## DESCRIPTION

**Title of Invention:** THERMOSETTING RESIN FILM FOR SEMICONDUCTORS, INTEGRATED DICING/DIE BONDING FILM AND METHOD FOR MANUFACTURING SEMICONDUCTOR DEVICE

### Technical Field

[0001] The present disclosure relates to a thermosetting resin film, 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 a thermosetting resin film is sometimes referred to as FOW (Film Over Wire). The structure of a semiconductor package in which a semiconductor chip is embedded by a thermosetting resin film is sometimes referred to as FOD (Film Over Die). As an example of a semiconductor package employing FOD, one having a controller chip disposed at the lowermost stage and a thermosetting resin film 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 a structure of FOD or FOW, it is required that a semiconductor chip or a wire be sufficiently embedded by a thermosetting resin film. A thermosetting resin film having reduced viscosity and high fluidity may exhibit good embeddability; however, a phenomenon called bleed, in which the thermosetting resin film protrudes from the edge of the semiconductor chip, may occur.

[0005] Therefore, the main object of the present disclosure is to provide a thermosetting resin film capable of suppressing bleed.

**Solution to Problem**

[0006] In the manufacturing process of a semiconductor chip, a film referred to as a dicing/die bonding integrated film is used. This film has a structure in which a base material layer, a pressure-sensitive adhesive layer, and an adhesive layer (a thermosetting resin film) are laminated in this order, and is used, for example, as follows. First, the semiconductor wafer is diced in a state where the surface on the adhesive layer side is stuck to the semiconductor wafer and the semiconductor wafer is fixed with a dicing ring. As a result, the semiconductor wafer is singulated into a large number of semiconductor chips. Subsequently, after the adhesive force of the pressure-sensitive adhesive layer with respect to the adhesive layer is reduced by irradiating the pressure-sensitive adhesive layer containing an ultraviolet curable pressure-sensitive adhesive agent with ultraviolet rays, the semiconductor chip is picked up from the pressure-sensitive adhesive layer together with an adhesive layer piece (a thermosetting resin film piece) obtained by singulating the

adhesive layer. Thereafter, a semiconductor device is manufactured through a step of mounting the semiconductor chip on a substrate or the like via the adhesive layer piece. Note that a laminate consisting of a semiconductor chip obtained through the dicing step and an adhesive layer piece attached thereto is referred to as a semiconductor chip with an adhesive layer piece.

[0007] Regarding the control of the fluidity of the thermosetting resin film, the present inventors studied the effective utilization of ultraviolet rays irradiated to the pressure-sensitive adhesive layer, based on the above-described manufacturing process of the semiconductor chip. As a result, it was found that by incorporating a photobase generator that generates a base upon light irradiation into the adhesive layer (the thermosetting resin film), a base is generated in the adhesive layer (the thermosetting resin film) by ultraviolet irradiation, and the curability of the adhesive layer from room temperature (25°C) to around 120°C is improved. In addition, according to further studies by the present inventors, it was found that by improving the curability of the adhesive layer, the fluidity of the adhesive layer is controlled, and as a result, it is possible to suppress bleed in the method for manufacturing a semiconductor device, and the invention of the present disclosure has been completed.

[0008] The present disclosure provides the thermosetting resin film according to [1] to [6], the dicing/die bonding integrated film according to [7], and the method for manufacturing a semiconductor device according to [8] and [9].

[1] A thermosetting resin film containing a photobase generator that

generates a base upon light irradiation.

[2] The thermosetting resin film according to [1], further containing a photosensitizer.

[3] The thermosetting resin film according to [1] or [2], further containing a thermosetting resin component and an elastomer,

wherein the thermosetting resin component includes a resin that is cured by being heated in the presence of the base.

[4] The thermosetting resin film according to [3], further containing an inorganic filler.

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

[6] The thermosetting resin film according to any one of [1] to [4], used for bonding a semiconductor chip to another semiconductor chip while embedding part or all of a wire connected to the other semiconductor chip.

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

a dicing film having a base material layer and a pressure-sensitive adhesive layer provided on the base material layer; and

an adhesive layer consisting of the thermosetting resin film according to any one of [1] to [4], provided on the pressure-sensitive adhesive layer of the dicing film,

wherein the pressure-sensitive adhesive layer contains an ultraviolet curable pressure-sensitive adhesive agent.

[8] A method for manufacturing a semiconductor device, comprising:

disposing a semiconductor wafer on the adhesive layer of the dicing/die bonding integrated film according to [7];

singulating the semiconductor wafer and the adhesive layer;

irradiating the pressure-sensitive adhesive layer of the dicing film with ultraviolet rays via the base material layer;

picking up, from the pressure-sensitive adhesive layer, a first semiconductor chip with an adhesive layer piece having a first semiconductor chip and an adhesive layer piece attached to the first semiconductor chip; and

bonding the first semiconductor chip to a substrate on which a second semiconductor chip is mounted, with the adhesive layer piece of the first semiconductor chip with an adhesive layer piece,

wherein the second semiconductor chip is embedded by the adhesive layer piece of the first semiconductor chip with an adhesive layer piece.

