DESCRIPTION

Title of Invention

ADHESIVE COMPOSITION, FILM-LIKE ADHESIVE, ADHESIVE SHEET AND METHOD FOR PRODUCING SEMICONDUCTOR DEVICE

Technical Field

[0001] The present invention relates to an adhesive composition, a film-form adhesive, an adhesive sheet, and a method for producing a semiconductor device.

Background Art

[0002] Conventionally, silver pastes have been mainly used for the joining of semiconductor chips and supporting members for mounting semiconductor chips. However, along with size reduction/integration of semiconductor chips in recent years, there have been demands for size reduction and integration also in the supporting members to be used. On the other hand, in the case of using a silver paste, there may be problems such as the occurrence of inconvenience upon wire bonding, which is attributed to protrusion of the paste or tilting of semiconductor chips, difficulties in the control of the film thickness, and void generation.

[0003] Therefore, in recent years, film-form adhesives for joining semiconductor chips and supporting members have been used (see, for example, Patent Literature 1). In a case in which an adhesive sheet including a dicing tape and a film-form adhesive laminated on the dicing tape is used, a film-form adhesive-attached semiconductor chip can be obtained by sticking a film-form adhesive on the rear surface of a semiconductor wafer and individualizing the semiconductor wafer by

dicing. The film-form adhesive-attached semiconductor chip thus obtained can be stuck to a supporting member by means of the film-form adhesive and joined by thermocompression bonding.

Citation List

Patent Literature

[0004] Patent Literature 1: JP No. 2007-053240

Summary of Invention

Technical Problem

[0005] However, as the size of a semiconductor chip decreases, the force exerted per unit area at the time of thermocompression bonding increases, and a phenomenon called bleeding, in which a film-form adhesive protrudes from the semiconductor chip, may occur.

[0006] Furthermore, in a case in which a film-form adhesive is used as a film over wire (FOW), which is a wire-embedded type film-form adhesive, or a film over die (FOD), which is a semiconductor chip-embedded type film-form adhesive, high fluidity is required at the time of thermocompression bonding, from the viewpoint of enhancing the embedding properties. Therefore, the frequency of occurrence and the amount for bleeding tend to further increase. Depending on cases, bleeding may occur up to the top face of the semiconductor chip. Furthermore, as the resin flows in a high-temperature pressurization treatment after thermocompression bonding, the bleed amount increases as compared to the bleed amount during thermocompression bonding, and as a result, there is a risk that bleeding may lead to electrical defects or wire bonding defects.

[0007] The present invention was achieved in view of such

circumstances, and it is a main object of the present invention to provide an adhesive composition that has satisfactory embedding properties at the time of thermocompression bonding and is capable of suppressing bleeding at the time of high-temperature pressurization treatment.

Solution to Problem

[0008] An aspect of the present invention provides an adhesive composition containing a thermosetting resin, a curing agent, and an elastomer, in which the thermosetting resin includes an epoxy resin having an alicyclic ring, and the elastomer includes an elastomer having a carboxy group. According to such an adhesive composition, it is possible to suppress bleeding at the time of high-temperature pressurization treatment while having satisfactory embedding properties at the time of thermocompression bonding.

[0009] The curing agent may include a phenolic resin. Furthermore, the elastomer may include an acrylic resin.

[0010] The elastomer may further include an elastomer having no carboxy group.

[0011] The thermosetting resin may further include an aromatic epoxy resin that does not have an alicyclic ring. The aromatic epoxy resin that does not have an alicyclic ring may be a liquid at 25°C.

[0012] The adhesive composition may further contain an inorganic filler. Furthermore, the adhesive composition may further contain a curing accelerator.

[0013] The adhesive composition may be a composition that is used in a semiconductor device in which a first semiconductor element is connected by wire bonding onto a substrate by means of a first wire, and

a second semiconductor element is also compression-bonded onto the first semiconductor element, in order to compression-bond the second semiconductor element and also to embed at least a portion of the first wire.

[0014] The present invention may further relate to an application as an adhesive or an application for the production of an adhesive, of a composition containing a thermosetting resin, a curing agent, and an elastomer, with the thermosetting resin including an epoxy resin having an alicyclic ring, in a semiconductor device in which a first semiconductor element is connected by wire bonding onto a substrate by means of a first wire, and a second semiconductor element is also compression-bonded onto the first semiconductor element, in order to compression-bond the second semiconductor element and also to embed at least a portion of the first wire.

[0015] According to another aspect, the present invention provides a film-form adhesive obtained by forming the above-mentioned adhesive composition into a film form.

[0016] According to another aspect, the present invention provides an adhesive sheet including a base material and the above-mentioned film-form adhesive provided on the base material.

[0017] The base material may be a dicing tape. Meanwhile, according to the present specification, an adhesive sheet in which the base material is a dicing tape may be referred to as "dicing-die bonding integrated type adhesive sheet".

[0018] The adhesive sheet may further include a protective film laminated on the surface of the film-form adhesive on the opposite side

of the base material.

[0019] Furthermore, according to another aspect, the present invention provides a method for producing a semiconductor device, the method including a wire bonding step of electrically connecting a first semiconductor element onto a substrate by means of a first wire, a lamination step of sticking the above-mentioned film-form adhesive on one side of a second semiconductor element, and a die bonding step of subjecting the second semiconductor element having the film-form adhesive stuck thereto, to compression-bonding by means of the film-form adhesive, and thereby embedding at least a portion of the first wire in the film-form adhesive.

[0020] Meanwhile, the semiconductor device may be a wire-embedded type semiconductor device in which a first semiconductor chip is connected by wire bonding onto a semiconductor substrate by means of a first wire, a second semiconductor chip is also compression-bonded onto the first semiconductor chip by means of an adhesive film, and thereby at least a portion of the first wire is embedded in the adhesive film, or may be a chip-embedded type semiconductor device in which a first wire and a first semiconductor chip are embedded in an adhesive film.

Advantageous Effects of Invention

[0021] According to the present invention, there is provided an adhesive composition that has satisfactory embedding properties at the time of thermocompression bonding and is capable of suppressing bleeding at the time of high-temperature pressurization treatment. Therefore, a film-form adhesive obtained by forming this adhesive composition into a film

form can be useful as a film over die (FOD), which is a semiconductor chip-embedded type film-form adhesive, or a film over wire (FOW), which is a wire-embedded type film-form adhesive. Furthermore, according to the present invention, there are provided an adhesive sheet obtained using such a film-form adhesive, and a method for producing a semiconductor device.

Brief Description of Drawings

[0022] FIG. 1 is a schematic cross-sectional view illustrating a film-form adhesive according to an embodiment.

FIG. 2 is a schematic cross-sectional view illustrating an adhesive sheet according to an embodiment.

FIG. 3 is a schematic cross-sectional view illustrating an adhesive sheet according to another embodiment.

FIG. 4 is a schematic cross-sectional view illustrating a semiconductor device according to an embodiment.

FIG. 5 is a schematic cross-sectional view illustrating a series of steps of a method for producing a semiconductor device according to an embodiment.

FIG. 6 is a schematic cross-sectional view illustrating a series of steps of a method for producing a semiconductor device according to an embodiment.

FIG. 7 is a schematic cross-sectional view illustrating a series of steps of a method for producing a semiconductor device according to an embodiment.

