl (meth)acrylate, ethyl (meth)acrylate, butyl (meth)acrylate, isobutyl (meth)acrylate, tert-butyl (meth)acrylate, butoxyethyl (meth)acrylate, isoamyl (meth)acrylate, hexyl (meth)acrylate, 2-ethylhexyl (meth)acrylate, heptyl (meth)acrylate, octylheptyl (meth)acrylate, nonyl (meth)acrylate, decyl (meth)acrylate, undecyl (meth)acrylate, lauryl (meth)acrylate, tridecyl (meth)acrylate, tetradecyl (meth)acrylate, pentadecyl (meth)acrylate, hexadecyl (meth)acrylate, stearyl (meth)acrylate, behenyl (meth)acrylate, methoxypolyethylene glycol (meth)acrylate, ethoxypolyethylene glycol (meth)acrylate, methoxypolypropylene glycol (meth)acrylate, ethoxypolypropylene glycol (meth)acrylate, and mono(2-(meth)acryloyloxyethyl) succinate; alicyclic (meth)acrylates such as cyclopentyl (meth)acrylate, cyclohexyl (meth)acrylate, cyclopentyl (meth)acrylate, dicyclopentanyl (meth)acrylate, dicyclopentenyl (meth)acrylate, isobornyl (meth)acrylate, mono(2-(meth)acryloyloxyethyl) tetrahydrophthalate, and mono(2-(meth)acryloyloxyethyl) hexahydrophthalate; aromatic (meth)acrylates such as benzyl (meth)acrylate, phenyl (meth)acrylate, o-biphenyl (meth)acrylate, 1-naphthyl (meth)acrylate, 2-naphthyl (meth)acrylate, phenoxyethyl (meth)acrylate, p-cumylphenoxyethyl (meth)acrylate, o-phenylphenoxyethyl (meth)acrylate, 1-naphthoxyethyl (meth)acrylate, 2-

naphthoxyethyl (meth)acrylate, phenoxypolyethylene glycol
 (meth)acrylate, nonylphenoxypolyethylene glycol (meth)acrylate,
 phenoxypolypropylene glycol (meth)acrylate, 2-hydroxy-3-
 phenoxypropyl (meth)acrylate, 2-hydroxy-3-(o-phenylphenoxy)propyl
 (meth)acrylate, 2-hydroxy-3-(1-naphthoxy)propyl (meth)acrylate, and 2-
 hydroxy-3-(2-naphthoxy)propyl (meth)acrylate; heterocyclic
 (meth)acrylates such as 2-tetrahydrofurfuryl (meth)acrylate, N-
 (meth)acryloyloxyethylhexahydrophthalimide, and 2-
 (meth)acryloyloxyethyl-N-carbazole; caprolactone-modified products
 thereof; ω -carboxy-polycaprolactone mono(meth)acrylate; compounds
 having an ethylenically unsaturated group and an epoxy group, such as
 glycidyl (meth)acrylate, α -ethylglycidyl (meth)acrylate, α -propylglycidyl
 (meth)acrylate, α -butylglycidyl (meth)acrylate, 2-methylglycidyl
 (meth)acrylate, 2-ethylglycidyl (meth)acrylate, 2-propylglycidyl
 (meth)acrylate, 3,4-epoxybutyl (meth)acrylate, 3,4-epoxyheptyl
 (meth)acrylate, α -ethyl-6,7-epoxyheptyl (meth)acrylate, 3,4-
 epoxycyclohexylmethyl (meth)acrylate, o-vinylbenzyl glycidyl ether, m-
 vinylbenzyl glycidyl ether, and p-vinylbenzyl glycidyl ether; compounds
 having an ethylenically unsaturated group and an oxetanyl group, such as
 (2-ethyl-2-oxetanyl)methyl (meth)acrylate, (2-methyl-2-oxetanyl)methyl
 (meth)acrylate, 2-(2-ethyl-2-oxetanyl)ethyl (meth)acrylate, 2-(2-methyl-
 2-oxetanyl)ethyl (meth)acrylate, 3-(2-ethyl-2-oxetanyl)propyl
 (meth)acrylate, and 3-(2-methyl-2-oxetanyl)propyl (meth)acrylate;
 compounds having an ethylenically unsaturated group and an isocyanate
 group, such as 2-(meth)acryloyloxyethyl isocyanate; and compounds
 having an ethylenically unsaturated group and a hydroxyl group, such as

2-hydroxyethyl (meth)acrylate, 2-hydroxypropyl (meth)acrylate, 4-hydroxybutyl (meth)acrylate, 3-chloro-2-hydroxypropyl (meth)acrylate, and 2-hydroxybutyl (meth)acrylate. The desired composition can be obtained by appropriately combining these monomers.

5 [0099] Furthermore, if necessary, monomers exemplified below that are copolymerizable with the above-mentioned monomers may be used.

styrene; alkylmaleimides such as N-methylmaleimide, N-ethylmaleimide, N-propylmaleimide, N-isopropylmaleimide, N-butylmaleimide, N-isobutylmaleimide, N-2-methyl-2-propylmaleimide, N-pentylmaleimide,

10 N-2-pentylmaleimide, N-3-pentylmaleimide, N-2-methyl-1-butylmaleimide, N-2-methyl-2-butylmaleimide, N-3-methyl-1-butylmaleimide, N-3-methyl-2-butylmaleimide, N-hexylmaleimide, N-2-hexylmaleimide, N-3-hexylmaleimide, N-2-methyl-1-pentylmaleimide, N-2-methyl-2-pentylmaleimide, N-2-methyl-3-pentylmaleimide, N-3-

15 methyl-1-pentylmaleimide, N-3-methyl-2-pentylmaleimide, N-3-methyl-3-pentylmaleimide, N-4-methyl-1-pentylmaleimide, N-4-methyl-2-pentylmaleimide, N-2,2-dimethyl-1-butylmaleimide, N-3,3-dimethyl-1-butylmaleimide, N-3,3-dimethyl-2-butylmaleimide, N-2,3-dimethyl-1-butylmaleimide, N-2,3-dimethyl-2-butylmaleimide, N-

20 hydroxymethylmaleimide, N-1-hydroxyethylmaleimide, N-2-hydroxyethylmaleimide, N-1-hydroxy-1-propylmaleimide, N-2-hydroxy-1-propylmaleimide, N-3-hydroxy-1-propylmaleimide, N-1-hydroxy-2-propylmaleimide, N-2-hydroxy-2-propylmaleimide, N-1-hydroxy-1-butylmaleimide, N-2-hydroxy-1-butylmaleimide, N-3-hydroxy-1-

25 butylmaleimide, N-4-hydroxy-1-butylmaleimide, N-1-hydroxy-2-butylmaleimide, N-2-hydroxy-2-butylmaleimide, N-3-hydroxy-2-

butylmaleimide, N-4-hydroxy-2-butylmaleimide, N-2-methyl-3-hydroxy-
 1-propylmaleimide, N-2-methyl-3-hydroxy-2-propylmaleimide, N-2-
 methyl-2-hydroxy-1-propylmaleimide, N-1-hydroxy-1-pentylmaleimide,
 N-2-hydroxy-1-pentylmaleimide, N-3-hydroxy-1-pentylmaleimide, N-4-
 5 hydroxy-1-pentylmaleimide, N-5-hydroxy-1-pentylmaleimide, N-1-
 hydroxy-2-pentylmaleimide, N-2-hydroxy-2-pentylmaleimide, N-3-
 hydroxy-2-pentylmaleimide, N-4-hydroxy-2-pentylmaleimide, N-5-
 hydroxy-2-pentylmaleimide, N-1-hydroxy-3-pentylmaleimide, N-2-
 hydroxy-3-pentylmaleimide, N-3-hydroxy-3-pentylmaleimide, N-1-
 10 hydroxy-2-methyl-1-butylmaleimide, N-1-hydroxy-2-methyl-2-
 butylmaleimide, N-1-hydroxy-2-methyl-3-butylmaleimide, N-1-hydroxy-
 2-methyl-4-butylmaleimide, N-2-hydroxy-2-methyl-1-butylmaleimide,
 N-2-hydroxy-2-methyl-3-butylmaleimide, N-2-hydroxy-2-methyl-4-
 butylmaleimide, N-2-hydroxy-3-methyl-1-butylmaleimide, N-2-hydroxy-
 15 3-methyl-2-butylmaleimide, N-2-hydroxy-3-methyl-3-butylmaleimide,
 N-2-hydroxy-3-methyl-4-butylmaleimide, N-4-hydroxy-2-methyl-1-
 butylmaleimide, N-4-hydroxy-2-methyl-2-butylmaleimide, N-1-hydroxy-
 3-methyl-2-butylmaleimide, N-1-hydroxy-3-methyl-1-butylmaleimide,
 N-1-hydroxy-2,2-dimethyl-1-propylmaleimide, N-3-hydroxy-2,2-
 20 dimethyl-1-propylmaleimide, N-1-hydroxy-1-hexylmaleimide, N-1-
 hydroxy-2-hexylmaleimide, N-1-hydroxy-3-hexylmaleimide, N-1-
 hydroxy-4-hexylmaleimide, N-1-hydroxy-5-hexylmaleimide, N-1-
 hydroxy-6-hexylmaleimide, N-2-hydroxy-1-hexylmaleimide, N-2-
 hydroxy-2-hexylmaleimide, N-2-hydroxy-3-hexylmaleimide, N-2-
 25 hydroxy-4-hexylmaleimide, N-2-hydroxy-5-hexylmaleimide, N-2-
 hydroxy-6-hexylmaleimide, N-3-hydroxy-1-hexylmaleimide, N-3-