[9] A method for manufacturing a semiconductor device, comprising:

disposing a semiconductor wafer on the adhesive layer of the dicing/die bonding integrated film according to [7];

singulating the semiconductor wafer and the adhesive layer;

irradiating the pressure-sensitive adhesive layer of the dicing film with ultraviolet rays via the base material layer;

picking up, from the pressure-sensitive adhesive layer, a first semiconductor chip with an adhesive layer piece having a first semiconductor chip and an adhesive layer piece attached to the first semiconductor chip; and

bonding the first semiconductor chip to a second semiconductor

chip, with the adhesive layer piece of the first semiconductor chip with an adhesive layer piece,

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

part or all of the wire is embedded by the adhesive layer piece of the first semiconductor chip with an adhesive layer piece.

**Advantageous Effects of Invention**

[0009] According to the present disclosure, a thermosetting resin film capable of suppressing bleed is provided. In addition, according to the present disclosure, a dicing/die bonding integrated film using such a thermosetting resin film 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**

[0010] [FIG. 1] FIG. 1 is a schematic cross-sectional view illustrating one embodiment of a thermosetting resin film.

[FIG. 2] FIG. 2 is a schematic cross-sectional view illustrating one embodiment of a dicing/die bonding integrated film.

[FIG. 3] FIG. 3 is a schematic cross-sectional view illustrating one embodiment of a semiconductor device.

[FIG. 4] FIG. 4 is a process diagram illustrating one embodiment of a method for manufacturing a semiconductor chip with an adhesive layer piece. FIGS. 4(a), 4(b), 4(c), 4(d), and 4(e) are cross-sectional views schematically illustrating each step.

[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.

**Description of Embodiments**

[0011] 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.

[0012] 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.

[0013] In the present specification, (meth)acrylate means an acrylate or a methacrylate corresponding thereto. The same applies to other similar expressions such as a (meth)acrylic acid ester, a (meth)acryloyl group, and a (meth)acrylic copolymer.

[0014] The materials exemplified below can be used alone as one type, or in combination of two or more types, 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.

[0015] [Thermosetting Resin Film]

FIG. 1 is a schematic cross-sectional view illustrating one embodiment of a thermosetting resin film. A thermosetting resin film 10A illustrated in FIG. 1 contains a photobase generator that generates a base upon light irradiation (hereinafter, may be referred to as "component (A)"), and may further contain a photosensitizer (hereinafter, may be referred to as "component (B)"). The thermosetting resin film 10A may further contain a thermosetting resin component (hereinafter, may be referred to as "component (C)") and an elastomer (hereinafter, may be referred to as "component (D)"). The thermosetting resin film 10A may further contain 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)”), and the like. The thermosetting resin film 10A can be a film formed from a thermosetting composition containing the component (A), the component (B), the component (C), the component (D), and the like. The thermosetting resin film 10A may be in a semi-cured (B-stage) state. The thermosetting resin film 10A can be in a cured (C-stage) state after a curing treatment. The thermosetting resin film 10A can be an adhesive film for semiconductors.

[0016] Component (A): Photobase Generator

A base generator means a component that releases a base (an organic base) that initiates anionic polymerization by at least one of light irradiation and heat; a compound capable of releasing a base upon light irradiation is referred to as a photobase generator (the component (A)); and a compound capable of releasing a base by heat is referred to as a thermal base generator. Light irradiation may be, for example, ultraviolet irradiation. In the present specification, ultraviolet rays mean light rays (near-ultraviolet rays) in the range of 190 to 380 nm. Note that among base generators, there are compounds capable of releasing a base by either light irradiation or heat, and there are compounds that are classified as thermal base generators but are capable of releasing a base upon light irradiation.

[0017] Since the thermosetting resin film 10A contains the component (A), a base is generated in the thermosetting resin film 10A by ultraviolet irradiation, and the curability of the thermosetting resin film 10A (the adhesive layer 10) from room temperature (25°C) to around 120°C tends to be improved. As a result, the fluidity of the adhesive layer is

controlled, and it becomes possible to suppress bleed in the method for manufacturing a semiconductor device.

[0018] Examples of the component (A) include an ammonium salt, a DBU (diazabicycloundecenium) salt, a DBN (diazabicyclononenium) salt, a biguanidium salt, an aromatic phosphonium salt, an aromatic dimethylurea, an aliphatic dimethylurea, a guanidinium salt, a phosphazene salt, an imidazole salt, and the like. The component (A) may be a salt containing a borate anion, since it has good sensitivity to light. Examples of commercially available products of a salt containing a borate anion include U-CAT5002 (product name, manufactured by San-Apro Ltd.); P3B, BP3B, N3B, and MN3B (all manufactured by Resonac Corporation), and the like.

[0019] The content of the component (A) may be 0.01 to 3% by mass, on the basis of the total amount of the thermosetting resin film. The content of the component (A) may be 0.05% by mass or more, 0.1% by mass or more, 0.2% by mass or more, or 0.3% by mass or more, on the basis of the total amount of the thermosetting resin film, since the effects of the present disclosure are easily obtained. The content of the component (A) may be 2% by mass or less, or 1% by mass or less, on the basis of the total amount of the thermosetting resin film.

