DESCRIPTION

Title of Invention: ADHESIVE FILM FOR SEMICONDUCTOR, METHOD FOR MANUFACTURING SAME, DICING DIE-BONDING INTEGRATED FILM, AND METHOD FOR MANUFACTURING SEMICONDUCTOR DEVICE

Technical Field

[0001] The present disclosure relates to an adhesive film for a semiconductor and a method for manufacturing the same, a dicing/die bonding integrated film, and a method for manufacturing a semiconductor device.

Background Art

[0002] Stacked MCPs (Multi Chip Packages) with increased capacity by semiconductor chips stacked in multiple stages have become widespread. Examples of the stacked MCP include wire-embedded type and chip-embedded type semiconductor packages. The structure of a semiconductor package in which wires are embedded by an adhesive film for a semiconductor may be referred to as FOW (Film Over Wire). The structure of a semiconductor package in which a semiconductor chip is embedded by an adhesive film for a semiconductor may be referred to as FOD (Film Over Die). As an example of a semiconductor package employing FOD, one having a controller chip disposed at the lowest stage and an adhesive film for a semiconductor embedding the controller chip is known (refer to Patent Literature 1).

Citation List

Patent Literature

[0003] [Patent Literature 1] JP 2014-175459 A

Summary of Invention

Technical Problem

[0004] In the manufacture of a semiconductor package having an FOD or FOW structure, it is required that wires or semiconductor chips be sufficiently embedded by an adhesive film. The adhesive film tends to undergo a rapid decrease in viscosity of the adhesive film for a semiconductor upon heating (for example, at 60 to 150°C). Although the adhesive film with reduced viscosity can exhibit good embedding properties, if the viscosity is reduced excessively, problems such as a phenomenon called bleed, in which the adhesive film protrudes from the edge of the semiconductor chip, may occur.

[0005] Therefore, the present disclosure has as its main object to provide an adhesive film for a semiconductor capable of suppressing a decrease in viscosity due to heating without significantly changing the types and amounts of raw materials.

Solution to Problem

[0006] As a result of intensive studies by the present inventors, it has been found that by applying a predetermined modified elastomer as a contained component of the adhesive film for a semiconductor, it is possible to suppress a decrease in viscosity of the adhesive film for a semiconductor due to heating without significantly changing the types and amounts of raw materials, and the invention of the present disclosure has been completed.

[0007] The present disclosure provides an adhesive film for a semiconductor described in [1] to [5], a method for manufacturing an adhesive film for a semiconductor described in [6], a dicing/die bonding

integrated film described in [7], and methods for manufacturing a semiconductor device described in [8] and [9].

[1] An adhesive film for a semiconductor, containing an epoxy resin, a phenol resin, and a modified elastomer,

wherein the modified elastomer is a reaction product of an elastomer having an epoxy group and a phenol resin.

[2] The adhesive film for a semiconductor according to [1], further containing an elastomer.

[3] The adhesive film for a semiconductor according to [2], further containing an inorganic filler.

[4] The adhesive film for a semiconductor according to any one of [1] to [3], used for bonding a semiconductor chip to a substrate while embedding another semiconductor chip.

[5] The adhesive film for a semiconductor according to any one of [1] to [3], used for bonding a semiconductor chip to another semiconductor chip while embedding part or all of a wire connected to the other semiconductor chip.

[6] A method for manufacturing an adhesive film for a semiconductor, comprising:

reacting an elastomer having an epoxy group with a phenol resin to obtain a modified elastomer;

mixing an epoxy resin, a phenol resin, and the obtained modified elastomer to obtain an adhesive composition containing the epoxy resin, the phenol resin, and the modified elastomer; and

forming an adhesive film for a semiconductor using the obtained adhesive composition.

[7] A dicing/die bonding integrated film, comprising:

a dicing film; and

the adhesive film for a semiconductor according to any one of [1] to [3], provided on the dicing film.

[8] A method for manufacturing a semiconductor device, comprising bonding a second semiconductor chip to a substrate on which a first semiconductor chip is mounted, with the adhesive film for a semiconductor according to any one of [1] to [3],

wherein the first semiconductor chip is embedded by the adhesive film for a semiconductor.

[9] A method for manufacturing a semiconductor device, comprising bonding a second semiconductor chip to a first semiconductor chip with the adhesive film for a semiconductor according to any one of [1] to [3],

wherein a wire is connected to the first semiconductor chip, and

wherein part or all of the wire is embedded by the adhesive film for a semiconductor.

Advantageous Effects of Invention

[0008] According to the present disclosure, an adhesive film for a semiconductor capable of suppressing a decrease in viscosity due to heating without significantly changing the types and amounts of raw materials is provided. In addition, according to the present disclosure, a dicing/die bonding integrated film using such an adhesive film for a semiconductor is provided. Further, according to the present disclosure, a method for manufacturing a semiconductor device using such a dicing/die bonding integrated film is provided.

Brief Description of Drawings

[0009] [FIG. 1] FIG. 1 is a schematic cross-sectional view illustrating one embodiment of an adhesive film.

[FIG. 2] FIG. 2 is a schematic cross-sectional view illustrating one embodiment of a laminate including an adhesive film.

[FIG. 3] FIG. 3 is a schematic cross-sectional view illustrating one embodiment of a laminate including an adhesive film.

[FIG. 4] FIG. 4 is a schematic cross-sectional view illustrating one embodiment of a semiconductor device.

[FIG. 5] FIG. 5 is a process diagram illustrating one embodiment of a method for manufacturing a semiconductor device.

[FIG. 6] FIG. 6 is a process diagram illustrating one embodiment of a method for manufacturing a semiconductor device.

[FIG. 7] FIG. 7 is a process diagram illustrating one embodiment of a method for manufacturing a semiconductor device.

[FIG. 8] FIG. 8 is a process diagram illustrating one embodiment of a method for manufacturing a semiconductor device.

[FIG. 9] FIG. 9 is a process diagram illustrating one embodiment of a method for manufacturing a semiconductor device.

[FIG. 10] FIG. 10 is a schematic cross-sectional view illustrating another embodiment of a semiconductor device.

[FIG. 11] FIG. 11 is a schematic cross-sectional view illustrating another embodiment of a semiconductor device.

[FIG. 12] FIG. 12 is a graph showing changes in viscosity of the adhesive films of Examples 1 and 2 and Comparative Example 1.

Description of Embodiments

[0010] The present disclosure is not limited to the following examples.

In the following examples, the constituents thereof (also including steps and the like) are not essential, unless otherwise specified. The sizes of the constituents in each of the drawings are conceptual, and a relative relationship of the size between the constituents is not limited to that illustrated in each of the drawings. The numerical values and ranges thereof exemplified below also do not limit the present disclosure.

[0011] In the present specification, a numerical range represented by using "to" includes numerical values described before and after "to" as the minimum value and the maximum value, respectively. In numerical ranges described in stages in the present specification, the upper limit value or the lower limit value described in one numerical range may be replaced with the upper limit value or the lower limit value of a numerical range described in another stage. In the numerical range described in the present specification, the upper limit value or the lower limit value of the numerical range may be replaced with values described in Examples.