hydroxy-2-hexylmaleimide, N-3-hydroxy-3-hexylmaleimide, N-3-
 hydroxy-4-hexylmaleimide, N-3-hydroxy-5-hexylmaleimide, N-3-
 hydroxy-6-hexylmaleimide, N-1-hydroxy-2-methyl-1-pentylmaleimide,
 N-1-hydroxy-2-methyl-2-pentylmaleimide, N-1-hydroxy-2-methyl-3-
 5 pentylmaleimide, N-1-hydroxy-2-methyl-4-pentylmaleimide, N-1-
 hydroxy-2-methyl-5-pentylmaleimide, N-2-hydroxy-2-methyl-1-
 pentylmaleimide, N-2-hydroxy-2-methyl-2-pentylmaleimide, N-2-
 hydroxy-2-methyl-3-pentylmaleimide, N-2-hydroxy-2-methyl-4-
 pentylmaleimide, N-2-hydroxy-2-methyl-5-pentylmaleimide, N-2-
 10 hydroxy-3-methyl-1-pentylmaleimide, N-2-hydroxy-3-methyl-2-
 pentylmaleimide, N-2-hydroxy-3-methyl-3-pentylmaleimide, N-2-
 hydroxy-3-methyl-4-pentylmaleimide, N-2-hydroxy-3-methyl-5-
 pentylmaleimide, N-2-hydroxy-4-methyl-1-pentylmaleimide, N-2-
 hydroxy-4-methyl-2-pentylmaleimide, N-2-hydroxy-4-methyl-3-
 15 pentylmaleimide, N-2-hydroxy-4-methyl-4-pentylmaleimide, N-2-
 hydroxy-4-methyl-5-pentylmaleimide, N-3-hydroxy-2-methyl-1-
 pentylmaleimide, N-3-hydroxy-2-methyl-2-pentylmaleimide, N-3-
 hydroxy-2-methyl-3-pentylmaleimide, N-3-hydroxy-2-methyl-4-
 pentylmaleimide, N-3-hydroxy-2-methyl-5-pentylmaleimide, N-1-
 20 hydroxy-4-methyl-1-pentylmaleimide, N-1-hydroxy-4-methyl-2-
 pentylmaleimide, N-1-hydroxy-4-methyl-3-pentylmaleimide, N-1-
 hydroxy-4-methyl, N-1-hydroxy-3-methyl-1-pentylmaleimide, N-1-
 hydroxy-3-methyl-2-pentylmaleimide, N-1-hydroxy-3-methyl-3-
 pentylmaleimide, N-1-hydroxy-3-methyl-4-pentylmaleimide, N-1-
 25 hydroxy-3-methyl-5-pentylmaleimide, N-3-hydroxy-3-methyl-1-
 pentylmaleimide, N-3-hydroxy-3-methyl-2-pentylmaleimide, N-1-

hydroxy-3-ethyl-4-butylmaleimide, N-2-hydroxy-3-ethyl-4-butylmaleimide, N-2-hydroxy-2-ethyl-1-butylmaleimide, N-4-hydroxy-3-ethyl-1-butylmaleimide, N-4-hydroxy-3-ethyl-2-butylmaleimide, N-4-hydroxy-3-ethyl-3-butylmaleimide, N-4-hydroxy-3-ethyl-4-butylmaleimide, N-1-hydroxy-2,3-dimethyl-1-butylmaleimide, N-1-hydroxy-2,3-dimethyl-2-butylmaleimide, N-1-hydroxy-2,3-dimethyl-3-butylmaleimide, N-1-hydroxy-2,3-dimethyl-4-butylmaleimide, N-2-hydroxy-2,3-dimethyl-1-butylmaleimide, N-2-hydroxy-2,3-dimethyl-3-butylmaleimide, N-2-hydroxy-2,3-dimethyl-4-butylmaleimide, N-1-hydroxy-2,2-dimethyl-1-butylmaleimide, N-1-hydroxy-2,2-dimethyl-3-butylmaleimide, N-1-hydroxy-2,2-dimethyl-4-butylmaleimide, N-2-hydroxy-3,3-dimethyl-1-butylmaleimide, N-2-hydroxy-3,3-dimethyl-2-butylmaleimide, N-2-hydroxy-3,3-dimethyl-4-butylmaleimide, N-1-hydroxy-3,3-dimethyl-1-butylmaleimide, N-1-hydroxy-3,3-dimethyl-2-butylmaleimide, and N-1-hydroxy-3,3-dimethyl-4-butylmaleimide; cycloalkylmaleimides such as N-cyclopropylmaleimide, N-cyclobutylmaleimide, N-cyclopentylmaleimide, N-cyclohexylmaleimide, N-cycloheptylmaleimide, N-cyclooctylmaleimide, N-2-methylcyclohexylmaleimide, N-2-ethylcyclohexylmaleimide, and N-2-chlorocyclohexylmaleimide; and arylmaleimides such as N-phenylmaleimide, N-2-methylphenylmaleimide, N-2-ethylphenylmaleimide, and N-2-chlorophenylmaleimide.

[0100] Among the above, at least one selected from (meth)acrylic esters that are C8 to C23 aliphatic esters may be used. A (meth)acrylic resin obtained by copolymerizing such monomers exhibits excellent pressure-sensitive adhesive properties because its glass transition temperature is

low. In addition, since the resin has strong hydrophobic interactions, using the resin improves the peelability at the interface between the pressure-sensitive adhesive layer 3 and the film-like adhesive 2 after irradiation with ultraviolet rays or electron beams.

[0101] The polymerization initiator necessary for obtaining the (meth)acrylic resin is not particularly limited as long as it is a compound that generates radicals upon heating to 30 °C or higher. Examples of the polymerization initiator include ketone peroxides such as methyl ethyl ketone peroxide, cyclohexanone peroxide, and methylcyclohexanone peroxide; peroxyketals such as 1,1-bis(t-butylperoxy)cyclohexane, 1,1-bis(t-butylperoxy)-2-methylcyclohexane, 1,1-bis(t-butylperoxy)-3,3,5-trimethylcyclohexane, 1,1-bis(t-hexylperoxy)cyclohexane, and 1,1-bis(t-hexylperoxy)-3,3,5-trimethylcyclohexane; hydroperoxides such as p-menthane hydroperoxide; dialkyl peroxides such as α,α' -bis(t-butylperoxy)diisopropylbenzene, dicumyl peroxide, t-butyl cumyl peroxide, and di-t-butyl peroxide; diacyl peroxides such as octanoyl peroxide, lauroyl peroxide, stearyl peroxide, and benzoyl peroxide; peroxycarbonates such as bis(4-t-butylcyclohexyl) peroxydicarbonate, di-2-ethoxyethyl peroxydicarbonate, di-2-ethylhexyl peroxydicarbonate, and di-3-methoxybutyl peroxycarbonate; peroxyesters such as t-butyl peroxy-pivalate, t-hexyl peroxy-pivalate, 1,1,3,3-tetramethylbutyl peroxy-2-ethylhexanoate, 2,5-dimethyl-2,5-bis(2-ethylhexanoylperoxy)hexane, t-hexyl peroxy-2-ethylhexanoate, t-butyl peroxy-2-ethylhexanoate, t-butyl peroxyisobutyrate, t-hexyl peroxyisopropyl monocarbonate, t-butyl peroxy-3,5,5-trimethylhexanoate, t-butyl peroxy-laurate, t-butyl peroxyisopropyl monocarbonate, t-butyl peroxy-2-ethylhexyl

monocarbonate, t-butyl peroxybenzoate, t-hexyl peroxybenzoate, 2,5-dimethyl-2,5-bis(benzoylperoxy)hexane, and t-butyl peroxyacetate; 2,2'-azobisisobutyronitrile, 2,2'-azobis(2,4-dimethylvaleronitrile), 2,2'-azobis(4-methoxy-2'-dimethylvaleronitrile), and the like.