[0020] Component (B): Photosensitizer

The component (B) is a component that, after excitation by light absorption, transfers electrons or energy to the component (A), and contributes to the decomposition of the component (A) or the generation of a polymerization initiating species. The component (B) may have, for example, a maximum absorption wavelength in the ultraviolet region

(190 to 380 nm). When the thermosetting resin film 10A contains the component (B) in addition to the component (A), the curability of the thermosetting resin film 10A (the adhesive layer 10) tends to be further improved.

[0021] Examples of the component (B) include an anthracene compound such as a dimethylanthracene, a 9,10-diethoxyanthracene, and a 9,10-dibutoxyanthracene; a thioxanthone compound such as a 2-isopropylthioxanthone and a diethylthioxanthone; a quinone compound such as a 2-ethylanthraquinone; a naphthalene compound such as a dialkoxynaphthalene, and the like. The component (B) may contain at least one selected from the group consisting of an anthracene compound, a thioxanthone compound, a quinone compound, and a naphthalene compound, and may contain a thioxanthone compound.

[0022] The content of the component (B) may be 1 to 300 parts by mass, relative to 100 parts by mass of the total amount of the component (A). The content of the component (B) may be 5 parts by mass or more, 10 parts by mass or more, or 15 parts by mass or more, relative to 100 parts by mass of the total amount of the component (A), from the viewpoint of easily obtaining the effects of the present disclosure. The content of the component (B) may be 200 parts by mass or less, or 150 parts by mass or less, relative to 100 parts by mass of the total amount of the component (A).

[0023] Component (C): Thermosetting Resin Component

The component (C) includes a thermosetting resin (hereinafter, may be referred to as “component (C1)”) that is cured by being heated in the presence of the base generated from the component (A). The

component (C1) can be a compound having a functional group that forms a crosslinked structure by a thermosetting reaction. The component (C) may further contain a curing agent (hereinafter, may be referred to as "component (C2)") that reacts with the component (C1). The component (C1) may contain an epoxy resin, which is a compound having an epoxy group, from the viewpoint of adhesiveness. In that case, the component (C2) may contain a phenol resin, which is a compound having a phenolic hydroxyl group.

[0024] Examples of the epoxy resin used as the component (C1) 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 or polycyclic aromatics such as anthracene, and the like. Among them, the epoxy resin may contain 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.

[0025] The epoxy resin may contain 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 epoxy resin 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 means 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 40% by mass, on the basis of the total amount of the thermosetting resin film. When the component (C) contains the liquid epoxy resin, the flexibility of the thermosetting resin film tends to be improved. In addition, by combining the liquid epoxy resin and the solid epoxy resin, the embeddability of the semiconductor chip and the wire tends to be improved.

[0026] 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.

[0027] The epoxy equivalent of the epoxy resin 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 epoxy resin is in such a range, there is a tendency that it is easy to ensure the fluidity of the thermosetting composition when forming the thermosetting resin film while maintaining the bulk strength of the thermosetting resin film.

[0028] Examples of the phenol resin used as the component (C2) 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 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; and a naphthol aralkyl resin. The phenol resin may contain a phenyl aralkyl-type phenol resin, a phenol novolac resin, or a combination thereof.

[0029] The hydroxyl equivalent of the phenol resin 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 thermosetting resin 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.

[0030] Examples of commercially available products of the phenol resin 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.

[0031] In a case where the component (C1) contains an epoxy resin and the component (C2) contains a phenol resin, the ratio of the epoxy equivalent of the epoxy resin to the hydroxyl equivalent of the phenol

resin (epoxy equivalent:hydroxyl equivalent) 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. 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.

[0032] The softening point of the component (C2) may be 50 to 200°C, or 60 to 150°C. A curing agent having a softening point of 200°C or lower tends to have good compatibility with the component (C1).

[0033] The content of the component (C) (the total content of the component (C1) and the component (C2)) may be 15% by mass or more, on the basis of the total amount of the thermosetting resin film, and may be 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 content of the component (C) is 15% by mass or more, on the basis of the total amount of the thermosetting resin film, there is a tendency that the adhesive force of the thermosetting resin film is improved. The content of the component (C) 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 thermosetting resin film, from the viewpoint of film formability.

[0034] Component (D): Elastomer

The component (D) may be, for example, a polymer compound having 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.

[0035] The component (D) may contain an acrylic resin, from the viewpoint of fluidity. Here, the acrylic resin means a polymer having monomer units derived from a (meth)acrylic acid ester. The content of constitutional units derived from a (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 contain monomer units derived from a (meth)acrylic acid ester having a crosslinkable functional group such as an epoxy group, an alcoholic or phenolic hydroxyl group, or a carboxyl group. The acrylic resin may be an acrylic rubber that is a copolymer containing a (meth)acrylic acid ester and acrylonitrile as monomer units.