FIG. 8 is a schematic cross-sectional view illustrating a series of steps of a method for producing a semiconductor device according to an

embodiment.

FIG. 9 is a schematic cross-sectional view illustrating a series of steps of a method for producing a semiconductor device according to an embodiment.

Description of Embodiments

[0023] Hereinafter, embodiments of the present invention will be described with appropriate reference to the drawings. However, the present invention is not intended to be limited to the following embodiments.

[0024] According to the present specification, (meth)acrylic acid means acrylic acid or methacrylic acid corresponding thereto. The same also applies to other similar expressions such as a (meth)acryloyl group.

[0025] [Adhesive composition]

The adhesive composition according to the present embodiment contains: (A) a thermosetting resin, (B) a curing agent, and (C) an elastomer. The adhesive composition is thermosetting, and the adhesive composition can go through a semi-cured (stage B) state and enter a completely cured product (stage C) state after a curing treatment.

[0026] <Component (A): Thermosetting resin>

From the viewpoint of adhesiveness, the thermosetting resin may include an epoxy resin. The adhesive composition according to the present embodiment includes (A-1) an epoxy resin having an alicyclic ring as the thermosetting resin.

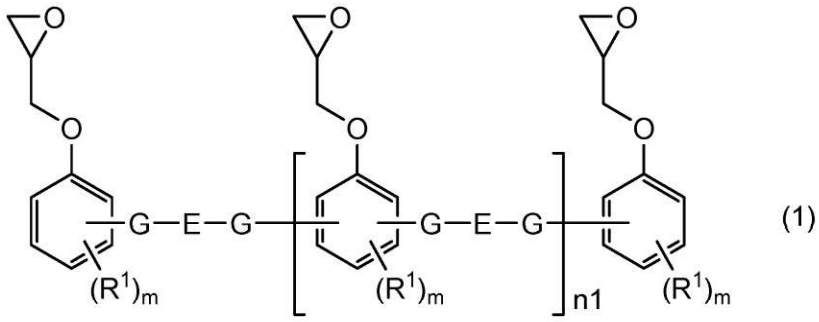
[0027] Component (A-1) is a compound having an alicyclic ring and an epoxy group in the molecule. The epoxy group may be bonded to the alicyclic ring of this compound or to a site other than the alicyclic ring,

through a single bond or a linking group (for example, an alkylene group, an oxyalkylene group, or the like). Furthermore, this compound may also be a compound having an epoxy group that is formed together with two carbon atoms constituting the alicyclic ring (that is, an alicyclic epoxy compound). By including the component (A-1) as the thermosetting resin, it is possible to suppress bleeding at the time of high-temperature pressurization treatment while having satisfactory embedding properties at the time of thermocompression bonding.

[0028] The epoxy equivalent of the component (A-1) is not particularly limited; however, the epoxy equivalent may be 90 to 600 g/eq, 100 to 500 g/eq, or 120 to 450 g/eq. When the epoxy equivalent of the component (A-1) is in such a range, more satisfactory reactivity and fluidity tend to be obtained.

[0029] The component (A-1) may be, for example, any one of epoxy resins represented by the following General Formulae (1) to (4).

[0030]



(1)

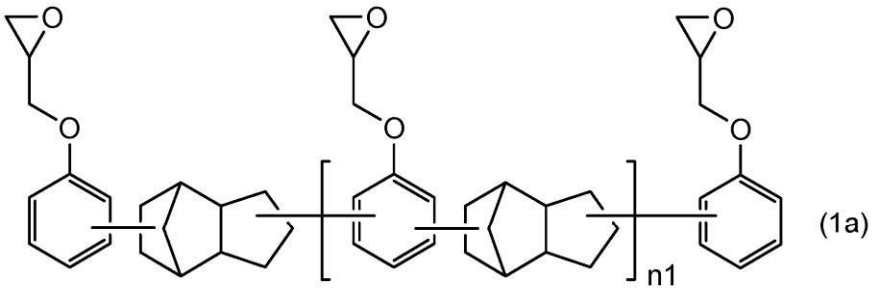
[0031] In Formula (1), E represents an alicyclic ring; G represents a single bond or an alkylene group; R^1's each independently represent a hydrogen atom or a monovalent hydrocarbon group; n1 represents an integer from 1 to 10; and m represents an integer from 1 to 3.

[0032] The number of carbon atoms of E may be 4 to 12, 5 to 11, or 6 to

10. E may be a monocyclic ring or a polycyclic ring; however, E is preferably a polycyclic ring, and more preferably a dicyclopentadiene ring. The alkylene group for G may be an alkylene group having 1 to 5 carbon atoms, such as a methylene group, an ethylene group, a propylene group, a butylene group, or a pentylene group. G is preferably a single bond. The monovalent hydrocarbon group for R^1 may be, for example, an alkylene group such as a methyl group, an ethyl group, a propyl group, a butyl group, or a pentyl group; an aryl group such as a phenyl group or a naphthyl group; or a heteroaryl group such a pyridyl group. It is preferable that R^1 is a hydrogen atom.

[0033] The epoxy resin represented by General Formula (1) may be an epoxy resin represented by the following General Formula (1a).

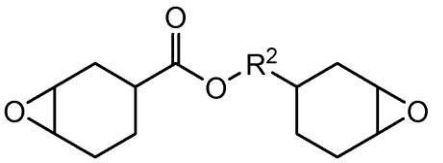
[0034]



[0035] In Formula (1a), n1 has the same meaning as described above.

[0036] Examples of commercially available products of the epoxy resin represented by General Formula (1a) include HP-7200L, HP-7200H, HP-7200 (all manufactured by DIC Corporation), XD-1000 (manufactured by Nippon Kayaku Co., Ltd.), and the like.

[0037]



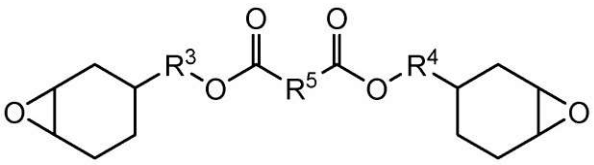
(2)

[0038] In Formula (2), R^2 represents a divalent hydrocarbon group.

[0039] The divalent hydrocarbon group for R^2 may be, for example, an alkylene group such as a methylene group, an ethylene group, a propylene group, a butylene group, or a pentylene group; an arylene group such as a phenylene group or a naphthylene group; or a heteroarylene group such as a pyridylene group. It is preferable that R^2 is an alkylene group having 1 to 5 carbon atoms.

[0040] Examples of commercially available products of the epoxy resin represented by General Formula (2) include CELLOXIDE 2021P, CELLOXIDE 2081 (all manufactured by Daicel Corporation), and the like.

[0041]



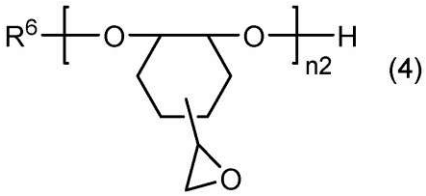
(3)

[0042] In Formula (3), R^3, R^4, and R^5 each independently represent a divalent hydrocarbon group.

[0043] Regarding the divalent hydrocarbon group for R^3, R^4, and R^5, the same ones mentioned as the examples of the divalent hydrocarbon group for R^2 may be mentioned.

[0044] Examples of commercially available products of the epoxy resin represented by General Formula (3) include Syna Epoxy 28 (manufactured by Synasia), and the like.