5 [0102] The reaction solvent used during solution polymerization is not particularly limited as long as it can dissolve the (meth)acrylic resin. Examples of the reaction solvent include aromatic hydrocarbons such as toluene, xylene, mesitylene, cumene, and p-cymene; cyclic ethers such as tetrahydrofuran and 1,4-dioxane; alcohols such as methanol, ethanol,
10 isopropanol, butanol, ethylene glycol, and propylene glycol; ketones such as acetone, methyl ethyl ketone, methyl isobutyl ketone, cyclohexanone, and 4-hydroxy-4-methyl-2-pentanone; esters such as methyl acetate, ethyl acetate, butyl acetate, methyl lactate, ethyl lactate, and γ -butyrolactone; carbonate esters such as ethylene carbonate and propylene carbonate;
15 polyhydric alcohol alkyl ethers such as ethylene glycol monomethyl ether, ethylene glycol monoethyl ether, ethylene glycol monobutyl ether, ethylene glycol dimethyl ether, ethylene glycol diethyl ether, propylene glycol monomethyl ether, propylene glycol monoethyl ether, propylene glycol dimethyl ether, propylene glycol diethyl ether, diethylene glycol monomethyl ether, diethylene glycol monoethyl ether, diethylene glycol monobutyl ether, diethylene glycol dimethyl ether, and diethylene glycol diethyl ether; polyhydric alcohol alkyl ether acetates such as ethylene glycol monomethyl ether acetate, ethylene glycol monoethyl ether acetate, ethylene glycol monobutyl ether acetate, propylene glycol monomethyl
20 ether acetate, propylene glycol monoethyl ether acetate, diethylene glycol monomethyl ether acetate, and diethylene glycol monoethyl ether acetate;

and amides such as N,N-dimethylformamide, N,N-dimethylacetamide, and N-methylpyrrolidone. These organic solvents can be used alone or in a combination of two or more. Supercritical carbon dioxide and the like can also be used as the reaction solvent for the polymerization.

5 [0103] Photosensitivity may be imparted to the (meth)acrylic resin by chemically bonding a functional group that can react upon irradiation with ultraviolet rays, electron beams, or visible light. Examples of the functional group that can react upon irradiation with ultraviolet rays, electron beams, or visible light mentioned here include a (meth)acryl
10 group, a vinyl group, an allyl group, a glycidyl group, an alicyclic epoxy group, an oxetane group, and the like.

[0104] As a method for imparting photosensitivity to the (meth)acrylic resin, for example, photosensitivity can be imparted to the (meth)acrylic resin by: introducing a functional group capable of an addition reaction
15 into the (meth)acrylic resin by using, as a comonomer, a monomer having a functional group capable of an addition reaction, such as a hydroxyl group, a carboxyl group, a maleic anhydride group, a glycidyl group, or an amino group, when synthesizing the above (meth)acrylic resin; and then introducing an ethylenically unsaturated group into a side chain by
20 subjecting a compound having at least one ethylenically unsaturated group and a group that can react with the above functional group capable of an addition reaction (for example, at least one functional group selected from an epoxy group, an oxetanyl group, an isocyanate group, a hydroxyl group, a carboxyl group, and the like) to an addition reaction therewith.

25 [0105] Examples of the compound having at least one ethylenically unsaturated group and a group that can react with the above functional

group capable of an addition reaction include: compounds having an ethylenically unsaturated group and an epoxy group, such as glycidyl (meth)acrylate, α -ethylglycidyl (meth)acrylate, α -propylglycidyl (meth)acrylate, α -butylglycidyl (meth)acrylate, 2-methylglycidyl (meth)acrylate, 2-ethylglycidyl (meth)acrylate, 2-propylglycidyl (meth)acrylate, 3,4-epoxybutyl (meth)acrylate, 3,4-epoxyheptyl (meth)acrylate, α -ethyl-6,7-epoxyheptyl (meth)acrylate, 3,4-epoxycyclohexylmethyl (meth)acrylate, o-vinylbenzyl glycidyl ether, m-vinylbenzyl glycidyl ether, and p-vinylbenzyl glycidyl ether; compounds having an ethylenically unsaturated group and an oxetanyl group, such as (2-ethyl-2-oxetanyl)methyl (meth)acrylate, (2-methyl-2-oxetanyl)methyl (meth)acrylate, 2-(2-ethyl-2-oxetanyl)ethyl (meth)acrylate, 2-(2-methyl-2-oxetanyl)ethyl (meth)acrylate, 3-(2-ethyl-2-oxetanyl)propyl (meth)acrylate, and 3-(2-methyl-2-oxetanyl)propyl (meth)acrylate; compounds having an ethylenically unsaturated group and an isocyanate group, such as methacryloyl isocyanate, 2-methacryloyloxyethyl isocyanate, 2-acryloyloxyethyl isocyanate, and m-isopropenyl- α,α -dimethylbenzyl isocyanate; compounds having an ethylenically unsaturated group and a hydroxyl group, such as 2-hydroxyethyl (meth)acrylate, 2-hydroxypropyl (meth)acrylate, 3-chloro-2-hydroxypropyl (meth)acrylate, and 2-hydroxybutyl (meth)acrylate; and compounds having an ethylenically unsaturated group and a carboxyl group, such as (meth)acrylic acid, crotonic acid, cinnamic acid, succinic acid (2-(meth)acryloyloxyethyl), 2-phthaloyl ethyl (meth)acrylate, 2-tetrahydrophthaloyl ethyl (meth)acrylate, 2-hexahydrophthaloyl ethyl (meth)acrylate, ω -carboxy-polycaprolactone mono(meth)acrylate, 3-

vinylbenzoic acid, and 4-vinylbenzoic acid. These compounds can be used alone or in a combination of two or more types.

[0106] Among the above, from the viewpoints of cost and reactivity, 2-(meth)acryloyloxyethyl isocyanate, glycidyl (meth)acrylate, 3,4-epoxycyclohexylmethyl (meth)acrylate, isocyanatoethyl (meth)acrylate, 2-hydroxyethyl (meth)acrylate, 2-hydroxypropyl (meth)acrylate, 2-hydroxybutyl (meth)acrylate, (meth)acrylic acid, crotonic acid, 2-hexahydrophthaloyl ethyl (meth)acrylate, and the like may be reacted with the (meth)acrylic resin to impart photosensitivity. The (meth)acrylic resin thus obtained may be a reaction product of a (meth)acrylic resin containing a hydroxyl group and the above compound, and may be a reaction product of a (meth)acrylic resin containing a hydroxyl group and at least one selected from 2-methacryloyloxyethyl isocyanate and 2-acryloyloxyethyl isocyanate. If necessary, a catalyst for promoting the addition reaction may be added, or a polymerization inhibitor may be added for the purpose of avoiding cleavage of double bonds during the reaction.

[0107] The cross-linking agent may be a compound having two or more functional groups in one molecule that can react with at least one selected from a hydroxyl group, a glycidyl group, and an amino group introduced into the (meth)acrylic resin. There is no limitation on the structure of the cross-linking agent. Examples of bonds formed by such a cross-linking agent include an ester bond, an ether bond, an amide bond, an imide bond, a urethane bond, and a urea bond. Among them, when the cross-linking agent has an aromatic group and an isocyanate group, the peeling force between the pressure-sensitive adhesive layer 3 and the film-like adhesive

2 is less likely to increase even if the amount of ultraviolet irradiation increases.

[0108] The amount of the cross-linking agent contained in the pressure-sensitive adhesive layer 3 may be 10 to 13 parts by mass per 100 parts by mass of the acrylic copolymer. When the amount of the cross-linking agent is 10 parts by mass or more, the elongation at break of the pressure-sensitive adhesive layer 3 before ultraviolet irradiation is less likely to be high, and the cutting property during the dicing step tends to be good. In addition, the peeling force between the pressure-sensitive adhesive layer 3 and the film-like adhesive 2 after ultraviolet irradiation can be favorably reduced, and it becomes possible to set the push-up amount during the pick-up step to be relatively small. On the other hand, when the amount of the cross-linking agent is 13 parts by mass or less, the adhesive force with the pressure-sensitive adhesive layer 3 before ultraviolet irradiation tends to be good.

[0109] As the cross-linking agent, one having two or more isocyanate groups in one molecule may be used. When such a compound is used, it easily reacts with hydroxyl groups, glycidyl groups, amino groups, and the like introduced into the (meth)acrylic resin to form a strong cross-linked structure, and can suppress the adhesion of the pressure-sensitive adhesive layer 3 to the semiconductor chip after the die bonding step.

[0110] Here, examples of the cross-linking agent having two or more isocyanate groups in one molecule include isocyanate compounds such as 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, and lysine isocyanate.

[0111] Furthermore, an isocyanate group-containing oligomer obtained by reacting the above-mentioned isocyanate compound with a polyhydric alcohol having two or more hydroxyl groups (OH groups) in one molecule can also be used. Examples of the polyhydric alcohol having two or more hydroxyl groups in one molecule include ethylene glycol, propylene glycol, butylene glycol, 1,6-hexanediol, 1,8-octanediol, 1,9-nonanediol, 1,10-decanediol, 1,11-undecanediol, 1,12-dodecanediol, glycerin, pentaerythritol, dipentaerythritol, 1,4-cyclohexanediol, and 1,3-cyclohexanediol.