[0036] 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, the thermosetting resin film tends to have good flexibility. A thermosetting resin film having good flexibility tends to be easily cut together with the semiconductor wafer during dicing, whereby the occurrence of burrs can be effectively suppressed. A thermosetting resin film having good flexibility tends to be easily stuck to the semiconductor wafer while sufficiently eliminating voids, and chipping during dicing due to a decrease in adhesiveness can also be suppressed. The glass transition temperature (Tg) means a value measured using a DSC (differential scanning calorimeter) (for example,

"Thermo Plus 2" manufactured by Rigaku Corporation). The Tg of the component (D) can be adjusted to a desired range by adjusting the type and content of the constitutional units constituting the component (D) (in the case of an acrylic resin, the constitutional units derived from a (meth)acrylic acid ester).

[0037] 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 thermosetting resin film, and it is also possible to achieve excellent reflow properties and improve embeddability. Mw means a value measured by gel permeation chromatography (GPC) and converted using a calibration curve of standard polystyrene.

[0038] 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).

[0039] The content of the component (D) may be 3% by mass or more, 5% by mass or more, 7% by mass or more, or 10% by mass or more, on the basis of the total amount of the thermosetting resin 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 thermosetting resin film, the thermosetting resin film has increased viscosity, and improvement in the handleability of the film and suppression 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 thermosetting resin 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 thermosetting resin film, there is a tendency that the embeddability is further improved.

[0040] 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 contain silica, from the viewpoint of adjusting the melt viscosity.

[0041] 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 10 μm or less, 5 μm or less, 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 means 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 obtained by using the thermosetting resin film containing the component (E). In this case, the average particle size of the component (E) can be obtained from a particle size distribution obtained by dispersing, in a solvent, a residue

obtained by heating the thermosetting resin film to decompose the resin component to prepare a dispersion liquid, and applying the laser diffraction/scattering method thereto.

[0042] The content of the component (E) may be 10 to 50% by mass, on the basis of the total amount of the thermosetting resin film, and may be 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.

[0043] The content of the component (E) may be 10 to 200 parts by mass, relative to 100 parts by mass of the total amount of the component (C). In a case where the content of the component (E) is in such a range, there is a tendency that the adhesive force of the thermosetting resin film is improved. The content of the component (E) may be 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 amount of the component (C).

[0044] Component (F): Curing Accelerator

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

[0045] Examples of the imidazoles include 2-methylimidazole, 1-benzyl-2-methylimidazole, 1-cyanoethyl-2-phenylimidazole, 1-cyanoethyl-2-methylimidazole, and the like.

[0046] 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.

[0047] The thermosetting resin film may further contain other components. Examples of the other components include a pigment, an ion scavenger, an antioxidant, and the like.

[0048] 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 thermosetting resin film.

[0049] The thermosetting resin film 10A can be formed, for example, by applying a thermosetting composition containing each component to a support film. In forming the thermosetting resin film 10A, a varnish of the thermosetting composition (a composition varnish) may be used. In the case of using the composition varnish, the thermosetting resin film 10A 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.

[0050] The support film is not particularly limited insofar as it can withstand the heating and drying described above. 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 polyether imide 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 thereof, or may be one whose surface is 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.

[0051] 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.

[0052] The solvent used for preparing the composition varnish is not particularly limited insofar as it allows each component to be uniformly dissolved, kneaded, or dispersed, and any 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.

[0053] 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, at 50 to 150°C for 1 to 30 minutes.

[0054] The thickness of the thermosetting resin film 10A can be suitably adjusted depending on the size of the object to be embedded. The thickness of the thermosetting resin film 10A 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 thermosetting resin film 10A is a thermosetting resin film for FOD, the thickness of the thermosetting resin film 10A 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 thermosetting resin film 10A is a thermosetting resin film for FOW, the thickness of the thermosetting resin film 10A 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.

[0055] The thermosetting resin film 10A prepared on the support film may include a cover film on the surface of the thermosetting resin film on the side 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.

[0056] The thermosetting resin film 10A 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.

[0057] [Dicing/Die Bonding Integrated Film]

FIG. 2 is a schematic cross-sectional view illustrating one embodiment of a dicing/die bonding integrated film. The thermosetting resin film 10A may be supplied in the form of the dicing/die bonding integrated film illustrated in FIG. 2. A dicing/die bonding integrated film 100 illustrated in FIG. 2 includes a dicing film 40 having a base material layer 30 and a pressure-sensitive adhesive layer 20 provided on the base material layer 30, and an adhesive layer 10 consisting of the thermosetting resin film 10A provided on the pressure-sensitive adhesive layer 20 of the dicing film 40. The dicing/die bonding integrated film 100 may further include a protective film provided on the surface of the adhesive layer 10 on the side opposite to the pressure-sensitive adhesive layer 20. The dicing/die bonding integrated film 100 may be in the shape of a film, a sheet, or a tape.

[0058] Examples of the base material layer 30 include the same resin films as those exemplified for the support film. The base material layer 30 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 thickness of the base material layer 30 may be, for example, 10 to 200 μm, or 20 to 170 μm.

[0059] The pressure-sensitive adhesive layer 20 contains an ultraviolet curable pressure-sensitive adhesive agent. The 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 20 can be suitably 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.