[0012] In the present specification, "(meth)acrylate" indicates an acrylate or a methacrylate corresponding thereto. The same also applies to other similar expressions such as a (meth)acrylic acid ester, a (meth)acryloyl group, and a (meth)acrylic copolymer.

[0013] Each of the materials exemplified below may be used alone, or two or more types thereof may be used in combination, unless otherwise specified. In a case where there are a plurality of substances corresponding to each component in a composition, the content of each component in the composition indicates the total amount of the plurality of substances present in the composition, unless otherwise specified.

[0014] [Adhesive Film for a semiconductor (Adhesive Film) and Method for Manufacturing Same]

FIG. 1 is a schematic cross-sectional view illustrating one embodiment of an adhesive film. An adhesive film 10 illustrated in FIG. 1 contains an epoxy resin (hereinafter, may be referred to as "component (A)"), a phenol resin (hereinafter, may be referred to as "component (B)"), and a modified elastomer (hereinafter, may be referred to as "component (C)"). The adhesive film 10 may contain, in addition to the component (A), the component (B), and the component (C), an elastomer (hereinafter, may be referred to as "component (D)"), an inorganic filler (hereinafter, may be referred to as "component (E)"), a curing accelerator (hereinafter, may be referred to as "component (F)"), a coupling agent (hereinafter, may be referred to as "component (G)"), other components, and the like. The adhesive film 10 may be a film formed from an adhesive composition containing the component (A), the component (B), the component (C), and the like. The adhesive film 10 may be in a semi-cured (B-stage) state. The adhesive film 10 can be in a cured (C-stage) state after a curing treatment.

[0015] Component (A): Epoxy Resin

Examples of the component (A) 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 biphenyl aralkyl-type epoxy resin; a naphthalene-type epoxy resin; diglycidyl ether compounds of polyfunctional phenols and polycyclic aromatics such as anthracene, and the like. Among them, the component (A) may include a cresol novolac-type epoxy resin, a bisphenol F-type epoxy resin, a bisphenol A-type epoxy resin, or a combination thereof, from the viewpoint of the tackiness, flexibility, and the like of the film.

[0016] The component (A) may include a liquid epoxy resin that is liquid at 30°C (an epoxy resin having a softening point of 40°C or lower). That is, the component (A) may be a combination of a liquid epoxy resin and a solid epoxy resin that is solid at 30°C (an epoxy resin having a softening point exceeding 40°C). Note that in the present specification, the softening point indicates a value measured by a ring-and-ball method in accordance with JIS K7234:1986. The content of the liquid epoxy resin may be 3 to 20% by mass, on the basis of the total amount of the adhesive film. When the component (A) contains the liquid epoxy resin, there is a tendency that the flexibility of the adhesive film is improved. In addition, by combining the liquid epoxy resin and the solid epoxy resin, there is a tendency that the embedding properties of the semiconductor chip and the wire are improved.

[0017] Examples of commercially available products of the liquid epoxy resin include EXA-830CRP (product name, manufactured by DIC Corporation, liquid at 30°C), YDF-8170C (product name, manufactured by NIPPON STEEL Chemical & Material Co., Ltd., liquid at 30°C), EP-4088S (product name, manufactured by ADEKA Corporation, liquid at 30°C), and the like.

[0018] The epoxy equivalent of the component (A) is not particularly limited, and may be 90 to 300 g/eq or 110 to 290 g/eq. In a case where the epoxy equivalent of the component (A) is in such a range, there is a tendency that it is easy to ensure the fluidity of the adhesive composition when forming the adhesive film while maintaining the bulk strength of the adhesive film.

[0019] Component (B): Phenol Resin

Examples of the component (B) include a novolac-type phenol resin obtained by the condensation or the cocondensation of phenols such as phenol, cresol, resorcine, catechol, bisphenol A, bisphenol F, phenyl phenol, and aminophenol and/or naphthols such as α-naphthol, β-naphthol, and dihydroxynaphthalene, and a compound having an aldehyde group, such as formaldehyde, under an acidic catalyst, a phenol aralkyl resin and a naphthol aralkyl resin synthesized from phenols and/or naphthols such as allylated bisphenol A, allylated bisphenol F, allylated naphthalene diol, phenol novolac, and phenol, and dimethoxyparaxylene or bis(methoxymethyl)biphenyl. The component (B) may include a phenyl aralkyl-type phenol resin, a phenol novolac resin, or a combination thereof.

[0020] The hydroxyl equivalent of the component (B) may be 70 g/eq or more, or 70 to 300 g/eq. In a case where the hydroxyl equivalent of the phenol resin is 70 g/eq or more, there is a tendency that the storage modulus of the adhesive film further increases. In a case where the hydroxyl equivalent of the phenol resin is 300 g/eq or less, the occurrence of foaming and outgassing can be further suppressed.

[0021] Examples of commercially available products of the component

(B) include PSM-4326 (product name, manufactured by Gunei Chemical Industry Co., Ltd., softening point: 120°C), J-DPP-140 (product name, manufactured by JFE Chemical Corporation, softening point: 140°C), GPH-103 (product name, manufactured by Nippon Kayaku Co., Ltd., softening point: 99 to 106°C), MEH-7800M (product name, manufactured by Meiwa Plastic Industries, Ltd., softening point: 80°C), J-DPP-85 (product name, manufactured by JFE Chemical Corporation, softening point: 85°C), MEH-5100-5S (product name, manufactured by Meiwa Plastic Industries, Ltd., softening point: 65°C), and the like.

[0022] A ratio of the epoxy equivalent of the component (A) to the hydroxyl equivalent of the component (B) (epoxy equivalent:hydroxyl equivalent), from the viewpoint of curability, 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. In a case where the equivalent ratio is 0.30/0.70 or more, there is a tendency that more sufficient curability is obtained. In a case where the equivalent ratio is 0.70/0.30 or less, it is possible to prevent the viscosity from excessively increasing, and obtain more sufficient fluidity.

[0023] The softening point of the component (B) may be 50 to 200°C or 60 to 150°C. The component (B) having a softening point of 200°C or lower tends to have good compatibility with the component (A).

[0024] The total content of the component (A) and the component (B) may be 5% by mass or more, on the basis of the total amount of the adhesive film, and may be 10% by mass or more, 15% by mass or more, 20% by mass or more, 25% by mass or more, 30% by mass or more,

35% by mass or more, or 40% by mass or more. In a case where the total content of the component (A) and the component (B) is 15% by mass or more, on the basis of the total amount of the adhesive film, there is a tendency that the adhesive strength of the adhesive film is improved. The total content of the component (A) and the component (B) may be 80% by mass or less, 75% by mass or less, 70% by mass or less, 65% by mass or less, or 60% by mass or less, on the basis of the total amount of the adhesive film, from the viewpoint of film formability.