[0112] Among the above, when the cross-linking agent used is a reaction product of a polyfunctional isocyanate having two or more isocyanate groups in one molecule and a polyhydric alcohol having three or more hydroxyl groups in one molecule, the pressure-sensitive adhesive layer 3 can form a dense cross-linked structure.

[0113] As the photopolymerization initiator, one that generates an active species that can cause chain polymerization of the acrylic copolymer upon irradiation with one or more types of light selected from ultraviolet rays, electron beams, and visible light may be used. The photopolymerization initiator may be a photo-radical polymerization initiator or a photo-cationic polymerization initiator. The chain-polymerizable active species may be one that initiates a polymerization reaction by reacting with a functional group of the acrylic copolymer.

[0114] Examples of the photo-radical polymerization initiator include

benzoin ketals such as 2,2-dimethoxy-1,2-diphenylethan-1-one; α -hydroxyketones such as 1-hydroxycyclohexyl phenyl ketone, 2-hydroxy-2-methyl-1-phenylpropan-1-one, and 1-[4-(2-hydroxyethoxy)phenyl]-2-hydroxy-2-methyl-1-propan-1-one; α -aminoketones such as 2-benzyl-2-dimethylamino-1-(4-morpholinophenyl)-butan-1-one and 1,2-methyl-1-[4-(methylthio)phenyl]-2-morpholinopropan-1-one; oxime esters such as 1-[4-(phenylthio)phenyl]-1,2-octadione-2-(benzoyl)oxime; phosphine oxides such as bis(2,4,6-trimethylbenzoyl)phenylphosphine oxide, bis(2,6-dimethoxybenzoyl)-2,4,4-trimethylpentylphosphine oxide, and 2,4,6-trimethylbenzoyldiphenylphosphine oxide; 2,4,5-triarylimidazole dimers such as 2-(o-chlorophenyl)-4,5-diphenylimidazole dimer, 2-(o-chlorophenyl)-4,5-di(methoxyphenyl)imidazole dimer, 2-(o-fluorophenyl)-4,5-diphenylimidazole dimer, 2-(o-methoxyphenyl)-4,5-diphenylimidazole dimer, and 2-(p-methoxyphenyl)-4,5-diphenylimidazole dimer; benzophenone compounds such as benzophenone, N,N,N',N'-tetramethyl-4,4'-diaminobenzophenone, N,N,N',N'-tetraethyl-4,4'-diaminobenzophenone, and 4-methoxy-4'-dimethylaminobenzophenone; quinone compounds such as 2-ethylanthraquinone, phenanthrenequinone, 2-tert-butylanthraquinone, octamethylanthraquinone, 1,2-benzanthraquinone, 2,3-benzanthraquinone, 2-phenylanthraquinone, 2,3-diphenylanthraquinone, 1-chloroanthraquinone, 2-methylanthraquinone, 1,4-naphthoquinone, 9,10-phenanthraquinone, 2-methyl-1,4-naphthoquinone, and 2,3-dimethylanthraquinone; benzoin ethers such as benzoin methyl ether, benzoin ethyl ether, and benzoin phenyl ether; benzoin compounds such as benzoin, methylbenzoin, and ethylbenzoin; benzyl compounds such as

benzyl dimethyl ketal; acridine compounds such as 9-phenylacridine and 1,7-bis(9,9'-acridinylheptane); N-phenylglycine, coumarin, and the like.

[0108] In the 2,4,5-triarylimidazole dimers described above, the substituents on the aryl groups of the two triarylimidazole moieties may be the same to give a symmetrical compound, or different to give an asymmetrical compound. A thioxanthone compound and a tertiary amine may be combined, such as a combination of diethylthioxanthone and dimethylaminobenzoic acid.

[0109] Examples of the photo-cationic polymerization initiator include:

aryldiazonium salts such as p-methoxybenzenediazonium hexafluorophosphate; diaryliodonium salts such as diphenyliodonium hexafluorophosphate and diphenyliodonium hexafluoroantimonate; triarylsulfonium salts such as triphenylsulfonium hexafluorophosphate, triphenylsulfonium hexafluoroantimonate, diphenyl-4-thiophenoxyphenylsulfonium hexafluorophosphate, diphenyl-4-thiophenoxyphenylsulfonium hexafluoroantimonate, and diphenyl-4-thiophenoxyphenylsulfonium pentafluorohydroxyantimonate; triarylselenonium salts such as triphenylselenonium hexafluorophosphate, triphenylselenonium tetrafluoroborate, and triphenylselenonium hexafluoroantimonate; dialkylphenacylsulfonium salts such as dimethylphenacylsulfonium hexafluoroantimonate and diethylphenacylsulfonium hexafluoroantimonate; dialkyl-4-hydroxy salts such as 4-hydroxyphenyldimethylsulfonium hexafluoroantimonate and 4-hydroxyphenylbenzylmethylsulfonium hexafluoroantimonate; and sulfonic acid esters such as α -hydroxymethylbenzoin sulfonic acid ester, N-hydroxyimide sulfonate, α -sulfonyloxyketone, and β -

sulfonyloxyketone. These cationic polymerization initiators can be used alone or in a combination of two or more types. The photo-cationic polymerization initiator can also be used in combination with a suitable sensitizer.

5 [0110] When strict insulation properties and insulation reliability are required for the pressure-sensitive adhesive layer 3, a photo-radical initiator may be used. Among them, benzoin ketals such as 2,2-dimethoxy-1,2-diphenylethan-1-one; α -hydroxyketones such as 1-hydroxycyclohexyl phenyl ketone, 2-hydroxy-2-methyl-1-phenylpropan-10 1-one, and 1-[4-(2-hydroxyethoxy)phenyl]-2-hydroxy-2-methyl-1-propan-1-one; quinone compounds such as benzophenone, 2-ethylanthraquinone, phenanthrenequinone, 2-tert-butylanthraquinone, octamethylanthraquinone, 1,2-benzanthraquinone, 2,3-benzanthraquinone, 2-phenylanthraquinone, 2,3-diphenylanthraquinone, 15 1-chloroanthraquinone, 2-methylanthraquinone, 1,4-naphthoquinone, 9,10-phenanthraquinone, 2-methyl-1,4-naphthoquinone, and 2,3-dimethylanthraquinone; benzoin ethers such as benzoin methyl ether, benzoin ethyl ether, and benzoin phenyl ether; benzoin compounds such as benzoin, methylbenzoin, and ethylbenzoin; benzyl compounds such as 20 benzyl dimethyl ketal; and acridine compounds such as 9-phenylacridine and 1,7-bis(9,9'-acridinyl)heptane): N-phenylglycine, coumarin, and the like are excellent in storage stability. Furthermore, 2,2-dimethoxy-1,2-diphenylethan-1-one, 1-hydroxycyclohexyl phenyl ketone, 2-hydroxy-2-methyl-1-phenylpropan-1-one, 1-[4-(2-hydroxyethoxy)phenyl]-2-25 hydroxy-2-methyl-1-propan-1-one, and benzophenone have the advantage that they can be handled under general UV-blocking fluorescent

lamps and do not require facilities such as a yellow room.

[0118] The optimal blending amount of the photopolymerization initiator varies depending on the target thickness of the pressure-sensitive adhesive layer 3 and the light source used, but may be, for example, 0.5 to 1.5 parts by mass per 100 parts by mass of the acrylic copolymer. When the amount of the photopolymerization initiator is 0.5 parts by mass or more, the peeling force from the film-like adhesive 2 after ultraviolet irradiation can be sufficiently reduced. When the amount of the photopolymerization initiator is 1.5 parts by mass or less, the occurrence of decomposition of the pressure-sensitive adhesive layer 3 upon irradiation with ultraviolet rays can be suppressed.

[0119] The thickness of the pressure-sensitive adhesive layer 3 may be 3 times or more the thickness of the film-like adhesive 2. If the thickness of the pressure-sensitive adhesive layer 3 is increased too much, thickness variation becomes large and the cost of raw materials increases, so the thickness of the pressure-sensitive adhesive layer 3 may be 3 to 5 times the thickness of the film-like adhesive 2.

[0120] The thickness of the pressure-sensitive adhesive layer 3 may be 25 to 295 μm , 50 to 150 μm , or 50 to 100 μm . When the thickness of the pressure-sensitive adhesive layer 3 is 25 μm or more, the occurrence of voids during lamination of the film-like adhesive 2 becomes easier to suppress, and there is a tendency to easily suppress the entrapment of voids, particularly even when the difference between the height of the electrodes and the thickness of the film-like adhesive 2 becomes large. When the thickness of the pressure-sensitive adhesive layer 3 is 295 μm or less, an increase in the amount of residual solvent in the pressure-

sensitive adhesive layer 3 can be suppressed, and there is a tendency to be able to suppress the occurrence of variations in adhesive force due to the influence of the residual solvent.

[0121] The pressure-sensitive adhesive layer 3 can be formed by dissolving or dispersing a pressure-sensitive adhesive composition containing the above-described components in a solvent to form a varnish, applying this varnish onto the base material 4, and removing the solvent by heating.