[0060] Examples of the protective film include the same films as those exemplified for the cover film. The thickness of the protective film may be, for example, 15 to 200 μm, or 30 to 170 μm.

[0061] [Semiconductor Device and Method for Manufacturing Same]

FIG. 3 is a schematic cross-sectional view illustrating one embodiment of a semiconductor device, and shows an example of a semiconductor device manufactured using a dicing/die bonding integrated film. A semiconductor device 200 illustrated in FIG. 3 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 an adhesive layer piece 10a (a thermosetting resin film piece) bonding the first semiconductor chip Wa 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 second semiconductor chip Waa is bonded to the substrate 14 with an adhesive agent 41. A second wire 88 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 88. The entire second semiconductor chip Waa and the entire second wire 88 are embedded in the adhesive layer piece 10a (the thermosetting resin film piece). A first wire 98 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 98. The entire first semiconductor chip Wa and the entire first wire 98 are embedded in the sealing layer 42.

[0062] FIG. 4 is a process diagram illustrating one embodiment of a method for manufacturing a semiconductor chip with an adhesive layer piece. FIGS. 4(a), 4(b), 4(c), 4(d), and 4(e) are cross-sectional views schematically illustrating each step. The method for manufacturing a semiconductor chip with an adhesive layer piece (a first semiconductor chip with an adhesive layer piece) illustrated in FIG. 4 includes disposing a semiconductor wafer W on the adhesive layer 10 of the dicing/die bonding integrated film 100 (a wafer lamination step, refer to FIGS. 4(a) and 4(b)), singulating the semiconductor wafer W and the adhesive layer 10 (a dicing step, refer to FIG. 4(c)), irradiating the pressure-sensitive adhesive layer 20 of the dicing film 40 with ultraviolet rays via the base material layer 30 (an ultraviolet irradiation step, refer to FIG. 4(d)), and picking up, from the pressure-sensitive adhesive layer 20a, a first semiconductor chip with an adhesive layer piece 60 having a first semiconductor chip Wa and an adhesive layer piece 10a attached to the first semiconductor chip Wa (a picking-up step, refer to FIG. 4(e)). As a result, the first semiconductor chip with an adhesive layer piece 60 can be obtained.

[0063] In the wafer lamination step, the dicing/die bonding integrated film 100 is disposed in a predetermined device. Subsequently, a surface Ws of the semiconductor wafer W is stuck to the adhesive layer 10 of the dicing/die bonding integrated film 100 (refer to FIGS. 4(a) and 4(b)).

The circuit surface of the semiconductor wafer W may be provided on the side opposite to the surface Ws.

[0064] Examples of the semiconductor wafer W include monocrystal silicon, polycrystalline silicon, various ceramics, a compound semiconductor such as gallium arsenide, and the like. The semiconductor wafer W may be, for example, a thin semiconductor wafer having a thickness of 10 to 100 μm.

[0065] The thickness of the first semiconductor chip Wa may be 10 to 100 μm. The first semiconductor chip Wa may have a size with a width of 20 mm or less. The width (or the length of one side) of the first semiconductor chip Wa may be 3 to 15 mm, or 5 to 10 mm.

[0066] In the dicing step, the semiconductor wafer W and the adhesive layer 10 are singulated by dicing (refer to FIG. 4(c)). At this time, a part of the pressure-sensitive adhesive layer 20, or the entire pressure-sensitive adhesive layer 20 and a part of the base material layer 30 may be singulated by dicing. As described above, the dicing/die bonding integrated film 100 also functions as a dicing sheet.

[0067] In the ultraviolet irradiation step, the pressure-sensitive adhesive layer 20 is irradiated with ultraviolet rays via the base material layer 30 (refer to FIG. 4(d)). In the ultraviolet irradiation, the wavelength of the ultraviolet rays may be 190 to 380 nm. The ultraviolet irradiation conditions may be such that the illuminance and the irradiation amount are in the range of 30 to 3200 $mW/cm^2$ and in the range of 50 to 800 $mJ/cm^2$, respectively. By irradiation of the pressure-sensitive adhesive layer 20 with ultraviolet rays, the ultraviolet curable pressure-sensitive adhesive agent contained in the pressure-sensitive adhesive layer 20 is

cured, and the adhesiveness to the adhesive layer 10 decreases.

[0068] In the ultraviolet irradiation step, the adhesive layer 10 can also be irradiated with ultraviolet rays. Since the adhesive layer 10 contains the component (A), a base can be generated by ultraviolet irradiation. As a result, the curability of the adhesive layer from room temperature (25°C) to around 120°C is improved, the fluidity of the adhesive layer is controlled, and it becomes possible to suppress bleed in the method for manufacturing a semiconductor device.