[0025] Component (C): Modified Elastomer

The component (C) is a reaction product obtained by reacting an elastomer having an epoxy group (or a glycidyl group) with a phenol resin. The modified elastomer can also be described as a modified product in which at least a part of the epoxy groups of the elastomer having an epoxy group has been modified by the phenol resin. When the adhesive film contains the component (C), it becomes possible to suppress a decrease in viscosity due to heating. In addition, the component (C) can be obtained by using the above-described component (B) and the component (D) described below, and there is no need to significantly change the types and amounts of raw materials. Therefore, by using the component (C), it becomes possible to suppress the occurrence of adverse effects on the initial viscosity, mechanical properties in the semi-cured (B-stage) state, curing behavior, and the like, which may be caused by a change in the composition of the adhesive film.

[0026] Examples of the elastomer having an epoxy group include resins having an epoxy group among the resins exemplified in the component

(D) described below, and the like. The elastomer having an epoxy group may include, for example, an acrylic resin having an epoxy group. The acrylic resin having an epoxy group indicates a polymer having a monomer unit derived from a (meth)acrylic acid ester and having a monomer unit derived from a (meth)acrylic acid ester having an epoxy group. The content of the constitutional unit derived from the (meth)acrylic acid ester in the acrylic resin having an epoxy group may be, for example, 70% by mass or more, 80% by mass or more, or 90% by mass or more, on the basis of the total amount of the acrylic resin. The elastomer as the component (D) described below and the elastomer having an epoxy group used in the synthesis of the modified elastomer may be the same or different.

[0027] The glass transition temperature (Tg) of the elastomer having an epoxy group may be -50°C or higher, -30°C or higher, 0°C or higher, or 3°C or higher, and may be 50°C or lower, 45°C or lower, 40°C or lower, 35°C or lower, 30°C or lower, or 25°C or lower. In the present specification, the glass transition temperature (Tg) indicates a value measured using a DSC (differential scanning calorimeter) (for example, "Thermo Plus 2" manufactured by Rigaku Corporation). The Tg of the elastomer having an epoxy group can be adjusted to a desired range by adjusting the types and contents of the constitutional units constituting the elastomer having an epoxy group (in the case of an acrylic resin, the constitutional units derived from the (meth)acrylic acid ester).

[0028] The weight average molecular weight (Mw) of the elastomer having an epoxy group may be 100,000 or more, 200,000 or more, or 300,000 or more, and may be 3,000,000 or less, 2,000,000 or less, or

1,000,000 or less. In the present specification, Mw indicates a value measured by gel permeation chromatography (GPC) and converted using a calibration curve of standard polystyrene.

[0029] Examples of commercially available products of the acrylic resin having an epoxy group include WS-023 EK30, SG-280 EK23, and SG-P3 (all manufactured by Nagase ChemteX Corporation), and H-CT-865 (manufactured by Resonac Corporation).

[0030] Examples of the phenol resin include the same ones as the above-described component (B). The phenol resin as the component (B) and the phenol resin used in the synthesis of the modified elastomer may be the same or different.

[0031] The component (C) can be obtained, for example, by mixing or kneading an elastomer having an epoxy group and a phenol resin in the presence or absence of a solvent to cause a reaction.

[0032] When reacting an elastomer having an epoxy group with a phenol resin, the mass ratio of the phenol resin to the total of the elastomer having an epoxy group and the phenol resin can be arbitrarily adjusted depending on the epoxy equivalent and molecular weight of the elastomer having an epoxy group, the hydroxyl equivalent and molecular weight of the phenol resin, and the like. The mass ratio of the phenol resin to the total of the elastomer having an epoxy group and the phenol resin may be, for example, 1% by mass or more, 5% by mass or more, 10% by mass or more, 20% by mass or more, 30% by mass or more, 40% by mass or more, or 50% by mass or more, and may be 80% by mass or less, 70% by mass or less, 65% by mass or less, or 60% by mass or less.

[0033] Mixing or kneading can be performed using a disperser such as a general stirrer, a mortar machine, a three-roll mill, or a ball mill. Mixing or kneading may be performed by suitably combining a plurality of these dispersers.

[0034] When mixing or kneading is performed in the presence of a solvent, the solvent used for mixing or kneading is not particularly limited insofar as each component can be uniformly dissolved, kneaded, or dispersed, and a conventionally known solvent can be used. Examples of such a solvent include ketone-based solvents such as acetone, methyl ethyl ketone, methyl isobutyl ketone, and cyclohexanone; dimethylformamide; dimethylacetamide; N-methylpyrrolidone; toluene; xylene; and the like. The same solvent as that used for the preparation of the composition varnish may be used.

[0035] Mixing or kneading may be performed under heating conditions. The heating conditions can be arbitrarily adjusted depending on the type of the elastomer having an epoxy group, the type of the phenol resin, and the like. The heating conditions may be, for example, 50 to 150°C for 1 minute to 24 hours.

[0036] Mixing or kneading may be performed with the addition of a curing accelerator as necessary. Examples of the curing accelerator include the same ones as the component (F) described below. The content of the curing accelerator may be, for example, 0.01 to 1% by mass, on the basis of the total amount of the elastomer having an epoxy group and the phenol resin.

[0037] The content of the component (C) may be 0.1% by mass or more, on the basis of the total amount of the adhesive film, and may be 0.3% by

mass or more, 0.5% by mass or more, 1% by mass or more, 2% by mass or more, or 3% by mass or more. In a case where the content of the component (C) is 0.1% by mass or more, on the basis of the total amount of the adhesive film, there is a tendency that the decrease in viscosity of the adhesive film for a semiconductor due to heating can be further suppressed. The content of the component (C) may be 20% by mass or less, 15% by mass or less, 10% by mass or less, 7% by mass or less, or 5% by mass or less, on the basis of the total amount of the adhesive film.

[0038] Component (D): Elastomer

The component (D) may be, for example, a polymer compound exhibiting a glass transition temperature (Tg) of 55°C or lower. Examples of the component (D) include an acrylic resin, a polyester resin, a polyamide resin, a polyimide resin, a silicone resin, a butadiene resin, an acrylonitrile resin, and the like.

[0039] The component (D) may include an acrylic resin from the viewpoint of fluidity. Here, the acrylic resin indicates a polymer having a monomer unit derived from a (meth)acrylic acid ester. The content of the constitutional unit derived from the (meth)acrylic acid ester in the acrylic resin may be, for example, 70% by mass or more, 80% by mass or more, or 90% by mass or more, on the basis of the total amount of the acrylic resin. The acrylic resin may include a monomer unit derived from a (meth)acrylic acid ester having a cross-linkable functional group such as an epoxy group, an alcoholic or phenolic hydroxyl group, and a carboxyl group. The acrylic resin may be an acrylic rubber that is a copolymer having a (meth)acrylic acid ester and acrylonitrile as monomer units.