[0122] Examples of the method for applying the varnish onto the base material 4 include generally known methods such as a knife coating method, a roll coating method, a spray coating method, a gravure coating method, a bar coating method, a curtain coating method, a comma coating method, and a die coating method.

[0123] The temperature condition for removing the solvent by heating may be 70 to 150 °C.

[0124] Examples of the solvent to be used include the same solvents as those used when forming the film-like adhesive 2.

[0125] Examples of the base material 4 include plastic films such as a polyester film, a polytetrafluoroethylene film, a polyethylene film, a polypropylene film, and a polymethylpentene film. Among these, when a polyester film is used, the coating appearance and easy peelability tend to be improved, and when a polyethylene terephthalate film is used, the coating appearance and easy peelability tend to be further improved. The base material 4 may be a mixture of two or more selected from the above materials, or a multilayered film of the above films.

[0126] The thickness of the base material 4 may be 5 to 50 μm or 12 to 38

μm. When the thickness of the base material 4 is 5 μm or more, it is easy to suppress deformation of the base material 4 due to thermal shrinkage during the drying process of the pressure-sensitive adhesive layer 3, and there is a tendency to easily suppress the occurrence of thickness variation in the pressure-sensitive adhesive layer 3. In addition, when the pressure-sensitive adhesive tape 5 is a back-grinding tape, if the thickness of the base material 4 is 50 μm or less, there is a tendency to more sufficiently suppress warpage of the wafer after back-grinding.

[0127] The thickness of the pressure-sensitive adhesive tape 5 may be, for example, 75 to 300 μm, and may be 75 to 175 μm or 85 to 125 μm. When the thickness of the pressure-sensitive adhesive tape 5 is 75 μm or more, there is a tendency to easily suppress the occurrence of insufficient embedding of the bump peripheral portions and scribe lines. When the thickness of the pressure-sensitive adhesive tape 5 is 300 μm or less, it is easy to suppress the occurrence of bleeding of the pressure-sensitive adhesive layer 3, and there is a tendency to easily suppress the film-like adhesive 2 from also peeling off from the wafer when the pressure-sensitive adhesive tape is peeled off.

[0128] The adhesive tape 10 described above can be obtained, for example, by a method including a step of laminating together the film-like adhesive 2 of the film-like adhesive with a support substrate, prepared by the method described above, and the pressure-sensitive adhesive layer 3 of the pressure-sensitive adhesive tape 5. It is also possible to produce the adhesive tape 10 by applying a coating liquid for the film-like adhesive 2 onto the pressure-sensitive adhesive layer 3 of the pressure-sensitive adhesive tape 5 to form the film-like adhesive 2. However, since if the

coating and drying of the coating liquid are performed on the pressure-sensitive adhesive layer 3, problems such as destruction of the pressure-sensitive adhesive layer 3 and migration of components between the pressure-sensitive adhesive and the adhesive may occur, from the viewpoint of suppressing the occurrence of such problems, the adhesive tape 10 may be obtained by laminating the film-like adhesive with a support substrate and the pressure-sensitive adhesive tape.

[0129] In the method for manufacturing the adhesive tape 10, the migration (penetration) of the liquid epoxy resin in the film-like adhesive 2 into the pressure-sensitive adhesive layer 3 can be suppressed. The effect of suppressing the migration of the liquid epoxy resin into the pressure-sensitive adhesive layer can be indirectly confirmed by the rate of increase of the liquid epoxy resin in the pressure-sensitive adhesive layer. For example, when a storage test is performed in which the adhesive tape 10 is stored at 40 °C for 48 hours immediately after its production, the rate of increase of the liquid epoxy resin in the pressure-sensitive adhesive tape 5 immediately after the end of the test from immediately before the start of the test can be 30 mass% or less (for example, 5 to 30 mass%). As described above, since the migration amount of the liquid epoxy resin can also vary depending on the type of the liquid epoxy resin and the like, by appropriately changing these, the rate of increase of the liquid epoxy resin can be made 25 mass% or less, 20 mass% or less, 15 mass% or less, or 10 mass% or less. The rate of increase of the liquid epoxy resin is obtained by measuring the amount of the liquid epoxy resin in the pressure-sensitive adhesive tape 5 immediately after lamination (initial amount) and the amount of the liquid epoxy resin in the pressure-sensitive adhesive

tape 5 in the adhesive tape 10 after the storage test (amount after storage) using reverse-phase liquid chromatography (RPLC), and determining the rate of increase of the amount of the liquid epoxy resin ([amount after storage - initial amount] / [initial amount] × 100). Specific measurement conditions are shown in the Examples.

[0130] <Method for Manufacturing Semiconductor Chip with Adhesive Layer and Semiconductor device>

Next, a method for manufacturing a semiconductor chip with an adhesive layer and a semiconductor device using the adhesive tape 10 of the above embodiment will be described. Hereinafter, the adhesive tape 10 from which the support substrate 1 has been peeled off is referred to as "adhesive tape X".

[0131] FIGS. 2 to 4 are schematic cross-sectional views for explaining a method for manufacturing a semiconductor chip with an adhesive layer 30 according to one embodiment.

[0132] The method for manufacturing the semiconductor chip with an adhesive layer 30 includes: laminating the adhesive tape X on a semiconductor wafer 20 from the film-like adhesive 2 side (hereinafter, also referred to as "lamination step"; see FIG. 2); grinding a surface of the semiconductor wafer 20 to which the adhesive tape X is laminated, on a side opposite to the adhesive tape 10 (hereinafter, also referred to as "back-grinding step"; see FIG. 3); and singulating the semiconductor wafer 20 to which the adhesive tape X is laminated to obtain the semiconductor chip with an adhesive layer 30 (hereinafter, also referred to as "dicing step"; see FIG. 4). As shown in FIGS. 3 to 4, the method for manufacturing the semiconductor chip with an adhesive layer 30 may further include peeling

the pressure-sensitive adhesive tape 5 from the adhesive tape X. In this embodiment, since the pressure-sensitive adhesive tape 5 of the adhesive tape 10 is a back-grinding tape, a back-grinding step is included, but the back-grinding step is not essential. In one embodiment, the adhesive tape may be laminated to a semiconductor wafer after it has undergone a back-grinding step. When the back-grinding step is not performed, the pressure-sensitive adhesive tape 5 can be, for example, a dicing tape, a protective tape, or the like.

[0133] The semiconductor wafer 20 used in this embodiment includes protruding electrodes (solder bumps) 26 on one main surface thereof ((a) of FIG. 2). The protruding electrode 26 is composed of a bump 22 and a solder ball 24 provided on the bump 22.

[0134] Examples of the semiconductor wafer 20 include 6-inch wafers, 8-inch wafers, and 12-inch wafers whose surfaces have been subjected to an oxide film treatment. The bump 22 is not particularly limited, but examples thereof include those composed of copper, silver, gold, and the like. Examples of the solder ball 24 include those composed of conventionally known solder materials such as lead-containing solder or lead-free solder.

[0135] On the main surface of the semiconductor wafer 20 on which the protruding electrodes 26 are provided, grooves 28 are formed as scribe lines to serve as marks during dicing. The groove 28 is composed of a recess with a depth of about 5 to 15 μm .

[0136] The thickness of the semiconductor wafer 20 before being thinned can be in the range of 250 to 800 μm . Typically, a cut-out semiconductor wafer has a thickness of 625 to 775 μm for a size of 6 to 12 inches.

[0137] The height of the bump 22 may be 5 to 50 μm from the viewpoint of semiconductor miniaturization. The height of the solder ball 24 may be 2 to 30 μm from the viewpoint of semiconductor miniaturization.

[0138] In the lamination step, the support substrate 1 is peeled off from the adhesive tape 10, and the tape is placed on the surface of the semiconductor wafer 20 on which the protruding electrodes (solder bumps) 26 are formed (hereinafter, referred to as "functional surface") such that the film-like adhesive (adhesive layer) 2, the pressure-sensitive adhesive layer 3, and the base material 4 are arranged in this order, and pressure is applied to the semiconductor wafer 20 and the base material 4 so that the tips of the solder balls 24 penetrate the film-like adhesive 2 (see (b) of FIG. 2). Although it is most desirable for the tips of the solder balls to penetrate the adhesive layer, it is acceptable as long as a few micrometers of the adhesive layer remain on the tips of the solder balls to an extent that does not affect the connectivity when the substrate and the semiconductor chip, to be described later, are electrically connected via the solder balls. In this embodiment, by laminating the film-like adhesive 2 on the functional surface of the semiconductor wafer 20 by vacuum lamination, exposure of the top of the bumps becomes easy.

[0139] The method of vacuum lamination may be a method using a diaphragm, a method using a roll, a press method, or the like, and from the viewpoint of embedding properties, it may be a diaphragm method.