[0069] In the picking-up step, while the base material layer 30 is expanded to separate the first semiconductor chips with an adhesive layer piece 60, each having the first semiconductor chip Wa and the adhesive layer piece 10a attached to the first semiconductor chip Wa from each other, the first semiconductor chip with an adhesive layer piece 60 thrust up by a needle 72 from the base material layer 30 side is sucked with a suction collet 74 and picked up from the pressure-sensitive adhesive layer 20a (refer to FIG. 4(e)). The first semiconductor chip Wa is obtained by singulating the semiconductor wafer W, and the adhesive layer piece 10a is obtained by singulating the adhesive layer 10. In addition, the pressure-sensitive adhesive layer 20a is obtained by singulating the pressure-sensitive adhesive layer 20, and may contain a cured product of the ultraviolet curable pressure-sensitive adhesive agent. The pressure-sensitive adhesive layer 20a may remain on the base material layer 30 after the first semiconductor chip with an adhesive layer piece 60 is picked up. In the picking-up step, it is not always necessary to expand the base material layer 30, but by expanding the base material layer 30, the picking-up property can be further

improved.

[0070] The amount of thrust by the needle 72 can be suitably set. Further, from the viewpoint of ensuring a sufficient picking-up property for an extremely thin wafer, for example, two or three stages of thrust may be performed. In addition, the first semiconductor chip with an adhesive layer piece 60 may be picked up by a method other than the method using the suction collet 74.

[0071] FIGS. 5, 6, 7, 8, and 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. 3. The manufacturing method illustrated in FIGS. 5 to 9 includes bonding the second semiconductor chip Waa to the substrate 14 via the adhesive agent 41, providing a second wire 88 connecting the second semiconductor chip Waa and the substrate 14 (the circuit pattern 84), crimping the first semiconductor chip with an adhesive layer piece 60 obtained by the manufacturing method illustrated in FIG. 4 to the substrate 14, and thereby bonding the first semiconductor chip Wa to the substrate 14 such that the second semiconductor chip Waa and the second wire 88 are embedded by the adhesive layer piece 10a (the thermosetting resin film piece), and providing a first wire 98 connecting the first semiconductor chip Wa and the substrate 14 (the circuit pattern 84). Thereafter, the semiconductor device 200 illustrated in FIG. 3 can be obtained by forming the sealing layer 42.

[0072] The thickness of the second semiconductor chip Waa may be 10 to 170 μm. The second semiconductor chip Waa may be a controller

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

[0073] As illustrated in FIG. 5, the substrate 14 (the circuit pattern 84) and the second semiconductor chip Waa are electrically connected via the second wire 88. The second wire 88 connecting the second semiconductor chip Waa and the substrate 14 (the circuit pattern 84) may be, for example, a gold wire, an aluminum wire, or a copper wire. The heating temperature for connecting the second wire 88 may be in the range of 80 to 250°C, or 80 to 220°C. The heating time for connecting the second wire 88 may be several seconds to several minutes. For connecting the second wire 88, vibrational energy due to an ultrasonic wave and crimping energy due to an applied pressure may be applied.

[0074] The first semiconductor chip with an adhesive layer piece 60 illustrated in FIG. 6 can be obtained by the method for manufacturing a semiconductor chip with an adhesive layer piece illustrated in FIG. 4.

[0075] As illustrated in FIG. 7, the first semiconductor chip with an adhesive layer piece 60 having the first semiconductor chip Wa and the adhesive layer piece 10a attached to the first semiconductor chip Wa is placed such that the second wire 88 and the second semiconductor chip Waa are covered by the adhesive layer piece 10a. Next, as illustrated in FIG. 8, the first semiconductor chip Wa is fixed to the substrate 14 by

crimping the first semiconductor chip Wa to the substrate 14. The heating temperature for crimping may be 50 to 200°C, or 100 to 150°C. In a case where the heating temperature for crimping is high, the adhesive layer piece 10a becomes soft, and thus the embeddability tends to be improved. The crimping time may be 0.5 to 20 seconds, or 1 to 5 seconds. The pressure for crimping may be 0.01 to 5 MPa, or 0.02 to 2 MPa.

[0076] After crimping, the structure containing the adhesive layer piece 10a may be further heated to cure the adhesive layer piece 10a. The temperature and time for curing can be suitably set depending on the curing temperature of the adhesive layer piece 10a and the like. The temperature may be changed in stages. 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.

[0077] As illustrated in FIG. 9, the substrate 14 and the first semiconductor chip Wa are electrically connected via the first wire 98. The type and connection method of the first wire 98 may be the same as those of the second wire 88.

[0078] Thereafter, a sealing layer 42 sealing the circuit pattern 84, the first wire 98, and the first semiconductor chip Wa 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 layer piece 10a 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.

[0079] 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 an adhesive layer piece 10a (a thermosetting resin film piece) bonding the first semiconductor chip Wa to the second semiconductor chip Waa. The substrate 14 has an organic substrate 90, circuit patterns 84 and 94 provided on the organic substrate 90, and a connection terminal 95 provided on the surface of the organic substrate 90 on the side opposite to the circuit patterns 84 and 94. The second semiconductor chip Waa is bonded to the substrate 14 with an adhesive agent 41. A second wire 88 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 88. A part of the second wire 88 is embedded in the adhesive layer piece 10a (the thermosetting resin film piece). A first wire 98 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 98.