[0040] The glass transition temperature (Tg) of the component (D) (for example, an acrylic resin) may be -50°C or higher, -30°C or higher, 0°C or higher, or 3°C or higher, and may be 50°C or lower, 45°C or lower, 40°C or lower, 35°C or lower, 30°C or lower, or 25°C or lower. In a case where the Tg of the component (D) is low, there is a tendency that the adhesive film tends to have good flexibility. An adhesive film having good flexibility tends to be easily cut together with a semiconductor wafer during dicing, whereby the occurrence of burrs can be effectively suppressed. An adhesive film having good flexibility tends to be easily attached to a semiconductor wafer while sufficiently eliminating voids, and chipping during dicing due to a decrease in adhesiveness can also be suppressed. The Tg of the component (D) can be adjusted to a desired range by adjusting the types and contents of the constitutional units constituting the component (D) (in the case of an acrylic resin, the constitutional units derived from the (meth)acrylic acid ester).

[0041] The weight average molecular weight (Mw) of the component (D) (for example, an acrylic resin) may be 100,000 or more, 200,000 or more, or 300,000 or more, and may be 3,000,000 or less, 2,000,000 or less, or 1,000,000 or less. In a case where the Mw of the component (D) is in such a range, it is possible to appropriately control the film formability and the strength, flexibility, tackiness, and the like of the adhesive film, and it is also possible to achieve excellent reflow properties and improve the embedding properties.

[0042] Examples of commercially available products of the acrylic resin include SG-70L, SG-708-6, WS-023 EK30, SG-280 EK23, and SG-P3 (all manufactured by Nagase ChemteX Corporation), and H-CT-865

(manufactured by Resonac Corporation).

[0043] The content of the component (D) may be 3% by mass or more, 5% by mass or more, 8% by mass or more, or 10% by mass or more, on the basis of the total amount of the adhesive film. In a case where the content of the component (D) is 3% by mass or more, on the basis of the total amount of the adhesive film, the adhesive film has an increased viscosity, and improvement in the handleability of the film and suppression of the occurrence of bleed can be expected. The content of the component (D) may be 40% by mass or less, 30% by mass or less, 25% by mass or less, or 20% by mass or less, on the basis of the total amount of the adhesive film. In a case where the content of the component (D) is 40% by mass or less, on the basis of the total amount of the adhesive film, there is a tendency that the embedding properties are further improved.

[0044] The total content of the component (C) and the component (D) may be 3% by mass or more, 5% by mass or more, 8% by mass or more, or 10% by mass or more, and may be 40% by mass or less, 30% by mass or less, 25% by mass or less, or 20% by mass or less, since the decrease in viscosity of the adhesive film for a semiconductor due to heating can be further suppressed.

[0045] The mass ratio of the component (C) to the total of the component (C) and the component (D) may be 1% by mass or more, 5% by mass or more, 10% by mass or more, or 15% by mass or more, and may be 60% by mass or less, 50% by mass or less, 40% by mass or less, or 30% by mass or less, since the decrease in viscosity of the adhesive film for a semiconductor due to heating can be further suppressed.

[0046] Component (E): Inorganic Filler

Examples of the component (E) include aluminum hydroxide, magnesium hydroxide, calcium carbonate, magnesium carbonate, calcium silicate, magnesium silicate, calcium oxide, magnesium oxide, aluminum oxide, aluminum nitride, aluminum borate whisker, boron nitride, silica, and the like. The component (E) may include silica from the viewpoint of adjusting the melt viscosity.

[0047] The average particle size of the component (E) may be 0.01 μm (10 nm) or more, 0.03 μm (30 nm) or more, 0.05 μm (50 nm) or more, or 0.1 μm (100 nm) or more, and may be 1.5 μm (1500 nm) or less, 1.0 μm (1000 nm) or less, 0.8 μm (800 nm) or less, or 0.6 μm (600 nm) or less, from the viewpoint of fluidity. Two or more types of the component (E) having different average particle sizes may be used in combination. Here, the average particle size indicates a particle size at a cumulative frequency of 50% in a particle size distribution obtained by a laser diffraction/scattering method. Note that the average particle size of the component (E) can also be determined by using the adhesive film containing the component (E). In this case, the average particle size of the component (E) can be determined from a particle size distribution obtained by heating the adhesive film to decompose the resin components to obtain a residue, dispersing the residue in a solvent to prepare a dispersion liquid, and applying the laser diffraction/scattering method thereto.

[0048] The content of the component (E) is 5 to 50% by mass, on the basis of the total amount of the adhesive film, and may be 10% by mass or more, 12% by mass or more, 15% by mass or more, 18% by mass or

more, 20% by mass or more, or 25% by mass or more, and may be 45% by mass or less, 40% by mass or less, or 35% by mass or less.

[0049] The content of the component (E) may be 5 to 200 parts by mass relative to 100 parts by mass of the total of the component (A) and the component (B). In a case where the content of the component (E) is in such a range, there is a tendency that the adhesive strength of the adhesive film is improved. The content of the component (E) may be 10 parts by mass or more, 20 parts by mass or more, 30 parts by mass or more, or 40 parts by mass or more, and may be 150 parts by mass or less, 120 parts by mass or less, 100 parts by mass or less, or 80 parts by mass or less, relative to 100 parts by mass of the total of the component (A) and the component (B).

[0050] Component (F): Curing Accelerator

Examples of the component (F) include imidazoles and derivatives thereof, organic phosphorus-based compounds, secondary amines, tertiary amines, quaternary ammonium salts, and the like. Among them, the component (F) may be the imidazoles and the derivatives thereof from the viewpoint of reactivity.

[0051] Examples of the imidazoles include 2-methylimidazole, 1-benzyl-2-methylimidazole, 1-cyanoethyl-2-phenylimidazole, 1-cyanoethyl-2-methylimidazole, and the like.

[0052] Component (G): Coupling Agent

The component (G) may be a silane coupling agent. Examples of the silane coupling agent include γ-ureidopropyltriethoxysilane, γ-mercaptopropyltrimethoxysilane, 3-phenylaminopropyltrimethoxysilane,

3-(2-aminoethyl)aminopropyltrimethoxysilane, and the like.

[0053] The adhesive film may further contain other components. Examples of the other components include a pigment, an ion scavenger, an antioxidant, and the like.

[0054] The total content of the component (F), the component (G), and the other components may be 0.1% by mass or more, 0.3% by mass or more, or 0.5% by mass or more, and may be 30% by mass or less, 20% by mass or less, 10% by mass or less, or 5% by mass or less, on the basis of the total amount of the adhesive film.

[0055] The adhesive film 10 can be formed, for example, by applying an adhesive composition containing each component to a support film. In forming the adhesive film 10, a varnish of the adhesive composition (a composition varnish) may be used. In the case of using the composition varnish, the adhesive film 10 can be obtained by mixing or kneading each component to be added in a solvent to prepare the composition varnish, applying the obtained composition varnish to a support film, and removing the solvent by heating and drying.