[0045]



(4)

[0046] In Formula (4), R^6 represents a hydrogen atom or a monovalent hydrocarbon group; and n2 represents an integer from 1 to 10.

[0047] Regarding the monovalent hydrocarbon group for R^6, the same ones mentioned as examples of the monovalent hydrocarbon group for R^1 may be mentioned.

[0048] Examples of commercially available products of the epoxy resin represented by General Formula (4) include EHPE 3150 (manufactured by Daicel Corporation), and the like.

[0049] From the viewpoint of heat resistance, component (A-1) is preferably an epoxy resin represented by General Formula (1), and more preferably an epoxy resin represented by General Formula (1a).

[0050] The content of the component (A-1) may be 15% to 100% by mass based on the total amount of the component (A). The content of the component (A-1) may be 40% by mass or more, 50% by mass or more, or 60% by mass or more.

[0051] The content of the component (A-1) may be 5% by mass or more, 10% by mass or more, or 20% by mass or more, based on the total amount of the adhesive composition. When the content of the component (A-1) is 5% by mass or more based on the total amount of the adhesive composition, there is a tendency that bleeding at the time of high-temperature pressurization treatment can be suppressed thoroughly, while having more satisfactory embedding properties at the time of

thermocompression bonding.

[0052] Component (A) may further include (A-2) an aromatic epoxy resin that does not have an alicyclic ring, in addition to the component (A-1). Here, the aromatic epoxy resin that does not have an alicyclic ring is a compound that has an aromatic ring and an epoxy group in the molecule but does not have an alicyclic ring. Examples of the component (A-2) include a bisphenol A type epoxy resin, a bisphenol F type epoxy resin, a bisphenol S type epoxy resin, a phenol novolac type epoxy resin, a cresol novolac type epoxy resin, a bisphenol A novolac type epoxy resin, a bisphenol F novolac type epoxy resin, a stilbene type epoxy resin, a triazine skeleton-containing epoxy resin, a fluorene skeleton-containing epoxy resin, a triphenol methane type epoxy resin, a biphenyl type epoxy resin, a xylylene type epoxy resin, a phenyl aralkyl type epoxy resin, a biphenyl aralkyl type epoxy resin, a naphthalene type epoxy resin, a polyfunctional phenol, a diglycidyl ether compound of a polycyclic aromatic compound such as anthracene, and the like. These may be used singly or in combination of two or more kinds thereof. Among these, the component (A-2) may be a liquid at 25°C.

[0053] The epoxy equivalent of the component (A-2) is not particularly limited; however, the epoxy equivalent may be 90 to 600 g/eq, 100 to 500 g/eq, or 120 to 450 g/eq. When the epoxy equivalent of the component (A-2) is in such a range, more satisfactory reactivity and fluidity tend to be obtained.

[0054] The content of the component (A-2) may be 0% to 85% by mass based on the total amount of the component (A). The content of the component (A-2) may be 60% by mass or less, 50% by mass or less, or

40% by mass or less.

[0055] <Component (B): Curing agent>

Regarding component (B), any compound that is generally used as a curing agent for a thermosetting resin, can be used without any particularly limitations. In a case in which the thermosetting resin includes an epoxy resin, examples of the component (B) include a phenolic resin, an ester compound, an aromatic amine, an aliphatic amine, an acid anhydride, and the like. These may be used singly or in combination of two or more kinds thereof. Among these, from the viewpoints of reactivity and stability over time, the component (B) may include a phenolic resin.

[0056] Regarding the phenolic resin, any compound having a phenolic hydroxyl group in the molecule can be used without any particular limitations. Examples of the phenolic resin include a novolac type phenolic resin obtainable by condensing or co-condensing a phenol such as phenol, cresol, resorcin, catechol, bisphenol A, bisphenol F, phenylphenol, or aminophenol, and/or a naphthol such as α-naphthol, β-naphthol, or dihydroxynaphthalene, with a compound having an aldehyde group, such as formaldehyde, in the presence of an acidic catalyst; a phenol aralkyl resin synthesized from a phenol and/or a naphthol, such as allylated bisphenol A, allylated bisphenol F, allylated naphthalenediol, phenol novolac, or phenol, and dimethoxy-para-xylene or bis(methoxymethyl)biphenyl; a naphthol aralkyl resin, a biphenyl aralkyl type phenolic resin, a phenyl aralkyl type phenolic resin, and the like. These may be used singly or in combination of two or more kinds thereof. Among these, from the viewpoint of heat resistance, it is preferable for

the phenolic resin that the coefficient of water absorption under the conditions of 48 hours in a constant-temperature and constant-humidity chamber at 85°C and 85%RH is 2% by mass or less, and the mass reduction ratio on heating at 350°C (rate of temperature increase: 5°C/min, atmosphere: nitrogen) measured with a thermogravimetric analyzer (TGA) is less than 5% by mass.

[0057] Examples of commercially available products of the phenolic resin include PHENOLITE KA series, TD series (manufactured by DIC Corporation), MILEX XLC series, XL series (manufactured by Mitsui Chemicals, Inc.), HE series (manufactured by AIR WATER INC.), and the like.

[0058] The hydroxyl group equivalent of the phenolic resin is not particularly limited; however, the hydroxyl group equivalent may be 80 to 400 g/eq, 90 to 350 g/eq, or 100 to 300 g/eq. When the hydroxyl group equivalent of the phenolic resin is in such a range, more satisfactory reactivity and fluidity tend to be obtained.

[0059] In a case in which component (A) is an epoxy resin and component (B) is a phenolic resin, the ratio between the epoxy equivalent of the epoxy resin and the hydroxyl group equivalent of the phenolic resin (epoxy equivalent of epoxy resin/hydroxyl group equivalent of phenolic resin) may be 0.30/0.70 to 0.70/0.30, 0.35/0.65 to 0.65/0.35, 0.40/0.60 to 0.60/0.40, or 0.45/0.55 to 0.55/0.45, from the viewpoint of curability. When this equivalent ratio is 0.30/0.70 or higher, more sufficient curability tends to be obtained. When this equivalent ratio is 0.70/0.30 or lower, the viscosity can be prevented from becoming excessively high, and more sufficient fluidity can be obtained.

[0060] The content of the sum of the component (A) and the component (B) may be 30% to 70% by mass based on the total amount of the adhesive composition. The content of the sum of the component (A) and the component (B) may be 33% by mass or more, 36% by mass or more, or 40% by mass or more, and may be 65% by mass or less, 60% by mass or less, or 55% by mass or less. When the content of the sum of the component (A) and the component (B) is 30% by mass or more based on the total amount of the adhesive composition, the adhesiveness tends to be enhanced. When the content of the sum of the component (A) and the component (B) is 70% by mass or less based on the total amount of the adhesive composition, there is a tendency that the viscosity can be prevented from becoming excessively low, and bleeding at the time of high-temperature pressurization treatment can be further suppressed.

[0061] <Component (C): Elastomer>

The adhesive composition according to the present embodiment contains (C) an elastomer. The adhesive composition according to the present embodiment includes (C-1) an elastomer having a carboxy group as the elastomer. It is preferable for the component (C) that the glass transition temperature (Tg) of the polymer constituting the elastomer is 50°C or lower.