[0080] 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 first semiconductor chip Wa to the second semiconductor chip Waa with the adhesive layer piece 10a (the thermosetting resin film piece).

[0081] 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 (an 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 an adhesive layer piece 10a (a thermosetting resin film piece) bonding the first semiconductor chip Wa to the substrate 14 while embedding the entire second semiconductor chip Waa. The second semiconductor chip Waa is a flip-chip type semiconductor chip, and is electrically connected to the substrate 14 via a plurality of electrodes 96. An underfill 50 is filled between the second semiconductor chip Waa and the substrate 14.

Examples

[0082] Hereinafter, the present disclosure will be described specifically on the basis of Examples, but the present disclosure is not limited thereto.

[0083] Examples 1 to 5

[Preparation of Thermosetting Resin Film]

<Preparation of Composition Varnish>

Composition varnishes of Examples 1 to 5 were prepared by stirring the component (A) to the component (G) and cyclohexanone at the composition ratio (unit: parts by mass) shown in Table 1 until each component became uniform. Note that the numerical values of each component shown in Table 1 indicate parts by mass of the solid content.

[0084] Component (A): Photobase Generator

(A-1) U-CAT5002 (product name, manufactured by San-Apro Ltd., tetraphenylborate salt of DBU benzyl-modified product)

Component (B): Photosensitizer

(B-1) IPTX (2-isopropylthioxanthone)

Component (C): Thermosetting Resin Component

(C1) Thermosetting Resin

(C1-1) 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)

(C1-2) EXA-830CRP (product name, manufactured by DIC Corporation, liquid bisphenol F-type epoxy resin, epoxy equivalent: 159 g/eq)

(C2) Curing Agent

(C2-1) 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 (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)

[0085] <Preparation of Thermosetting Resin Film>

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

[0086] [Table 1]

| | | | Exam. 1 | Exam. 2 | Exam. 3 | Exam. 4 | Exam. 5 |
|---|---|---|---|---|---|---|---|
| (A) | | (A-1) | 0.36 | 0.36 | 0.36 | 0.36 | 0.36 |
| (B) | | (B-1) | 0.07 | 0.22 | 0.29 | 0.36 | 0.43 |
| (C) | (C1) | (C1-1) | 15.36 | 15.36 | 15.36 | 15.36 | 15.36 |
| | | (C1-2) | 14.27 | 14.27 | 14.27 | 14.27 | 14.27 |
| | (C2) | (C2-1) | 23.86 | 23.86 | 23.86 | 23.86 | 23.86 |
| (D) | | (D-1) | 16.77 | 16.77 | 16.77 | 16.77 | 16.77 |
| (E) | | (E-1) | 29.40 | 29.40 | 29.40 | 29.40 | 29.40 |
| (F) | | (F-1) | 0.07 | 0.07 | 0.07 | 0.07 | 0.07 |
| (G) | | (G-1) | 0.09 | 0.09 | 0.09 | 0.09 | 0.09 |
| | | (G-2) | 0.18 | 0.18 | 0.18 | 0.18 | 0.18 |

[0087] [Evaluation of Thermosetting Resin Film]

<Measurement of Curing Time>

Using the thermosetting resin films of Examples 1 to 5, the curing time of the thermosetting resin film was measured for the case where light irradiation was performed on the thermosetting resin film and the case where light irradiation was not performed. Note that the measurement sample for the case where light irradiation was performed was prepared by the following procedure. Using a UV conveyor device (Eye Grandage, manufactured by Eye Graphics Co., Ltd.) with a 365 nm LED light source, the conveyor speed and irradiation distance were adjusted so that the exposure amount was 650 mJ/cm$^2$, and light irradiation was performed on the thermosetting resin film. Thereafter, the thermosetting resin films after light irradiation having a thickness of 120 μm were stacked until the thickness reached 960 μm, and these were bonded together at 70°C to obtain a measurement sample. The measurement sample for the case where light irradiation was not performed was obtained in the same manner as the method for preparing

the measurement sample for the case where light irradiation was performed, except that light irradiation was not performed. Subsequently, for these measurement samples, the change in viscosity over time was measured under conditions of a measurement temperature of 120°C and a frequency of 4 Hz using a rheometer (HAAKE RheoStress 600, manufactured by ThermoElactron Corporation), and the time at which the viscosity reached 1000 Pa·s was defined as the curing time of the thermosetting resin film. The results are shown in Table 2.