[0056] The support film is not particularly limited insofar as it can withstand the above-described heating and drying. Examples of the support film include resin films such as a polyester film, a polyethylene film, a polypropylene film, a polyethylene terephthalate film, a polyimide film, a polyetherimide film, a polyethylene naphthalate film, a polymethylpentene film, and a polytetrafluoroethylene film. The support film may be a multilayer film combining two or more types, or may be one whose surface has been treated with a release agent such as a silicone-based or silica-based release agent. The thickness of the

support film may be, for example, 10 to 200 μm or 20 to 170 μm.

[0057] Mixing or kneading can be performed using a disperser such as a general stirrer, a mortar machine, a three-roll mill, or a ball mill. Mixing or kneading may be performed by suitably combining a plurality of these dispersers.

[0058] The solvent used for the preparation of the composition varnish is not particularly limited insofar as each component can be uniformly dissolved, kneaded, or dispersed, and a conventionally known solvent can be used. Examples of such a solvent include ketone-based solvents such as acetone, methyl ethyl ketone, methyl isobutyl ketone, and cyclohexanone; dimethylformamide; dimethylacetamide; N-methylpyrrolidone; toluene; xylene; and the like. The solvent may be methyl ethyl ketone or cyclohexanone from the viewpoint of drying speed and cost.

[0059] As a method for applying the composition varnish to the support film, a known method can be used, and for example, 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 can be used. The heating and drying conditions are not particularly limited insofar as the used solvent is sufficiently volatilized, and may be, for example, 50 to 150°C for 1 to 30 minutes.

[0060] The method for manufacturing the adhesive film 10 may include, for example, reacting an elastomer having an epoxy group with a phenol resin to obtain a modified elastomer, mixing an epoxy resin, a phenol resin, and the obtained modified elastomer to obtain an adhesive composition containing the epoxy resin, the phenol resin, and the

modified elastomer, and forming an adhesive film for a semiconductor using the obtained adhesive composition.

[0061] The viscosity of the adhesive film at 60°C may be, for example, 100 to 800 Pa·s from the viewpoint of bleed suppression. The viscosity of the adhesive film at 60°C may be 150 Pa·s or more, 200 Pa·s or more, 250 Pa·s or more, 300 Pa·s or more, or 350 Pa·s or more, and may be 750 Pa·s or less, 700 Pa·s or less, 650 Pa·s or less, 600 Pa·s or less, or 550 Pa·s or less.

[0062] The viscosity of the adhesive film at 120°C may be, for example, 60 Pa·s or more, 70 Pa·s or more, 80 Pa·s or more, 90 Pa·s or more, or 100 Pa·s or more, from the viewpoint of bleed suppression. The viscosity of the adhesive film at 120°C may be, for example, 300 Pa·s or less, 250 Pa·s or less, or 200 Pa·s or less.

[0063] The ratio of the viscosity at 120°C to the viscosity at 60°C (viscosity at 120°C/viscosity at 60°C) may be, for example, 0.14 or more, 0.16 or more, 0.18 or more, 0.20 or more, or 0.22 or more, from the viewpoint of bleed suppression.

[0064] The temperature at which the viscosity becomes 100 Pa·s or less may be, for example, 100°C or higher, 105°C or higher, 110°C or higher, 115°C or higher, or 120°C or higher, from the viewpoint of bleed suppression.

[0065] The viscosity of the adhesive film at 60°C and the viscosity at 120°C indicate values measured by, for example, the following method. A plurality of adhesive films are heated on a hot plate and laminated with a roller to form a laminate having a thickness of approximately 1 mm. A measurement sample having a circular surface with a diameter of 20 mm

is punched out from the laminate. The measurement sample is mounted on a circular disposable cone/plate jig with a diameter of 20 mm. The viscosity of the measurement sample is measured using a rheometer (for example, HAAKE rheostress 600 (manufactured by Thermo Scientific)) under the following conditions. From the measurement results, the values at 60°C and 120°C are read, and the respective values are taken as the viscosity at 60°C and the viscosity at 120°C.

(Measurement Conditions)

· Mode: strain application mode

· Measurement temperature: 55 to 150°C

· Temperature increase rate: 10°C/min

· Strain: 5%

· Frequency: 4 Hz

[0066] The thickness of the adhesive film 10 may be, for example, 1 μm or more, 3 μm or more, 20 μm or more, 25 μm or more, 30 μm or more, 35 μm or more, 40 μm or more, 50 μm or more, 60 μm or more, 70 μm or more, or 80 μm or more, and may be 200 μm or less, 150 μm or less, 120 μm or less, 100 μm or less, 80 μm or less, or 60 μm or less. In a case where the adhesive film 10 is an adhesive film for FOD, the thickness of the adhesive film 10 may be, for example, 40 to 200 μm, 60 to 150 μm, or 80 to 120 μm, in order to appropriately embed the entire semiconductor chip (for example, a controller chip). In a case where the adhesive film 10 is an adhesive film for FOW, the thickness of the adhesive film 10 may be, for example, 20 to 120 μm, 25 to 80 μm, or 30 to 60 μm, in order to embed the wire so that the wire does not come into contact with the semiconductor chip.

[0067] The adhesive film 10 prepared on the support film may include a cover film on the surface of the adhesive film opposite to the support film, from the viewpoint of preventing damage or contamination. Examples of the cover film include a polyethylene film, a polypropylene film, a surface release agent-treated film, and the like. The thickness of the cover film may be, for example, 15 to 200 μm or 30 to 170 μm.

[0068] The adhesive film 10 can be used, for example, as a protective sheet for protecting the back surface of a semiconductor chip of a flip-chip type semiconductor device, or as a sealing sheet for sealing a gap between the surface of a semiconductor chip of a flip-chip type semiconductor device and an adherend.

[0069] [Dicing/Die Bonding Integrated Film]

FIG. 2 and FIG. 3 are schematic cross-sectional views illustrating one embodiment of a laminate including an adhesive film. The adhesive film 10 may be supplied in the form of a laminate illustrated in FIG. 2 or FIG. 3. A laminate 100 illustrated in FIG. 2 includes a base material layer 20 and the adhesive film 10 provided on the base material layer 20. A laminate 110 illustrated in FIG. 3 further includes a protective film 30 provided on the surface of the adhesive film 10 of the laminate 100 on the side opposite to the base material layer 20.

[0070] The base material layer 20 may be a resin film similar to the support film. The thickness of the base material layer 20 may be, for example, 10 to 200 μm or 20 to 170 μm.

[0071] The base material layer 20 may be a dicing film. A laminate in which the base material layer 20 is a dicing film can be used as a dicing/die bonding integrated film. The dicing/die bonding integrated

film can be described as one including a dicing film and the adhesive film 10 provided on the dicing film. The dicing/die bonding integrated film may be in the shape of a film, a sheet, or a tape.