[0062] The component (C-1) is a compound (elastomer) having a carboxy group in the molecule. By including the component (C-1) as the elastomer, it is possible to suppress bleeding at the time of high-temperature pressurization treatment while having satisfactory embedding properties at the time of thermocompression bonding.

[0063] Examples of the component (C-1) include an acrylic resin, a

polyester resin, a polyamide resin, a polyimide resin, a silicone resin, a butadiene resin, an acrylonitrile resin, modification products of these, and the like.

[0064] The component (C-1) may include an acrylic resin having a carboxy group, from the viewpoints of solubility in a solvent and fluidity. Here, the acrylic resin means a polymer including a constituent unit derived from a (meth)acrylic acid ester. It is preferable that the acrylic resin is a polymer including a constituent unit derived from a (meth)acrylic acid ester having, in addition to a carboxy group, a crosslinkable functional group such as an epoxy group or an alcoholic or phenolic hydroxyl group, as a constituent unit. Furthermore, the acrylic resin may be an acrylic rubber such as a copolymer of a (meth)acrylic acid ester and acrylonitrile.

[0065] The glass transition temperature (Tg) of the acrylic resin may be -50°C to 50°C or -30°C to 30°C. When the Tg of the acrylic resin is -50°C or higher, there is a tendency that the flexibility of the adhesive composition can be prevented from becoming excessively high. Thereby, it is easier to cut the film-form adhesive at the time of wafer dicing, and it is possible to prevent the occurrence of burrs. When the Tg of the acrylic resin is 50°C or lower, there is a tendency that a decrease in the flexibility of the adhesive composition can be suppressed. Thereby, at the time of sticking the film-form adhesive to a wafer, voids tend to be easily embedded sufficiently. Furthermore, it is possible to prevent chipping at the time of dicing, which is caused by a decrease in the adhesiveness of the wafer. Here, the glass transition temperature (Tg) means a value measured using a DSC (thermal differential scanning

calorimeter) (for example, "Thermo Plus 2" manufactured by Rigaku Corporation).

[0066] The weight average molecular weight (Mw) of the acrylic resin may be 100000 to 3000000 or 500000 to 2000000. When the Mw of the acrylic resin is in such a range, the film-forming properties and the strength, flexibility, tackiness, and the like in a film form can be appropriately controlled, the reflow characteristics are also excellent, and the embedding properties can be enhanced. Here, the Mw means a value measured by gel permeation chromatography (GPC) and converted using a calibration curve based on polystyrene standards.

[0067] The acid value of the component (C-1) may be 1 to 60 mg KOH/g, 2 to 40 mg KOH/g, or 3 to 30 mg KOH/g, from the viewpoint of curability. When the acid value is in such a range, there is a tendency that bleeding at the time of high-temperature pressurization treatment can be further suppressed.

[0068] Examples of a commercially available product of the component (C-1) (acrylic resin) include SG-70L, SG-708-6, WS-023 EK30, SG-280 EK23 (all manufactured by Nagase ChemteX Corporation), and the like.

[0069] The component (C) may further include (C-2) an elastomer having no carboxy group, in addition to the component (C-1). The component (C-2) is a compound (elastomer) that does not have a carboxy group in the molecule.

[0070] Examples of the component (C-2) include an acrylic resin, a polyester resin, a polyamide resin, a polyimide resin, a silicone resin, a butadiene resin, an acrylonitrile resin, modification products of these, and the like.

[0071] The component (C-2) may include an acrylic resin that does not have a carboxy group, from the viewpoints of solubility in a solvent and fluidity. Here, the acrylic resin means a polymer including a constituent unit derived from a (meth)acrylic acid ester. It is preferable that the acrylic resin is a polymer including a constituent unit derived from a (meth)acrylic acid ester having a crosslinkable functional group such as an epoxy group or an alcoholic or phenolic hydroxyl group as a constituent unit. Furthermore, the acrylic resin may be an acrylic rubber such as a copolymer of a (meth)acrylic acid ester and acrylonitrile.

[0072] The glass transition temperature (Tg) of the acrylic resin may be similar to the Tg of the acrylic resin of the component (C-1). The weight average molecular weight (Mw) of the acrylic resin may be similar to the Mw of the acrylic resin of the component (C-1).

[0073] Examples of a commercially available product of the component (C-2) (acrylic resin) include SG-P3, SG-80H (all manufactured by Nagase ChemteX Corporation), and the like.

[0074] The content of component (C) may be 20 to 200 parts by mass or 30 to 100 parts by mass with respect to a total amount of 100 parts by mass of the component (A) and the component (B). When the content of the component (C) is 20 parts by mass or more with respect to a total amount of 100 parts by mass of the component (A) and the component (B), handleability (for example, crease performance, and the like) of the film-form adhesive tends to be more satisfactory. When the content of the component (C) is 200 parts by mass or less with respect to a total amount of 100 parts by mass of the component (A) and the component (B), there is a tendency that the flexibility of the adhesive composition

can be further prevented from becoming excessively high. Thereby, it is easier to cut the film-form adhesive at the time of wafer dicing, and there is a tendency that it is even further possible to prevent the occurrence of burrs.

[0075] The mass ratio of the content of the component (C-1) with respect to the content of the component (C) (content of the sum of the component (C-1) and component (C-2)) (content of component (C-1)/content of component (C)) may be 0.05 to 1, 0.10 to 1, 0.20 to 1, 0.40 to 1, or 0.60 to 1.

[0076] <Component (D): Inorganic filler>

The adhesive composition according to the present embodiment may further contain (D) an inorganic filler. Examples of the inorganic filler include aluminum hydroxide, magnesium hydroxide, calcium carbonate, magnesium carbonate, calcium silicate, magnesium silicate, calcium oxide, magnesium oxide, aluminum oxide, aluminum nitride, aluminum borate whiskers, boron nitride, crystalline silica, amorphous silica, and the like. These may be used singly, or two or more kinds thereof may be used in combination. From the viewpoint that the thermal conductivity of the resulting film-form adhesive is further enhanced, the inorganic filler may include aluminum oxide, aluminum nitride, boron nitride, crystalline silica, or amorphous silica. Furthermore, from the viewpoint of adjusting the melt viscosity of the adhesive composition and from the viewpoint of imparting thixotropic properties to the adhesive composition, the inorganic filler may include aluminum hydroxide, magnesium hydroxide, calcium carbonate, magnesium carbonate, calcium silicate, magnesium silicate, calcium

oxide, magnesium oxide, aluminum oxide, crystalline silica, or amorphous silica.

[0077] The average particle size of the component (D) may be 0.005 to 0.5 μm or 0.05 to 0.3 μm, from the viewpoint that adhesiveness is further enhanced. Here, the average particle size means a value that is determined by converting from the BET specific surface area.

[0078] The component (D) may be surface-treated with a surface treatment agent, from the viewpoints of compatibility between the surface of the component (D) and a solvent, other components, and the like, and the adhesive strength. Examples of the surface treatment agent include a silane coupling agent and the like. Examples of the functional group of the silane coupling agent include a vinyl group, a (meth)acryloyl group, an epoxy group, a mercapto group, an amino group, a diamino group, an alkoxy group, an ethoxy group, and the like.