[0140] The lamination conditions may be: lamination temperature: 50 to 100 $^{\circ}\text{C}$, linear pressure: 0.5 to 3.0 kgf/cm , and feed speed: 0.2 to 2.0 m/min .

[0141] The conditions when using the diaphragm method of vacuum lamination may be: stage temperature: 20 to 60 $^{\circ}\text{C}$, diaphragm

temperature: 50 to 100 °C, deaeration time: 10 to 100 sec, pressurization time: 10 to 100 sec, and pressure: 0.1 to 1.0 MPa. In the case of the diaphragm method, the lamination temperature refers to the diaphragm temperature.

5 [0142] If lamination is performed at a high temperature exceeding 80 °C, wafer warpage after back-grinding tends to increase. On the other hand, if the lamination temperature is too low, it tends to be difficult to embed the area around the bumps. Therefore, lamination may be performed at 50 to 80 °C.

10 [0143] In the back-grinding step, the side of the semiconductor wafer 20 to which the adhesive tape X is laminated that is opposite to the adhesive tape X, that is, the surface opposite to the side on which the protruding electrodes (solder bumps) 26 of the semiconductor wafer 20 are formed, is ground to thin the semiconductor wafer 20 (FIG. 3). The grinding can
15 be performed using a back grinder.

[0144] In the back-grinding step, the semiconductor wafer 20 may be thinned to a thickness of 10 to 150 μm. When the thickness of the thinned semiconductor wafer 20 is 10 μm or more, breakage of the semiconductor wafer is less likely to occur. When the thickness of the thinned
20 semiconductor wafer 20 is 150 μm or less, it is possible to meet the demand for miniaturization of semiconductor devices.

[0145] In the dicing step, first, the ground surface side of the thinned semiconductor wafer 20 is laminated to a dicing tape 6 ((a) of FIG. 4). Next, using a dicing apparatus, the semiconductor wafer 20 and the film-
25 like adhesive 2 are cut along the grooves 28, thereby singulating the semiconductor wafer 20 ((b) of FIG. 4). This yields a semiconductor chip

with an adhesive layer 30 composed of a semiconductor chip 29 and an adhesive layer 9. The pressure-sensitive adhesive tape 5 composed of the base material 4 and the pressure-sensitive adhesive layer 3 may be peeled off from the film-like adhesive 2 before dicing.

5 [0146] After the completion of the dicing step, the semiconductor chip with an adhesive is picked up using a pickup apparatus, and this is used for the manufacture of a semiconductor device.

[0147] Although not shown, from the viewpoint of obtaining a semiconductor chip with an adhesive layer applicable to stacking and multi-level technologies, the manufacturing method of this embodiment may include a step of forming electrodes on the main surface opposite to the main surface on which the protruding electrodes 26 of the semiconductor wafer 20 or the semiconductor chip 29 are formed, and may include a step of forming through-electrodes in the semiconductor wafer 20 or the semiconductor chip 29. The method for producing the electrodes is not particularly limited, and a known method may be adopted.

10 [0148] FIGS. 5 and 6 are schematic cross-sectional views for explaining a method for manufacturing a semiconductor device 100 according to this embodiment.

20 [0149] The method for manufacturing the semiconductor device 100 includes: placing a first semiconductor chip with an adhesive layer 30a on a substrate 7 from the adhesive layer 9a side and performing compression bonding while heating to obtain a stacked body 40 (hereinafter, also referred to as "first stacking step"; see FIG. 5); and placing a second semiconductor chip with an adhesive layer 30b on the stacked body 40 from the adhesive layer 9b side and performing compression bonding

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while heating (hereinafter, also referred to as "second stacking step"; see FIG. 6). The first semiconductor chip with an adhesive layer 30a and the second semiconductor chip with an adhesive layer 30b are semiconductor chips with an adhesive layer obtained by the method of the above embodiment. The first semiconductor chip with an adhesive layer 30a and the second semiconductor chip with an adhesive layer 30b have electrodes (31a, 31b) on the surface opposite to the surface on which the protruding electrodes (26a, 26b) are provided, and through-electrodes (32a, 32b) are formed between the electrodes (31a, 31b) and the protruding electrodes (26a, 26b). The substrate 7 is another semiconductor chip having electrodes 8 or a support member for mounting a semiconductor chip having electrodes (such as a wiring circuit board).

[0150] In the first stacking step, the first semiconductor chip with an adhesive layer 30a is pressurized while being heated in a direction in which the protruding electrodes 26a and the electrodes 8 face each other to melt the solder of the protruding electrodes 26a, thereby bonding the protruding electrodes 26a of the first semiconductor chip with an adhesive layer 30a and the electrodes 8 of the substrate 7 ((a) and (b) of FIG. 5).

[0151] The first stacking step may include: pressurizing the semiconductor chip with an adhesive layer 30a and the substrate 7 in a direction in which the protruding electrodes 26a and the electrodes 8 face each other at a temperature lower than the melting point of the solder of the protruding electrodes 26a (first thermocompression bonding step); and melting the solder of the protruding electrodes 26a by heating to bond the protruding electrodes 26a and the electrodes 8 (second thermocompression bonding step).

[0152] When the adhesive layer 9a further contains a flux component, the pressurization in the first thermocompression bonding step may be performed at a temperature higher than the melting point or softening point of the flux component and lower than the melting point of the solder of the protruding electrodes. In this case, a stronger connection state can be obtained.

[0153] The conditions for the thermocompression bonding in the first thermocompression bonding step may be: temperature: 100 to 200 °C, pressure: 0.1 to 1.5 MPa, and time: 1 to 15 seconds, and may be temperature: 100 to 180 °C, pressure: 0.1 to 1.0 MPa, and time: 1 to 10 seconds. The conditions for the thermocompression bonding in the second thermocompression bonding step may be: temperature: 230 to 350 °C, pressure: 0.1 to 1.5 MPa, and time: 1 to 15 seconds, and may be temperature: 230 to 300 °C, pressure: 0.1 to 1.0 MPa, and time: 1 to 15 seconds. The above temperature and pressure conditions refer to the temperature and pressure applied to the adhesive layer.

[0154] In this way, the electrodes 8 of the substrate 7 and the bumps 22a of the semiconductor chip 29a are electrically connected via the solder balls 24a, and the space between the substrate 7 and the semiconductor chip 29a is sealed by a sealing part 35a, which is a cured product of the adhesive, to obtain the stacked body 40 ((b) of FIG. 5).

[0155] In the second stacking step, the second semiconductor chip with an adhesive layer 30b is pressurized while being heated in a direction in which the protruding electrodes (solder bumps) 26b and the electrodes 31a face each other to melt the solder of the protruding electrodes 26b, thereby bonding the protruding electrodes 26b of the second semiconductor chip

with an adhesive layer 30b and the electrodes 31a of the stacked body 40 ((a) and (b) of FIG. 6).

[0156] The second stacking step can be performed in the same manner as the first stacking step. The details of the heating and compression bonding conditions in the second stacking step are the same as the details of the heating and compression bonding conditions in the first stacking step.

[0157] In this way, the electrodes 31a of the stacked body 40 and the bumps 22b of the semiconductor chip 29b are electrically connected via the solder balls 24b, and the space between the stacked body 40 and the semiconductor chip 29b is sealed by a sealing part 35b, which is a cured product of the adhesive, to obtain the semiconductor device 100 ((b) of FIG. 6).

[0158] In this embodiment, semiconductor chips with an adhesive layer may be stacked in multiple stages by repeating a step similar to the second stacking step. That is, the manufacturing method of this embodiment may include a plurality of steps of further stacking a semiconductor chip with an adhesive layer on the semiconductor device 100.

[0159] Since the film-like adhesive of the adhesive tape used in the manufacturing method of this embodiment is less likely to cause a viscosity increase over time, according to the manufacturing method of this embodiment, even if the first semiconductor chip with an adhesive layer and the second semiconductor chip with an adhesive layer are produced using adhesive tapes manufactured at different times, variation in the distance between the chips (gap height) is less likely to occur when the chips are stacked under the same conditions.

[0160] Although some embodiments of the present disclosure have been

described above, the present disclosure is not limited to the above-described embodiments.

[Examples]

[0161] Hereinafter, the present disclosure will be described more specifically with reference to Examples, but the present disclosure is not limited to the Examples.

[0162] Details of the materials used in the Examples are as follows. The number-average molecular weight was measured using GPC (Gel Permeation Chromatography) under the following conditions.

[Conditions]

Column: GL-A130-S + GL-A120-S + GL-A110-S, manufactured by Hitachi High-Tech Corporation

Column temperature: 35 °C

Eluent: THF

Flow rate: 1.0 ml/min

Sample concentration: 3 g/l (THF soluble fraction)

Injection volume: 70 µl

Detector: Differential refractometer (RI)

Molecular weight calibration standard: Standard polystyrene

Data processing: OpenLAB CDS (EZChrom Edition), manufactured by Agilent Technologies, Inc.