[0072] Examples of the dicing film include resin films such as a polytetrafluoroethylene film, a polyethylene terephthalate film, a polyethylene film, a polypropylene film, a polymethylpentene film, and a polyimide film. The dicing film may be a resin film that has been surface-treated by primer application, UV treatment, corona discharge treatment, grinding treatment, or etching treatment, as necessary. The dicing film may have adhesiveness. A dicing film having adhesiveness may be, for example, a resin film to which adhesiveness has been imparted, or a laminated film having a resin film and a pressure-sensitive adhesive layer provided on one surface thereof. The pressure-sensitive adhesive layer can be formed from a non-ultraviolet curable or ultraviolet curable pressure-sensitive adhesive agent. A non-ultraviolet curable pressure-sensitive adhesive agent is a pressure-sensitive adhesive agent that exhibits a certain adhesiveness under short-time pressurization. An ultraviolet curable pressure-sensitive adhesive agent is a pressure-sensitive adhesive agent having a property of decreasing in adhesiveness upon irradiation with ultraviolet rays. The thickness of the pressure-sensitive adhesive layer can be appropriately set according to the shape and dimensions of the semiconductor device, and may be, for example, 1 to 100 μm, 5 to 70 μm, or 10 to 40 μm. The thickness of the base material layer 20 that is a dicing film may be 60 to 150 μm or 70 to 130 μm from the viewpoint of economic efficiency and handleability of the film.

[0073] The protective film 30 may be a resin film similar to the cover film. The thickness of the protective film 30 may be, for example, 15 to 200 μm or 30 to 170 μm.

[0074] [Semiconductor Device and Method for Manufacturing Same]

FIG. 4 is a schematic cross-sectional view illustrating one embodiment of a semiconductor device, and shows an example of a semiconductor device manufactured using an adhesive film. A semiconductor device 200 illustrated in FIG. 4 is mainly composed of a substrate 14, a first semiconductor chip Wa and a second semiconductor chip Waa mounted on the substrate 14, a sealing layer 42 sealing the second semiconductor chip Waa, and the adhesive film 10 bonding the second semiconductor chip Waa to the substrate 14. The substrate 14 has an organic substrate 90 and circuit patterns 84 and 94 provided on the organic substrate 90. The first semiconductor chip Wa is bonded to the substrate 14 by an adhesive agent 41. A first wire 88 is connected to the first semiconductor chip Wa, and the first semiconductor chip Wa is electrically connected to the circuit pattern 84 via the first wire 88. The entire first semiconductor chip Wa and the entire first wire 88 are embedded in the adhesive film 10. A second wire 98 is connected to the second semiconductor chip Waa, and the second semiconductor chip Waa is electrically connected to the circuit pattern 84 via the second wire 98. The entire second semiconductor chip Waa and the entire second wire 98 are embedded in the sealing layer 42.

[0075] FIG. 5, FIG. 6, FIG. 7, FIG. 8, and FIG. 9 are process diagrams illustrating one embodiment of a method for manufacturing a semiconductor device, and are process diagrams showing an example of

a method for manufacturing the semiconductor device 200 illustrated in FIG. 4. The method illustrated in FIGS. 5 to 9 includes bonding the first semiconductor chip Wa to the substrate 14 via the adhesive agent 41, providing the first wire 88 connecting the first semiconductor chip Wa and the substrate 14 (circuit pattern 84), preparing a chip with adhesive agent having the second semiconductor chip Waa and the adhesive film 10 attached thereto, pressing the chip with adhesive agent onto the substrate 14, thereby bonding the second semiconductor chip Waa to the substrate 14 such that the first semiconductor chip Wa and the first wire 88 are embedded by the adhesive film 10, and providing the second wire 98 connecting the second semiconductor chip Waa and the substrate 14 (circuit pattern 84). After that, the semiconductor device 200 illustrated in FIG. 4 can be obtained by forming the sealing layer 42.

[0076] The thickness of the first semiconductor chip Wa may be 10 to 170 μm. The first semiconductor chip Wa may be a controller chip for driving the semiconductor device 200. The first semiconductor chip Wa may be a flip-chip type chip. The size of the first semiconductor chip Wa is usually equal to or smaller than the size of the second semiconductor chip Waa. The adhesive agent 41 interposed between the first semiconductor chip Wa and the substrate 14 may be a known adhesive agent for a semiconductor used in the relevant field.

[0077] As illustrated in FIG. 5, the substrate 14 (circuit pattern 84) and the first semiconductor chip Wa are electrically connected via the first wire 88. The first wire 88 connecting the first semiconductor chip Wa and the substrate 14 (circuit pattern 84) may be, for example, a gold wire, an aluminum wire, or a copper wire. The heating temperature for

connecting the first wire 88 may be in the range of 80 to 250°C or 80 to 220°C. The heating time for connecting the first wire 88 may be several seconds to several minutes. For the connection of the first wire 88, vibrational energy due to ultrasonic waves and compression energy due to applied pressure may be applied.

[0078] The chip with adhesive agent consisting of the second semiconductor chip Waa and the adhesive film 10 can be prepared, for example, using a dicing/die bonding integrated film having a configuration similar to that of the laminate 100 illustrated in FIG. 2. In this case, for example, the laminate 100 (dicing/die bonding integrated film) is attached to one surface of a semiconductor wafer with the adhesive film 10 facing the semiconductor wafer. The surface to which the adhesive film 10 is attached may be the circuit surface of the semiconductor wafer or the back surface on the opposite side. By dicing the semiconductor wafer to which the laminate 100 (dicing/die bonding integrated film) is attached, the singulated second semiconductor chip Waa is formed. Examples of dicing include blade dicing using a rotary blade, and stealth dicing in which a modified region is formed in the semiconductor wafer by a laser, followed by expanding the base material layer. The second semiconductor chip Waa is picked up together with the divided adhesive film 10. In a case where the pressure-sensitive adhesive layer of the dicing film is formed of an ultraviolet curable pressure-sensitive adhesive agent, before picking up the second semiconductor chip Waa, the adhesive force of the pressure-sensitive adhesive layer may be reduced by irradiating the pressure-sensitive adhesive layer with ultraviolet rays as necessary.

[0079] The second semiconductor chip Waa may have a size with a width of 20 mm or less. The width (or the length of one side) of the second semiconductor chip Waa may be 3 to 15 mm or 5 to 10 mm.

[0080] The semiconductor wafer used to form the second semiconductor chip Waa may be, for example, a thin semiconductor wafer having a thickness of 10 to 100 μm. The semiconductor wafer may be a wafer of single-crystal silicon, polycrystalline silicon, various ceramics, or a compound semiconductor such as gallium arsenide. The second semiconductor chip Waa may also be formed from a similar semiconductor wafer.

[0081] As illustrated in FIG. 7, the chip with adhesive agent consisting of the adhesive film 10 and the second semiconductor chip Waa is placed such that the first wire 88 and the first semiconductor chip Wa are covered by the adhesive film 10. Next, as illustrated in FIG. 8, the second semiconductor chip Waa is fixed to the substrate 14 by pressing the second semiconductor chip Waa against the substrate 14. The heating temperature for pressing may be 50 to 200°C or 100 to 150°C. In a case where the heating temperature for pressing is high, the adhesive film 10 becomes soft, and there is a tendency that the embedding properties are improved. The pressing time may be 0.5 to 20 seconds or 1 to 5 seconds. The pressure for pressing may be 0.01 to 5 MPa or 0.02 to 2 MPa.