[0079] The content of the component (D) may be 10 to 90 parts by mass or 10 to 50 parts by mass with respect to a total amount of 100 parts by mass of the component (A), component (B), and component (C). When the content of the component (D) is 10 parts by mass or more with respect to a total amount of 100 parts by mass of the component (A), component (B), and component (C), the dicing characteristics of the adhesive layer before curing are enhanced, and the adhesive force of the adhesive layer after curing tends to be enhanced. When the content of the component (D) is 90 parts by mass or less with respect to a total amount of 100 parts by mass of the component (A), component (B), and component (C), a decrease in the fluidity can be suppressed, and it is possible to prevent the elastic modulus of the film-form adhesive after curing from becoming

excessively high.

[0080] <Component (E): Curing accelerator>

The adhesive composition according to the present embodiment may contain (E) a curing accelerator. The curing accelerator is not particularly limited, and agents that are generally used can be used. Examples of the component (E) include an imidazole and derivatives thereof, an organic phosphorus-based compound, a secondary amine, a tertiary amine, a quaternary ammonium salt, and the like. These may be used singly or in combination of two or more kinds thereof. Among these, from the viewpoint of reactivity, the component (E) may be an imidazole or a derivative thereof.

[0081] Examples of the imidazole include 2-methylimidazole, 1-benzyl-2-methylimidazole, 1-cyanoethyl-2-phenylimidazole, 1-cyanoethyl-2-methylimidazole, and the like. These may be used singly or in combination of two or more kinds thereof.

[0082] The content of the component (E) may be 0.04 to 3 parts by mass or 0.04 to 0.2 parts by mass with respect to a total amount of 100 parts by mass of the component (A), component (B), and component (C). When the content of the component (E) is in such a range, there is a tendency that curability and reliability can be achieved in a well-balanced manner.

[0083] <Other components>

The adhesive composition according to the present embodiment may further contain an oxidation inhibitor, a silane coupling agent, a rheology control agent, and the like as other components. The content of these components may be 0.02 to 3 parts by mass with respect to a total amount of 100 parts by mass of the component (A), component (B), and

component (C).

[0084] The adhesive composition according to the present embodiment may be used as an adhesive varnish diluted with a solvent. The solvent is not particularly limited as long as it can dissolve components other than the component (D). Examples of the solvent include aromatic hydrocarbons such as toluene, xylene, mesitylene, cumene, and p-cymene; aliphatic hydrocarbons such as hexane and heptane; cyclic alkanes such as methylcyclohexane; cyclic ethers such as tetrahydrofuran and 1,4-dioxane; 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; carbonic acid esters such as ethylene carbonate and propylene carbonate; amides such as N,N-dimethylformamide, N,N-dimethylacetamide, and N-methyl-2-pyrrolidone; and the like. These may be used singly or in combination of two or more kinds thereof. Among these, the solvent may be toluene, xylene, methyl ethyl ketone, methyl isobutyl ketone, or cyclohexanone, from the viewpoints of solubility and the boiling point.

[0085] The solid component concentration in the adhesive varnish may be 10% to 80% by mass based on the total mass of the adhesive varnish.

[0086] The adhesive varnish can be prepared by mixing and kneading the component (A), component (B), component (C), a solvent, and if necessary, the component (D), component (E), as well as other components. Mixing and kneading can be carried out by appropriately combining conventional dispersing machines such as a stirrer, a grinding machine, a three-roll mill, a ball mill, and a bead mill. In a case in which

the adhesive varnish contains the component (D), the time for mixing can be shortened by mixing in advance the component (D) and low molecular weight components and then incorporating high molecular weight components thereto. Furthermore, after the adhesive varnish is prepared, gas bubbles in the varnish may be removed by vacuum degassing or the like.

[0087] [Film-form adhesive]

FIG. 1 is a schematic cross-sectional view illustrating a film-form adhesive according to an embodiment. The film-form adhesive 10 is obtained by forming the above-mentioned adhesive composition into a film form. The film-form adhesive 10 may be in a semi-cured (stage B) state. Such a film-form adhesive 10 can be formed by applying the adhesive composition on a supporting film. In the case of using an adhesive varnish, the film-form adhesive 10 can be formed by applying the adhesive varnish on a supporting film and removing the solvent by heating and drying the solvent.

[0088] The supporting film is not particularly limited, and examples include films of polytetrafluoroethylene, polyethylene, polypropylene, polymethylpentene, polyethylene terephthalate, polyimide, and the like. The thickness of the supporting film may be, for example, 60 to 200 μm or 70 to 170 μm.

[0089] Regarding the method of applying an adhesive varnish on a supporting film, any known method can be used, and examples include a knife coating method, a roll coating method, a spray coating method, a gravure coating method, a bar coating method, a curtain coating method, and the like. The conditions for heating and drying are not particularly

limited as long as the conditions are conditions in which the solvent used is sufficiently volatilized; however, for example, the conditions may be 50°C to 200°C for 0.1 to 90 minutes.

[0090] The thickness of the film-form adhesive can be appropriately adjusted according to the use application. The thickness of the film-form adhesive may be 20 to 200 μm, 30 to 200 μm, or 40 to 150 μm, from the viewpoint of sufficiently embedding the surface unevenness of a semiconductor chip, a wire, a wiring circuit of a substrate, and the like.

[0091] [Adhesive sheet]

FIG. 2 is a schematic cross-sectional view illustrating an adhesive sheet according to an embodiment. The adhesive sheet 100 includes a base material 20 and the above-mentioned film-form adhesive 10 provided on the base material.

[0092] The base material 20 is not particularly limited; however, the base material may be a base material film. The base material film may be a film similar to the above-mentioned supporting film.

[0093] The base material 20 may be a dicing tape. Such an adhesive sheet can be used as a dicing-die bonding integrated type adhesive sheet. In this case, since the lamination step on a semiconductor wafer is carried out once, the operation can be made more efficient.

[0094] Examples of the dicing tape include plastic films such as a polytetrafluoroethylene film, a polyethylene terephthalate film, a polyethylene film, a polypropylene film, a polymethylpentene film, and a polyimide film, and the like. Furthermore, if necessary, the dicing tape may be subjected to a surface treatment such as primer application, a UV treatment, a corona discharge treatment, a polishing treatment, or an

etching treatment. It is preferable that the dicing tape has tacky adhesiveness. Such a dicing tape may be a product obtained by imparting tacky adhesiveness to the above-mentioned plastic film, or may be a product in which a tacky adhesive layer is provided on one surface of the above-mentioned plastic film.

[0095] The adhesive sheet 100 can be formed by applying an adhesive composition on a base material film, similarly to the above-mentioned method for forming a film-form adhesive. The method of applying the adhesive composition on a base material 20 may be similar to the above-mentioned method of applying the adhesive composition on a supporting film.

[0096] The adhesive sheet 100 may be formed using a film-form adhesive that has been produced in advance. In this case, the adhesive sheet 100 can be formed by performing lamination under predetermined conditions (for example, room temperature (20°C) or a heated state) using a roll laminator, a vacuum laminator, or the like. It is preferable that the adhesive sheet 100 is formed using a roll laminator in a heated state, from the viewpoint that production can be carried out continuously, and the efficiency is good.

[0097] The thickness of the film-form adhesive 10 may be 20 to 200 μm, 30 to 200 μm, or 40 to 150 μm, from the viewpoint of the embedding properties for the surface unevenness of a semiconductor chip, a wire, a wiring circuit of a substrate, and the like. When the thickness of the film-form adhesive 10 is 20 μm or more, more sufficient adhesive force tends to be obtained, and when the thickness of the film-form adhesive 10 is 200 μm or less, it is economically efficient, and it is possible to meet

the requirement for the size reduction of semiconductor devices.