[0163] (a) Epoxy resin

[Liquid epoxy resin]

- YL983U (liquid epoxy resin listed in Table 1, product name, manufactured by Mitsubishi Chemical Corporation)

- RE-305S (mixture including liquid epoxy resin listed in Table 1, product

name, manufactured by Nippon Kayaku Co., Ltd.)

- BATG (liquid epoxy resin listed in Table 1, product name, manufactured by Resonac Corporation)

5

- CDMDG (liquid epoxy resin listed in Table 1, product name, manufactured by Resonac Corporation)

- EP-4000L (liquid epoxy resin listed in Table 1, product name, manufactured by DIC Corporation)

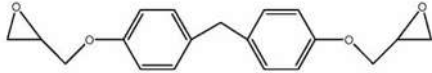
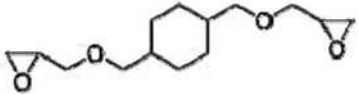
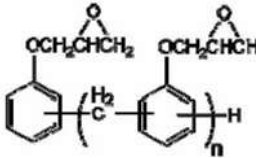
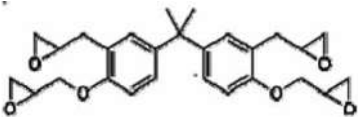
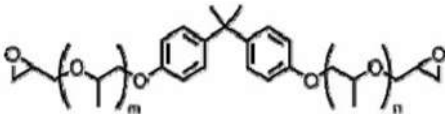
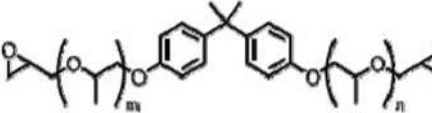
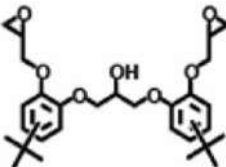
- EP-4010L (liquid epoxy resin listed in Table 1, product name, manufactured by DIC Corporation)

10

- EXA-4850-150 (liquid epoxy resin listed in Table 1, product name, manufactured by DIC Corporation)

- HP-820 (liquid epoxy resin listed in Table 1, product name, manufactured by DIC Corporation)

[0164] [Table 1]

Name	Structure	Molecular Weight
YL983U		312
CDMDG		256
RE-305S	 (53 mass%: n=1, 47 mass%: n>2 (+ others))	≥383
BATG		453
EP-4010L	 (15 mass%: n+m=1, 35 mass%: n+m=2, 50 mass%: n+m>3 (+ others))	≥476
EP-4000L	 (21 mass%: n+m=1, 62 mass%: n+m=2, 17 mass%: others)	≥442
EXA-4850-150		480
HP-820		501

The molecular weight in the table is the molecular weight (number-average molecular weight) of the liquid epoxy resin.

[0165] [Solid epoxy resin]

- YX7110B80 (Flexible solid epoxy resin, product name, manufactured by Mitsubishi Chemical Corporation)

- EP1032H60 (Polyfunctional solid epoxy resin having a triphenolmethane skeleton, product name, manufactured by Mitsubishi Chemical Corporation)

[0166] (b) Curing agent

- 2PHZ-PW (2-phenyl-4,5-dihydroxymethylimidazole, product name, manufactured by Shikoku Chemicals Corporation)

[0167] (c) Flux compound

- Glutaric acid (manufactured by Tokyo Chemical Industry Co., Ltd., melting point: approx. 98 °C)

[0168] (d) Macromolecular component having a weight-average molecular weight of 10,000 or more

- FX-293 (Phenoxy resin, product name, manufactured by NIPPON STEEL Chemical & Material Co., Ltd., Tg: approx. 160 °C, weight-average molecular weight: 40,000 to 50,000)

[0169] (e) Filler

- EXL2655 (Acrylic rubber-based organic filler, product name, manufactured by Dow)

- KE180G-HLA (Silica filler, product name, manufactured by Admatechs Co., Ltd.)

[0170] <Examples 1 to 6 and Comparative Examples 1 to 2>

(Preparation of Coating Liquid)

Coating liquids for forming film-like adhesives of Examples 1 to 6 and Comparative Examples 1 to 2 were prepared. Specifically, the components shown in Table 2 were added to an organic solvent (cyclohexanone) so

that the NV value ($[\text{mass of paint component after drying}] / [\text{mass of paint component before drying}] \times 100$) became 60%, to obtain a mixed liquid. At this time, the amount of each component added was the amount shown in Table 2 (unit: parts by mass). Thereafter, beads of $\Phi 1.0$ mm and beads of $\Phi 2.0$ mm were added to the mixed liquid, and the mixture was stirred for 30 minutes with a bead mill (Planetary Micro Mill P-7, FRITSCH Japan Co., Ltd.). The amount of beads added was the same mass as the non-volatile content amount of the mixed liquid (total amount of components other than the organic solvent). After stirring, the beads were removed by filtration to obtain a coating liquid for forming a film-like adhesive.

[0171] [Table 2]

		Example						Comparative Example	
		1	2	3	4	5	6	1	2
Liquid epoxy resin	YL983U	-	-	-	-	-	-	15.0	-
	CDMDG	-	-	-	-	-	-	-	15.0
	RE-305S	15.0	-	-	-	-	-	-	-
	BATG	-	15.0	-	-	-	-	-	-
	EP-4010L	-	-	15.0	-	-	-	-	-
	EP-4000L	-	-	-	15.0	-	-	-	-
	EXA-4850-150	-	-	-	-	15.0	-	-	-
	HP-820	-	-	-	-	-	15.0	-	-
Solid epoxy resin	YX7110B80	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0
	EP1032H60	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0
Curing agent	2PHZ-PW	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0
Flux agent	Glutaric acid	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0
Polymer component	FX-293	20.0	20.0	20.0	20.0	20.0	20.0	20.0	13.9
Organic filler	EXL2655	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0
Silica filler	KE180G-HLA	65.0	65.0	65.0	65.0	65.0	65.0	65.0	65.0

[0172] (Preparation of Film-like Adhesive with Support Substrate)

The coating liquid prepared above was applied onto a release film (product name "Purex A55", manufactured by Toyobo Co., Ltd.), which is a support substrate, with a small precision coating apparatus (Yasui Seiki Co., Ltd.) so that the film thickness after drying would be 12 μm . Next, the coating film was dried in a clean oven (manufactured by ESPEC CORP.) (100 °C/10 min) to form a film-like adhesive, thereby obtaining a film-like adhesive with a support substrate.

[0173] (Preparation of Pressure-sensitive Adhesive Tape)

An acrylic copolymer was obtained by a solution polymerization method using 2-ethylhexyl acrylate and methyl methacrylate as main monomers,

and hydroxyethyl acrylate and acrylic acid as functional group monomers. The weight-average molecular weight of this synthesized acrylic copolymer was 400,000, and its glass transition point was -38 °C. A varnish for a pressure-sensitive adhesive was prepared by blending 100 parts by mass of this acrylic copolymer with 10 parts by mass of a polyfunctional isocyanate cross-linking agent (product name "Coronate HL", manufactured by Nippon Polyurethane Industry Co., Ltd.).

[0174] The varnish for a pressure-sensitive adhesive was applied onto a 38 µm thick polyethylene terephthalate (PET) base material (product name "Emblet S25", manufactured by Unitika Ltd.) using an applicator while adjusting the gap so that the thickness of the pressure-sensitive adhesive layer after drying would be 60 µm, and dried at 80 °C for 5 minutes. This yielded a pressure-sensitive adhesive tape in which a pressure-sensitive type adhesive layer was formed on a base material.

[0175] (Preparation of Adhesive Tape)

Using the film-like adhesives with a support substrate of each of the Examples and Comparative Examples and the pressure-sensitive adhesive tape prepared above, the adhesive tapes of Examples 1 to 6 and Comparative Examples 1 to 2 were prepared. Specifically, the pressure-sensitive adhesive tape was laminated with the film-like adhesive with a support substrate using a roll laminator (lamination temperature: 30±10 °C) to obtain an adhesive tape having a laminated structure of PET base material/pressure-sensitive adhesive layer/adhesive layer/support substrate.

[0176] <Evaluation>

(Migration Property of Liquid epoxy resin)

The migration property of the liquid epoxy resin in the adhesive tapes of Examples 1 to 4 and Comparative Examples 1 to 2 was confirmed by the following method. Specifically, first, the pressure-sensitive adhesive tape was peeled off from the adhesive tape immediately after production, the pressure-sensitive adhesive tape was immersed in acetonitrile to extract the liquid epoxy resin from the pressure-sensitive adhesive tape, and then the content of the liquid epoxy resin in the extracted components (peak area of the peak derived from the liquid epoxy resin, initial content) was determined using reverse-phase liquid chromatography (RPLC). Next, a storage test was performed in which the adhesive tape was stored at 40 °C for 48 hours immediately after production, the pressure-sensitive adhesive tape was peeled off from the adhesive tape after the storage test, the liquid epoxy resin was extracted from the peeled pressure-sensitive adhesive tape by the same method as above, and the content of the liquid epoxy resin in the extracted components (peak area of the peak derived from the liquid epoxy resin, content after storage) was determined. Next, the rate of increase r ($[\text{content after storage} - \text{initial content}] / [\text{initial content}] \times 100$) before and after the storage test was determined from the content of the liquid epoxy resin determined above, and the migration property of the liquid epoxy resin in each adhesive tape was confirmed from the rate of increase r . The rate of increase r is shown in Table 5. The RPLC measurement conditions were as follows.