[0082] After pressing, the structure including the adhesive film 10 may be further heated to cure the adhesive film 10. The temperature and time for curing can be appropriately set depending on the curing temperature of the adhesive film 10 and the like. The temperature may be changed

stepwise. The heating temperature may be, for example, 40 to 300°C or 60 to 200°C. The heating time may be, for example, 30 to 300 minutes.

[0083] As illustrated in FIG. 9, the substrate 14 and the second semiconductor chip Waa are electrically connected via the second wire 98. The type and connection method of the second wire 98 may be the same as those of the first wire 88.

[0084] After that, a sealing layer 42 sealing the circuit pattern 84, the second wire 98, and the second semiconductor chip Waa is formed by a sealing material. The sealing layer 42 can be formed, for example, by a general method using a mold. After the sealing layer 42 is formed, the adhesive film 10 and the sealing layer 42 may be further thermally cured by heating. The heating temperature therefor may be, for example, 165 to 185°C, and the heating time may be approximately 0.5 to 8 hours.

[0085] FIG. 10 is a schematic cross-sectional view illustrating another embodiment of a semiconductor device. A semiconductor device 201 is mainly composed of a substrate 14, a first semiconductor chip Wa and a second semiconductor chip Waa mounted on the substrate 14, a sealing layer 42 sealing the first semiconductor chip Wa and the second semiconductor chip Waa, and the adhesive film 10 bonding the second semiconductor chip Waa to the first semiconductor chip Wa. The substrate 14 has an organic substrate 90, circuit patterns 84 and 94 provided on the organic substrate 90, and connection terminals 95 provided on the surface of the organic substrate 90 on the side opposite to the circuit patterns 84 and 94. The first semiconductor chip Wa is bonded to the substrate 14 by an adhesive agent 41. A first wire 88 is connected to the first semiconductor chip Wa, and the first

semiconductor chip Wa is electrically connected to the circuit pattern 84 via the first wire 88. A part of the first wire 88 is embedded in the adhesive film 10. A second wire 98 is connected to the second semiconductor chip Waa, and the second semiconductor chip Waa is electrically connected to the circuit pattern 84 via the second wire 98.

[0086] The semiconductor device 201 illustrated in FIG. 10 can be manufactured by a method similar to the method for manufacturing the semiconductor device 200, the method including bonding the second semiconductor chip Waa to the first semiconductor chip Wa by the adhesive film 10.

[0087] FIG. 11 is a schematic cross-sectional view illustrating another embodiment of a semiconductor device. A semiconductor device 202 is mainly composed of a substrate 14 (organic substrate 90), a first semiconductor chip Wa and a second semiconductor chip Waa mounted on the substrate 14, a sealing layer 42 sealing the first semiconductor chip Wa and the second semiconductor chip Waa, and the adhesive film 10 bonding the second semiconductor chip Waa to the substrate 14 while embedding the entire first semiconductor chip Wa. The first semiconductor chip Wa is a flip-chip type chip and is electrically connected to the substrate 14 via a plurality of electrodes 96. Underfill 50 is filled between the first semiconductor chip Wa and the substrate 14.

Examples

[0088] Hereinafter, the present disclosure will be described in detail on the basis of Examples, but the present disclosure is not limited thereto.

[0089] Synthesis Examples 1 to 3

[Synthesis and Physical Properties of Modified Elastomer]

<Synthesis of Modified Elastomer>

A cyclohexanone solution containing a modified elastomer was obtained by stirring an elastomer having an epoxy group, a phenol resin, a curing accelerator, and a solvent (cyclohexanone and the like) in the composition ratio (unit: parts by mass) shown in Table 1 under the reaction conditions shown in Table 1. Note that the numerical values of each component shown in Table 1 indicate parts by mass of solid content.

[0090] · Elastomer having an epoxy group

SG-P3 product with a changed solvent (product name, manufactured by Nagase ChemteX Corporation, acrylic resin, weight average molecular weight: 800,000, Tg: 12°C)

· Phenol resin

MEH-7800M (product name, manufactured by Meiwa Plastic Industries, Ltd. (currently UBE Corporation), phenyl aralkyl-type phenol resin, hydroxyl equivalent: 174 g/eq, softening point: 80°C)

· Curing accelerator

2PZ-CN (product name, manufactured by Shikoku Chemicals Corporation, 1-cyanoethyl-2-phenylimidazole)

[0091] <Physical Properties of Modified Elastomer>

(Actual Measurement of Concentration after Reaction)

A predetermined amount of the cyclohexanone solution containing the modified elastomer was weighed and heated at 160°C for 1 hour. The concentration of the cyclohexanone solution containing the modified elastomer was determined based on the amount of non-volatile content after heating. The results are shown in Table 1.

[0092] (Measurement of Viscosity)

The viscosity at 25°C was measured using the following apparatus and conditions. The results are shown in Table 1.

Apparatus: E-type viscometer (manufactured by Toki Sangyo Co., Ltd., RE-85R), rotor No. 4, rotation speed 10 rpm

Preheat: 2 minutes

Measurement time: 3 minutes

[0093] [Table 1]

	Synthesis Exam. 1	Synthesis Exam. 2	Synthesis Exam. 3
SG-P3 product with a changed solvent	12.20	12.20	12.20
MEH-7800M	17.36	17.36	6.94
2PZ-CN	0.05	0.08	0.02
Solvent	99.18	92.15	87.99
Reaction conditions	135°C, 8 hours	135°C, 8 hours	125°C, 9 hours → 135°C, 3 hours
Actual measured concentration after reaction (% by mass)	23.5	23.3	17.9
Viscosity (25°C) (Pa·s)	14.61	16.31	5.81

[0094] Examples 1 and 2 and Comparative Example 1

[Preparation and Evaluation of Adhesive Film]

<Preparation of Composition Varnish>

Composition varnishes of Examples 1 and 2 and Comparative Example 1 were prepared by stirring the component (A) to the component (G) and a solvent (cyclohexanone and the like) in the composition ratio (unit: parts by mass) shown in Table 2 until each

component became uniform. Note that the numerical values of each component shown in Table 2 indicate parts by mass of solid content.