[0098] FIG. 3 is a schematic cross-sectional view illustrating an adhesive sheet according to another embodiment. An adhesive sheet 110 further includes a protective film 30 laminated on the surface of the film-form adhesive 10 on the opposite side of the base material 20. The protective film 30 may be a film similar to the above-mentioned supporting film. The thickness of the protective film may be, for example, 15 to 200 μm or 70 to 170 μm.

[0099] [Semiconductor device]

FIG. 4 is a schematic cross-sectional view illustrating a semiconductor device according to an embodiment. The semiconductor device 200 is a semiconductor device in which a first semiconductor element Wa of a first stage is connected by wire bonding onto a substrate 14 by means of a first wire 88, a second semiconductor element Waa is also compression-bonded onto the first semiconductor element Wa by means of a film-form adhesive 10, and thereby at least a portion of the first wire 88 is embedded in the film-form adhesive 10. The semiconductor device may be a wire-embedded type semiconductor device in which at least a portion of the first wire 88 is embedded, or may be a semiconductor device in which the first wire 88 and the first semiconductor element Wa are embedded. Furthermore, in the semiconductor device 200, the substrate 14 and the second semiconductor element Waa are further electrically connected by means of a second wire 98, and also, the second semiconductor element Waa is sealed by a sealing material 42.

[0100] The thickness of the first semiconductor element Wa may be 10

to 170 μm, and the thickness of the second semiconductor element Waa may be 20 to 400 μm. The first semiconductor element Wa embedded inside the film-form adhesive 10 is a controller chip for driving the semiconductor device 200.

[0101] The substrate 14 is formed from an organic substrate 90 having circuit patterns 84 and 94 respectively formed at two sites each on the surface. The first semiconductor element Wa is compression-bonded onto a circuit pattern 94 by means of an adhesive 41. The second semiconductor element Waa is compression-bonded onto the substrate 14 by means of the film-form adhesive 10 such that a circuit pattern 94 onto which the first semiconductor element Wa is not compression-bonded, the first semiconductor element Wa, and a portion of the circuit pattern 84 are covered. At the level difference of the surface unevenness attributed to the circuit patterns 84 and 94 on the substrate 14, the film-form adhesive 10 is embedded. Further, the second semiconductor element Waa, the circuit pattern 84, and the second wire 98 are sealed by a sealing material 42 made of a resin.

[0102] [Method for producing semiconductor device]

The method for producing a semiconductor device according to the present embodiment includes a first wire bonding step of electrically connecting a first semiconductor element onto a substrate by means of a first wire, a lamination step of sticking the above-mentioned film-form adhesive on one side of a second semiconductor element, and a die bonding step of subjecting the second semiconductor element to which the film-form adhesive is stuck, to compression-bonding by means of a film-form adhesive, and thereby embedding at least a portion of the first

wire in the film-form adhesive.

[0103] FIGS. 5 to 9 are schematic cross-sectional views illustrating a series of steps of the method for producing a semiconductor device according to an embodiment. The semiconductor device 200 according to the present embodiment is a semiconductor device in which a first wire 88 and a first semiconductor element Wa are embedded, and the semiconductor device 200 is produced by the following procedure. First, as shown in FIG. 5, the first semiconductor element Wa having an adhesive 41 is compression-bonded onto a circuit pattern 94 on a substrate 14, and the circuit pattern 84 on the substrate 14 and the first semiconductor element Wa are electrically connected by bonding by means of the first wire 88 (first wire bonding step).

[0104] Next, the adhesive sheet 100 is laminated on one side of a semiconductor wafer (for example, thickness 100 μm, size: 8 inches), the base material 20 is peeled off, and thereby the film-form adhesive 10 (for example, thickness 110 μm) is stuck on one side of the semiconductor wafer. Then, a dicing tape is pasted together with the film-form adhesive 10, subsequently the assembly is diced into a predetermined size (for example, 7.5 mm on each side), and thereby, as shown in FIG. 6, a second semiconductor element Waa having the film-form adhesive 10 stuck thereto is obtained (lamination step).

[0105] The temperature conditions for the lamination step may be 50°C to 100°C or 60°C to 80°C. When the temperature of the lamination step is 50°C or higher, satisfactory adhesiveness to the semiconductor wafer can be obtained. When the temperature of the lamination step is 100°C or lower, since the film-form adhesive 10 excessively flowing during the

lamination step is suppressed, the occurrence of a change in the thickness and the like can be prevented.

[0106] Regarding the dicing method, for example, blade dicing of using a rotating blade, a method of cutting the film-form adhesive or both the wafer and the film-form adhesive using a laser, and the like may be mentioned.

[0107] Then, the second semiconductor element Waa having the film-form adhesive 10 stuck thereto is compression-bonded onto the substrate 14, onto which the first semiconductor element Wa is connected by bonding by means of the first wire 88. Specifically, as shown in FIG. 7, the second semiconductor element Waa having the film-form adhesive 10 stuck thereto is placed such that the first wire 88 and the first semiconductor element Wa are covered by the film-form adhesive 10, and subsequently, as shown in FIG. 8, the second semiconductor element Waa is compression-bonded onto the substrate 14. Thereby, the second semiconductor element Waa is fixed to the substrate 14 (die bonding step). In the die bonding step, it is preferable that the film-form adhesive 10 is compression-bonded for 0.5 to 3.0 seconds under the conditions of 80°C to 180°C and 0.01 to 0.50 MPa. After the die bonding step, the film-form adhesive 10 is pressed and heated for 5 minutes or longer under the conditions of 60°C to 175°C and 0.3 to 0.7 MPa, as a high-temperature pressurization treatment.

[0108] Next, as shown in FIG. 9, the substrate 14 and the second semiconductor element Waa are electrically connected by means of a second wire 98 (second wire bonding step), and then the circuit pattern 84, the second wire 98, and the second semiconductor element Waa are

sealed with a sealing material 42. By going through such steps, the semiconductor device 200 can be produced.

[0109] A semiconductor device as another embodiment may also be a wire-embedded type semiconductor device in which at least a portion of the first wire 88 is embedded.

Examples

[0110] Hereinafter, the present invention will be more specifically described by way of Examples. However, the present invention is not intended to be limited to these Examples.

[0111] (Examples 1 to 8 and Comparative Examples 1-1 to 1-3 and 2 to 4)

<Production of adhesive sheet>

The various components described below were mixed at the mixing ratios (parts by mass) shown in Table 1, Table 2, and Table 3, and a varnish of an adhesive composition having a solid content of 40% by mass was prepared using cyclohexanone as a solvent. Next, the varnish thus obtained was filtered through a 100-mesh filter and was subjected to vacuum degassing. The varnish after vacuum degassing was applied on a polyethylene terephthalate (PET) film having a thickness of 38 μm that had been subjected to a mold release treatment as a base material film. The varnish thus applied was dried by heating in two stages for 5 minutes at 90°C and subsequently for 5 minutes at 140°C. In this way, an adhesive sheet including a film-form adhesive having a thickness of 110 μm in a semi-cured (stage B) state on a base material film was obtained.

[0112] Meanwhile, the various components in Table 1, Table 2, and Table 3 are as follows.