[Conditions]

- Apparatus: ACQUITY UPLC H-Class/eλPDA, manufactured by Waters
- Detection wavelength: 210 to 800 nm
- Column: ACQUITY UPLC BEH C18 (2.1 mmφ × 100 mm)

- Column temperature: 60 °C for Examples 3 and 4, 40 °C for others
- Eluent: A Acetonitrile B H₂O
- Gradient conditions: The conditions described in Table 3 for Examples 3 and 4, and the conditions described in Table 4 for others.

5 [0177] [Table 3]

Time (min)	Flow rate (mL/min)	%A	%B
Initial	0.50	20	80
1.00	0.50	20	80
16.00	0.50	100	0
23.00	0.50	100	0

[0178] [Table 4]

Time (min)	Flow rate (mL/min)	%A	%B
Initial	0.30	20	80
1.00	0.30	20	80
26.00	0.30	100	0
32.00	0.30	100	0

[0179] (Viscosity Stability)

10 The viscosity stability of the film-like adhesive in the adhesive tapes of Examples 1 to 6 and Comparative Examples 1 to 2 was evaluated by the following method. Specifically, first, the support substrate and the pressure-sensitive adhesive tape were peeled off from the adhesive tape immediately after production to obtain a film-like adhesive. This film-like
15 adhesive was repeatedly laminated using a desktop laminator (product name: HotdogGK-13DX, manufactured by LAMI CORPORATION CO.,

LTD.) to obtain a 400 μm laminated film. At this time, the lamination temperature was 40 to 80 $^{\circ}\text{C}$. The obtained laminated film was punched out using a 10 mm square punch to prepare a sample for viscosity measurement. The viscosity at 80 $^{\circ}\text{C}$ of the obtained sample for viscosity measurement was measured with a rotational rheometer (product name: ARES-G2, manufactured by TA Instruments) under the following conditions, and this was taken as the 80 $^{\circ}\text{C}$ viscosity (initial) of the film-like adhesive in the adhesive tape. The results are shown in Table 5.

[Measurement conditions]

- Measurement tool size: 8 mm ϕ
- Heating rate: 10 $^{\circ}\text{C}/\text{min}$
- Frequency: 10 Hz
- Temperature range: 30 to 180 $^{\circ}\text{C}$

[0180] Next, to confirm the increase in viscosity of the adhesive tape over time, a storage test (accelerated test) was performed in which the adhesive tape immediately after production was stored at 40 $^{\circ}\text{C}$ for 48 hours. This storage test corresponds to a storage test in which the adhesive tape is stored at room temperature (25 $^{\circ}\text{C}$) for 4 weeks. After the test, the 80 $^{\circ}\text{C}$ viscosity (after accelerated test) of the film-like adhesive in the adhesive tape was measured in the same manner as above. In addition, the amount of change in the 80 $^{\circ}\text{C}$ viscosity ([80 $^{\circ}\text{C}$ viscosity after accelerated test] - [initial 80 $^{\circ}\text{C}$ viscosity]) was determined from the initial 80 $^{\circ}\text{C}$ viscosity and the 80 $^{\circ}\text{C}$ viscosity after the accelerated test, and the viscosity stability was evaluated based on this amount of change. The results are shown in Table 5.

[0181] [Table 5]

			Example						Comparative Example	
			1	2	3	4	5	6	1	2
Liquid epoxy resin	Molecular weight	g/mol	≥ 383	453	≥ 476	≥ 442	480	501	312	256
	Rate of increase r	%	24	8	8	17	-	-	38	66
80°C Viscosity	Initial	Pa·s	5190	5490	4730	3690	5170	4970	3700	2720
	After accelerated test	Pa·s	6020	6230	5530	4890	5440	5570	5950	9350
Change in 80°C viscosity		Pa·s	830	740	800	1200	270	600	2250	6630

Reference Signs List

[0182] 1... support substrate, 2... film-like adhesive, 3... pressure-sensitive adhesive layer, 4... base material, 5... pressure-sensitive adhesive tape, 6... dicing tape, 7... substrate, 8... electrode, 9... adhesive layer (film-like adhesive), 10... adhesive tape, 20... semiconductor wafer, 22, 22a, 22b... bump, 24, 24a, 24b... solder ball, 26, 26a, 26b... protruding electrode (solder bump), 28... groove, 29, 29a, 29b... semiconductor chip, 30, 30a, 30b... semiconductor chip with an adhesive layer, 31a, 31b... electrode, 32a, 32b... through-electrode, 100... semiconductor device.

CLAIMS

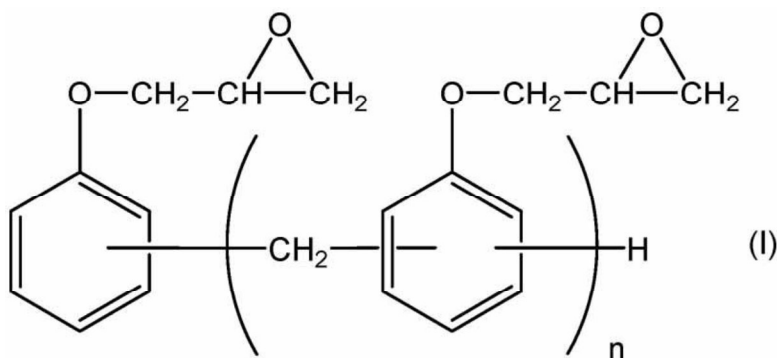
[Claim 1] An adhesive tape for semiconductor, comprising: a film-like adhesive; and a pressure-sensitive adhesive tape laminated to the film-like adhesive, wherein

the film-like adhesive comprises an epoxy resin and a curing agent,
the epoxy resin comprises an epoxy resin that is liquid at 25 °C,
and

a number-average molecular weight of the epoxy resin that is liquid at 25 °C is 350 or more.

[Claim 2] The adhesive tape for semiconductor according to claim 1, wherein the epoxy resin that is liquid at 25 °C comprises a compound represented by the following formula (I).

[Chem. 1]



[In formula (I), n represents an integer of 1 or more.]

[Claim 3] The adhesive tape for semiconductor according to claim 1 or 2, wherein a content of a compound having a molecular weight of 350 or more comprised in the epoxy resin that is liquid at 25 °C is 50 mass% or more based on a total mass of the epoxy resin that is liquid at 25 °C.

[Claim 4] The adhesive tape for semiconductor according to any one

of claims 1 to 3, wherein a content of the epoxy resin that is liquid at 25 °C is 1 to 30 mass% based on a total mass of the film-like adhesive.

[Claim 5] The adhesive tape for semiconductor according to any one of claims 1 to 4, wherein the epoxy resin comprises an epoxy resin that is solid at 25 °C.

[Claim 6] The adhesive tape for semiconductor according to any one of claims 1 to 5, wherein the curing agent comprises an imidazole-based curing agent.

[Claim 7] The adhesive tape for semiconductor according to any one of claims 1 to 6, wherein the film-like adhesive further comprises a flux compound.

[Claim 8] The adhesive tape for semiconductor according to any one of claims 1 to 7, wherein the film-like adhesive further comprises a macromolecular component having a weight-average molecular weight of 10,000 or more.

[Claim 9] The adhesive tape for semiconductor according to any one of claims 1 to 8, wherein the film-like adhesive further comprises a filler.

[Claim 10] The adhesive tape for semiconductor according to any one of claims 1 to 9, wherein a viscosity of the film-like adhesive at 80 °C is 3,000 to 10,000 Pa·s.

[Claim 11] The adhesive tape for semiconductor according to any one of claims 1 to 10, wherein a pressure-sensitive adhesive layer forming a contact surface with the film-like adhesive in the pressure-sensitive adhesive tape comprises a (meth)acrylic resin.

[Claim 12] A method for manufacturing a semiconductor chip with an adhesive layer, comprising:

laminating the adhesive tape for semiconductor according to any one of claims 1 to 11 to a semiconductor wafer from the film-like adhesive side; and

singulating the semiconductor wafer to which the adhesive tape is laminated to obtain a semiconductor chip with an adhesive layer.

[Claim 13] A method for manufacturing a semiconductor device in which semiconductor chips are stacked, comprising:

placing a first semiconductor chip with an adhesive layer obtained by the method according to claim 12 on a substrate from the adhesive layer side and performing compression bonding while heating to obtain a stacked body; and

placing a second semiconductor chip with an adhesive layer obtained by the method according to claim 12 on the stacked body from the adhesive layer side and performing compression bonding while heating.