[0095] Component (A): Epoxy Resin

(A-1) N-500P (product name, manufactured by DIC Corporation, o-cresol novolac-type epoxy resin, epoxy equivalent: 204 g/eq, softening point: 75 to 85°C)

(A-2) EXA-830CRP (product name, manufactured by DIC Corporation, liquid bisphenol F-type epoxy resin, epoxy equivalent: 159 g/eq)

Component (B): Phenol Resin

(B-1) MEH-7800M (product name, manufactured by Meiwa Plastic Industries, Ltd. (currently UBE Corporation), phenyl aralkyl-type phenol resin, hydroxyl equivalent: 174 g/eq, softening point: 80°C)

Component (C): Modified Elastomer

(C-1) Modified elastomer of Synthesis Example 1

Component (D): Elastomer

(D-1) SG-P3 product with a changed solvent (product name, manufactured by Nagase ChemteX Corporation, acrylic resin, weight average molecular weight: 800,000, Tg: 12°C)

Component (E): Inorganic Filler

(E-1) SC2050-HLG (product name, manufactured by Admatechs Company Limited, silica filler dispersion liquid, average particle size: 0.50 μm)

Component (F): Curing Accelerator

(F-1) 2PZ-CN (product name, manufactured by Shikoku

Chemicals Corporation, 1-cyanoethyl-2-phenylimidazole)

Component (G): Coupling Agent

(G-1) A-189 (product name, manufactured by Momentive Performance Materials Japan LLC, γ-mercaptopropyltrimethoxysilane)

(G-2) Z-6119 (product name, manufactured by Dow Toray Co., Ltd., 3-ureidopropyltriethoxysilane)

[0096] <Preparation of Adhesive Film>

The composition varnishes of Examples 1 and 2 and Comparative Example 1 were filtered through a 100-mesh filter and subjected to vacuum deaeration. A polyethylene terephthalate (PET) film with a thickness of 38 μm subjected to a release treatment was prepared as a base material layer, and the composition varnish after vacuum deaeration was applied onto the PET film. The applied composition varnish was heated and dried in two stages, at 90°C for 5 minutes and subsequently at 140°C for 5 minutes, to obtain adhesive films of Examples 1 and 2 and Comparative Example 1 in a B-stage state. For the adhesive films, the thickness was adjusted to 60 μm by the amount of the composition varnish applied. Two sheets of the obtained adhesive film with a thickness of 60 μm were prepared and laminated at 70°C to prepare an adhesive film with a thickness of 120 μm.

[0097] <Evaluation of Adhesive Film>

(Measurement of Viscosity Change)

The measurement of viscosity change was performed using the adhesive films of Examples 1 and 2 and Comparative Example 1. A plurality of adhesive films were heated on a hot plate and laminated with a roller to form a laminate having a thickness of approximately 1 mm. A

measurement sample having a circular surface with a diameter of 20 mm was punched out from the laminate. The measurement sample was mounted on a circular disposable cone/plate jig with a diameter of 20 mm. The viscosity of the measurement sample was measured using HAAKE rheostress 600 (manufactured by Thermo Scientific) under the following conditions. From the measurement results, the values at 60°C and 120°C were read, and the respective values were taken as the viscosity at 60°C and the viscosity at 120°C. The results are shown in Table 2.

Measurement Conditions

· Mode: strain application mode

· Measurement temperature: 55 to 150°C

· Temperature increase rate: 10°C/min

· Strain: 5%

· Frequency: 4 Hz

[0098] [Table 2]

		Comp. Exam. 1	Exam. 1	Exam. 2
(A)	(A-1)	15.36	15.36	15.36
	(A-2)	14.27	14.27	14.27
(B)	(B-1)	23.86	23.86	23.86
(C)	(C-1)	-	5.00	10.00
(D)	(D-1)	16.77	11.77	6.77
(E)	(E-1)	29.40	29.40	29.40
(F)	(F-1)	0.07	0.07	0.07
(G)	(G-1)	0.09	0.09	0.09
	(G-2)	0.18	0.18	0.18
Solvent		150.00	150.00	150.00
Total		250.00	250.00	250.00
Viscosity (60°C) (Pa·s)		480	530	390
Viscosity (120°C) (Pa·s)		60	120	110
Viscosity (120°C) / Viscosity (60°C)		0.13	0.23	0.28
Temperature at which viscosity becomes 100 Pa·s or less (°C)		98	124	123

[0099] FIG. 12 is a graph showing changes in viscosity of the adhesive films of Examples 1 and 2 and Comparative Example 1. As shown in FIG. 12 and Table 2, the adhesive films of Examples 1 and 2 had a higher temperature at which the viscosity became equal to or lower than a predetermined viscosity (100 Pa·s) compared to the adhesive film of Comparative Example 1, and also had a larger ratio of the viscosity at 120°C to the viscosity at 60°C (viscosity at 120°C/viscosity at 60°C), and the decrease in viscosity was suppressed. From these results, it was confirmed that the adhesive film for a semiconductor of the present disclosure is capable of suppressing a decrease in viscosity due to heating without significantly changing the types and amounts of raw materials.

Reference Signs List

[0100] 10: adhesive film (adhesive film for a semiconductor), 14: substrate, 20: base material layer (dicing film), 30: protective film, 41: adhesive agent, 42: sealing layer, 50: underfill, 84, 94: circuit pattern, 88: first wire, 90: organic substrate, 98: second wire, 95: connection terminal, 96: electrode, 100, 110: laminate, 200, 201, 202: semiconductor device, Wa: first semiconductor chip, Waa: second semiconductor chip.

CLAIMS

[Claim 1] An adhesive film for a semiconductor, comprising an epoxy resin, a phenol resin, and a modified elastomer,

wherein the modified elastomer is a reaction product of an elastomer having an epoxy group and a phenol resin.

[Claim 2] The adhesive film for a semiconductor according to claim 1, further comprising an elastomer.

[Claim 3] The adhesive film for a semiconductor according to claim 2, further comprising an inorganic filler.

[Claim 4] The adhesive film for a semiconductor according to any one of claims 1 to 3, used for bonding a semiconductor chip to a substrate while embedding another semiconductor chip.

[Claim 5] The adhesive film for a semiconductor according to any one of claims 1 to 3, used for bonding a semiconductor chip to another semiconductor chip while embedding part or all of a wire connected to the other semiconductor chip.

[Claim 6] A method for manufacturing an adhesive film for a semiconductor, comprising:

reacting an elastomer having an epoxy group with a phenol resin to obtain a modified elastomer;

mixing an epoxy resin, a phenol resin, and the obtained modified elastomer to obtain an adhesive composition comprising the epoxy resin, the phenol resin, and the modified elastomer; and

forming an adhesive film for a semiconductor using the obtained adhesive composition.

[Claim 7] A dicing/die bonding integrated film, comprising:

a dicing film; and

the adhesive film for a semiconductor according to any one of claims 1 to 3, provided on the dicing film.

[Claim 8] A method for manufacturing a semiconductor device, comprising bonding a second semiconductor chip to a substrate on which a first semiconductor chip is mounted, with the adhesive film for a semiconductor according to any one of claims 1 to 3,

wherein the first semiconductor chip is embedded by the adhesive film for a semiconductor.

[Claim 9] A method for manufacturing a semiconductor device, comprising bonding a second semiconductor chip to a first semiconductor chip with the adhesive film for a semiconductor according to any one of claims 1 to 3,

wherein a wire is connected to the first semiconductor chip, and

wherein part or all of the wire is embedded by the adhesive film for a semiconductor.