[0113] (A) Thermosetting resin

(A-1) Epoxy resin having alicyclic ring

A-1-1: Epoxy resin represented by General Formula (1a) (epoxy resin having a dicyclopentadiene structure), manufactured by DIC Corporation, trade name: HP-7200L, epoxy equivalent: 250 to 280 g/eq

A-1-2: Epoxy resin represented by General Formula (1a) (epoxy resin having a dicyclopentadiene structure), manufactured by Nippon Kayaku Co., Ltd., trade name: XD-1000, epoxy equivalent: 254 g/eq

A-1-3: Epoxy resin represented by General Formula (2) (liquid at 25°C), manufactured by Daicel Corporation, trade name: CELLOXIDE 2021P, epoxy equivalent: 128 to 145 g/eq

A-1-4: Epoxy resin represented by General Formula (4), manufactured by Daicel Corporation, trade name: EHPE3150, epoxy equivalent: 170 to 190 g/eq

(A-2) Aromatic epoxy resin not having alicyclic ring

A-2-1: Polyfunctional aromatic epoxy resin, manufactured by Printec Corporation, trade name: VG3101L, epoxy equivalent: 210 g/eq

A-2-2: Cresol novolac type epoxy resin, manufactured by Nippon Steel & Sumikin Chemical Co., Ltd., trade name: YDCN-700-10, epoxy equivalent: 209 g/eq

A-2-3: Bisphenol F type epoxy resin (liquid at 25°C), manufactured by DIC Corporation, trade name: EXA-830CRP, epoxy equivalent: 159 g/eq

(B) Curing agent

B-1: Bisphenol A novolac type phenolic resin, manufactured by DIC Corporation, trade name: LF-4871, hydroxyl group equivalent: 118

g/eq

B-2: Phenyl aralkyl type phenolic resin, manufactured by Mitsui Chemicals, Inc., trade name: XLC-LL, hydroxyl group equivalent: 175 g/eq

B-3: Phenyl aralkyl type phenolic resin, manufactured by AIR WATER INC., trade name: HE100C-30, hydroxyl group equivalent: 170 g/eq

(C) Elastomer

(C-1) Elastomer having carboxy group

C-1-1: Carboxy group-containing acrylic resin (acrylic rubber), manufactured by Nagase ChemteX Corporation, trade name: SG-70L, weight average molecular weight: 900000, acid value: 5 mg KOH/g, Tg: -13°C

C-1-2: Carboxy group-containing acrylic resin (acrylic rubber), manufactured by Nagase ChemteX Corporation, trade name; SG-708-6, weight average molecular weight: 700000, acid value: 9 mg KOH/g, Tg: 4°C

C-1-3: Carboxy group-containing acrylic resin (acrylic rubber), manufactured by Nagase ChemteX Corporation, trade name: WS-023 EK30, weight average molecular weight: 500000, acid value: 20 mg KOH/g, Tg: -10°C

(C-2) Elastomer having no carboxy group

C-2-1: Non-carboxy group-containing epoxy group-containing acrylic resin (acrylic rubber), manufactured by Nagase ChemteX Corporation, trade name: SG-P3 solvent-changed product, weight average molecular weight: 800000, Tg: 12°C

C-2-2: Non-carboxy group-containing epoxy group-containing acrylic resin (acrylic rubber), manufactured by Nagase ChemteX Corporation, trade name: SG-80H, weight average molecular weight: 350000, Tg: 11°C

(D) Inorganic filler

D-1: Silica filler dispersion liquid, molten silica, manufactured by Admatechs Company Limited, trade name: SC2050-HLG, average particle size: 0.50 μm

(E) Curing accelerator

E-1: 1-Cyanoethyl-2-phenylimidazole, manufactured by SHIKOKU CHEMICALS CORPORATION, trade name: CUREZOL 2PZ-CN

[0114] <Evaluation of various physical properties>

For the adhesive sheets thus obtained, evaluation of embedding properties and the amount of bleeding was carried out.

[0115] [Evaluation of embedding properties]

The embedding properties of an adhesive sheet were evaluated by producing the following evaluation sample. The film-form adhesive (thickness 110 μm) obtained as described above was stuck to a dicing tape after the base material film was peeled off, and thus a dicing-die bonding integrated type adhesive sheet was obtained. Next, a semiconductor wafer (8 inches) having a thickness of 100 μm was stuck to the adhesive side by heating to 70°C. Subsequently, this semiconductor wafer was diced into a size of 7.5 mm on each side, and thereby a semiconductor chip A was obtained. Next, a dicing-die bonding integrated type adhesive sheet (manufactured by Hitachi

Chemical Company, Ltd., trade name: HR9004-10) (thickness 10 μm) was prepared and was stuck to a semiconductor wafer (8 inches) having a thickness of 50 μm by heating to 70°C. Subsequently, this semiconductor wafer was diced into a size of 4.5 mm on each side, and thereby a die bonding film-attached semiconductor chip B was obtained. Next, a substrate for evaluation having a total thickness of 260 μm and having a solder resist (manufactured by TAIYO NIPPON SANSO CORPORATION, trade name: AUS308) applied thereon was prepared, and the die bonding film-attached semiconductor chip B and the substrate for evaluation were compression-bonded under the conditions of 120°C, 0.20 MPa, and 2 seconds such that the die bonding film of the semiconductor chip B and the solder resist of the substrate for evaluation were in contact. Subsequently, the semiconductor chip A and the semiconductor chip B were compression-bonded under the conditions of 120°C, 0.20 MPa, and 1.5 seconds such that the film-form adhesive of the semiconductor chip A and the semiconductor wafer of the semiconductor chip B were in contact, and thus an evaluation sample was obtained. At this time, alignment was implemented such that the semiconductor chip B that had been first compression-bonded would come at the center of the semiconductor chip A. The evaluation sample obtained as such was observed to see the presence or absence of voids with an ultrasonic digital image diagnostic apparatus (manufactured by Insight k.k., probe: 75 MHz). In a case in which voids were observed, the proportion of the area of voids per unit area was calculated, and these analysis results were evaluated as the embedding properties. The evaluation criteria are as follows. The results are presented in Table 1,

Table 2, and Table 3.

A: Voids were not observed.

B: Voids were observed; however, the proportion thereof was less than 5% by area.

C: Voids were observed, and the proportion thereof was 5% by area or more.

[0116] [Evaluation of amount of bleeding]

For the samples rated as "A" or "B" in the above-described evaluation for embedding properties, an evaluation of the amount of bleeding was carried out. Samples were produced in the same manner as in the case of the evaluation samples produced for the evaluation of embedding properties, and the samples were subjected to a high-temperature pressurization treatment (pressurized curing) using a pressurized oven under the conditions of 140°C, 0.7 MPa, and 30 minutes to obtain samples for evaluating bleeding. An amount of protrusion of the film-form adhesive was measured at the center of the four edges of each evaluation sample using a microscope, and the maximum value was designated as the amount of bleeding. The results are presented in Table 1, Table 2, and Table 3.

[0117] Table 1

Item		Exam. 1	Comp. Exam. 1-1	Comp. Exam. 1-2	Comp. Exam. 1-3
Component (A)	A-1-1	35	35	-	-
	A-1-2	-	-	-	-
	A-1-3	-	-	-	-
	A-1-4	-	-	-	-
	A-2-1	-	-	-	-
	A-2-2	-	-	35	35
	A-2-3	-	-	-	-
Component (B)	B-1	-	-	-	-
	B-2	15	15	15	15
	B-3	-	-	-	-
Component (C)	C-1-1	20	-	20	-
	C-1-2	-	-	-	-
	C-1-3	-	-	-	-
	C-2-1	-	20	-	20
	C-2-2	-	-	-	-
Component (D)	D-1	30	30	30	30
Component (E)	E-1	0.05	0.05	0.05	0.05
Embedding properties		B	B	C	C
Amount of bleeding (μm)		60.5	79.4	-	-

[0118] Table 2

Item		Exam. 2	Comp. Exam. 2	Exam. 3	Comp. Exam. 3
Component (A)	A-1-1	-	-	-	-
	A-1-2	20	-	20	-
	A-1-3	-	-	-	-
	A-1-4	-	-	-	20
	A-2-1	-	20	-	-
	A-2-2	-	-	-	-
	A-2-3	15	15	10	10
Component (B)	B-1	15	15	-	-
	B-2	-	-	-	-
	B-3	-	-	20	20
Component (C)	C-1-1	-	-	-	-
	C-1-2	4	-	-	-
	C-1-3	-	-	20	-
	C-2-1	16	20	-	-
	C-2-2	-	-	-	20
Component (D)	D-1	30	30	30	30
Component (E)	E-1	0.05	0.05	0.05	0.05
Embedding properties		A	B	A	B
Amount of bleeding (μm)		64.5	120.8	59.8	98.5

[0119] Table 3

Item		Exam. 4	Exam. 5	Exam. 6	Exam. 7	Exam. 8	Comp. Exam. 4
Component (A)	A-1-1	-	-	20	-	10	-
	A-1-2	40	-	-	10	-	-
	A-1-3	-	5	10	-	-	-
	A-1-4	-		-	10	-	-
	A-2-1	-	-	-	-	15	30
	A-2-2	-	25	-	-	-	-
	A-2-3	-	-	-	5	10	-
Component (B)	B-1	-	15	-	-	20	-
	B-2	15	-	20	-	-	-
	B-3	-	-	-	25	-	25
Component (C)	C-1-1	-	20	20	-	15	15
	C-1-2	15	-	-	-	-	-
	C-1-3	-	-	-	20	-	-
	C-2-1	-	5	-	-	-	-
	C-2-2	-	-	-	-	5	-
Component (D)	D-1	30	30	30	30	35	30
Component (E)	E-1	0.05	0.1	0.1	0.05	0.05	0.05
Embedding properties		B	B	A	A	B	C
Amount of bleeding (μm)		60.7	61.5	56.9	64.2	64.6	-

[0120] As shown in Table 1, in the adhesive composition of Example 1 which includes an epoxy resin having an alicyclic ring and in which the elastomer includes an elastomer having a carboxy group, bleeding at the time of high-temperature pressurization treatment could be suppressed while satisfactory embedding properties were maintained as compared to the adhesive compositions of Comparative Examples 1-1 to 1-3 that do not include those. Furthermore, from Examples 2 and 3 of Table 2 and Examples 4 to 8 of Table 3, it was found that a similar tendency was obtained even in a case where epoxy resins having other alicyclic rings were used, or in a case where elastomers having other carboxy groups were used. From these results, it was verified that the adhesive compositions according to the present invention are capable of suppressing bleeding at the time of high-temperature pressurization treatment while having satisfactory embedding properties at the time of thermocompression bonding.

Industrial Applicability

[0121] As shown from the results given above, since the adhesive composition according to the present invention has satisfactory embedding properties at the time of thermocompression bonding and can suppress bleeding at the time of high-temperature pressurization treatment, a film-form adhesive obtained by forming the adhesive composition into a film form can be useful as a film over die (FOD), which is a chip-embedded type film-form adhesive, or a film over wire (FOW), which is a wire-embedded type film-form adhesive.

Reference Signs List

[0122] 10: film-form adhesive, 14: substrate, 20: base material, 30:

protective film, 41: adhesive, 42: sealing material, 84, 94: circuit pattern, 88: first wire, 90: organic substrate, 98: second wire, 100, 110: adhesive sheet, 200: semiconductor device, Wa: first semiconductor element, Waa: second semiconductor element.

CLAIMS

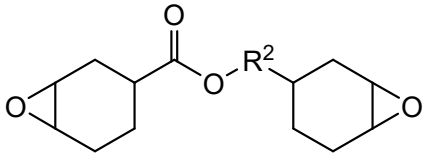
[Claim 1] An adhesive composition comprising a thermosetting resin, a curing agent, and an elastomer,

wherein the thermosetting resin includes an epoxy resin having an alicyclic ring,

the curing agent comprises a phenolic resin,

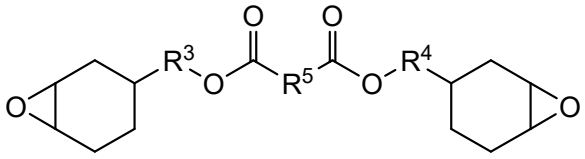
the elastomer comprises an acrylic resin having a carboxy group, and

the epoxy resin having an alicyclic ring is an epoxy resin represented by the following general formula (2), an epoxy resin represented by the following general formula (3), or an epoxy resin represented by the following general formula (4),



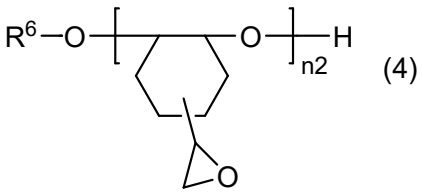
(2)

wherein R^2 represents a divalent hydrocarbon group,



(3)

wherein R^3, R^4, and R^5 each independently represent a divalent hydrocarbon group, and



(4)

wherein R^6 represents a hydrogen atom or a monovalent

hydrocarbon group; and n2 represents an integer from 1 to 10.

[Claim 2] The adhesive composition according to claim 1 , wherein the elastomer further comprises an elastomer having no carboxy group.

[Claim 3] The adhesive composition according to claim 1 or2, wherein the thermosetting resin further comprises an aromatic epoxy resin having no alicyclic ring.

[Claim 4] The adhesive composition according to claim 3, wherein the aromatic epoxy resin having no alicyclic ring is a liquid at 25°C.

[Claim 5] The adhesive composition according to any one of claims 1 to 4, further comprising an inorganic filler.

[Claim 6] The adhesive composition according to any one of claims 1 to 5, further comprising a curing accelerator.

[Claim 7] A film-form adhesive obtained by forming the adhesive composition according to any one of claims 1 to 6 into a film form.

[Claim 8] An adhesive sheet comprising:

a base material; and

the film-form adhesive according to claim 7 provided on the base material.

[Claim 9] The adhesive sheet according to claim 8, wherein the base material is a dicing tape.

[Claim 10] The adhesive sheet according to claim 8 or 9, further comprising a protective film laminated on the surface of the film-form adhesive on the opposite side of the base material.

[Claim 11] A method for producing a semiconductor device, the method comprising:

a wire bonding step of electrically connecting a first semiconductor element onto a substrate by means of a first wire;

a lamination step of sticking the film-form adhesive according to claim 7 on one side of a second semiconductor element; and

a die bonding step of subjecting the second semiconductor element having the film-form adhesive stuck thereto, to compression-bonding by means of the film-form adhesive, and thereby embedding at least a portion of the first wire in the film-form adhesive.