[0088] [Table 2]

| | | Exam. 1 | Exam. 2 | Exam. 3 | Exam. 4 | Exam. 5 |
|---|---|---|---|---|---|---|
| Curing time (min) | Without light irradiation | 30.0 | 31.6 | 30.6 | 29.5 | 28.1 |
| | With light irradiation | 24.5 | 23.0 | 22.5 | 24.0 | 23.5 |

[0089] <Evaluation of Embeddability>

(Preparation of Evaluation Sample)

The difference in embeddability between the case where light irradiation was performed on the thermosetting resin film and the case where light irradiation was not performed was evaluated in a simplified manner. A copper foil tape (length: 5 mm, width: 10 mm, thickness: 70 μm) was stuck onto a polyethylene terephthalate (PET) film (length: 210 mm, width: 300 mm, thickness: 125 μm), and the same copper foil tape was further stuck onto the copper foil tape to obtain a first laminate having the PET film and a copper foil tape layer having a thickness of 140 μm. Subsequently, three sheets of the thermosetting resin film of

Example 1 (thickness: 120 μm) were stacked and bonded together at 70°C to prepare a film having a thickness of 360 μm. This was cut to a length of 10 mm and a width of 25 mm, and bonded to a glass slide (length: 26 mm, width: 76 mm, thickness: 1 mm) to obtain a second laminate having the glass slide and the film having a thickness of 360 μm. Two sets of the first laminate and the second laminate were prepared. For one set, the first laminate was placed on a hot plate such that the PET film was in contact with the hot plate, and then the second laminate was placed on the first laminate such that the copper foil tape layer was embedded in the thermosetting resin film. Subsequently, the second laminate was crimped to the first laminate under conditions of a temperature of 110°C, a time of 30 seconds, and a pressure of 0.45 MPa to prepare an evaluation sample for the case where light irradiation was not performed (Evaluation Sample A). For the other set, the thermosetting resin film of the second laminate was irradiated with ultraviolet rays having a wavelength of 365 nm under conditions of an illuminance of 2650 $mW/cm^2$ and an integrated light quantity of 150 $mJ/cm^2$ using a UV conveyor device (Eye Grandage, manufactured by Eye Graphics Co., Ltd.). After being left to stand for 30 minutes after irradiation, in the same manner as Evaluation Sample A, the first laminate and the second laminate were placed on the hot plate such that the copper foil tape layer was embedded in the thermosetting resin film, and crimped under the same conditions as Evaluation Sample A to prepare an evaluation sample for the case where light irradiation was performed (Evaluation Sample B).

[0090] (Measurement of Bleed Amount)

For Evaluation Sample A and Evaluation Sample B, the position of the thermosetting resin film after crimping was measured from the position of the thermosetting resin film before crimping, and this was evaluated as the bleed amount when embedding the copper foil tape layer. The bleed amount of Evaluation Sample A was 0.14 cm, and the bleed amount of Evaluation Sample B was 0.08 cm.

[0091] As described above, it was found that the thermosetting resin films of Examples 1 to 5 had improved curability of the adhesive layer at 120°C after light irradiation. In addition, it was found that the thermosetting resin film of Example 1 had a reduced bleed amount when embedding the copper foil tape layer. It is expected that the thermosetting resin films of Examples 2 to 5 will also have a reduced bleed amount when embedding the copper foil tape layer, since the curability of the adhesive layer is improved after light irradiation in the same manner as in the thermosetting resin film of Example 1. From these results, it was confirmed that the thermosetting resin film of the present disclosure is capable of suppressing bleed.

**Reference Signs List**

[0092] 10: adhesive layer, 10A: thermosetting resin film, 10a: adhesive layer piece, 14: substrate, 20, 20a: pressure-sensitive adhesive layer, 30: base material layer, 40: dicing film, 41: adhesive agent, 42: sealing layer, 50: underfill, 60: first semiconductor chip with an adhesive layer piece, 72: needle, 74: suction collet, 84, 94: circuit pattern, 88: second wire, 90: organic substrate, 98: first wire, 95: connection terminal, 96: electrode, 100: dicing/die bonding integrated film, 200, 201, 202: semiconductor device, Wa: first semiconductor chip, Waa: second semiconductor chip.

## CLAIMS

[Claim 1] A thermosetting resin film comprising a photobase generator that generates a base upon light irradiation.

[Claim 2] The thermosetting resin film according to claim 1, further comprising a photosensitizer.

[Claim 3] The thermosetting resin film according to claim 1, further comprising a thermosetting resin component and an elastomer,

wherein the thermosetting resin component comprises a resin that is cured by being heated in the presence of the base.

[Claim 4] The thermosetting resin film according to claim 3, further comprising an inorganic filler.

[Claim 5] The thermosetting resin film according to any one of claims 1 to 4, used for bonding a semiconductor chip to a substrate while embedding another semiconductor chip.

[Claim 6] The thermosetting resin film according to any one of claims 1 to 4, 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 7] A dicing/die bonding integrated film, comprising:

a dicing film having a base material layer and a pressure-sensitive adhesive layer provided on the base material layer; and

an adhesive layer consisting of the thermosetting resin film according to any one of claims 1 to 4, provided on the pressure-sensitive adhesive layer of the dicing film,

wherein the pressure-sensitive adhesive layer comprises an

ultraviolet curable pressure-sensitive adhesive agent.

[Claim 8] A method for manufacturing a semiconductor device, comprising:

disposing a semiconductor wafer on the adhesive layer of the dicing/die bonding integrated film according to claim 7;

singulating the semiconductor wafer and the adhesive layer;

irradiating the pressure-sensitive adhesive layer of the dicing film with ultraviolet rays via the base material layer;

picking up, from the pressure-sensitive adhesive layer, a first semiconductor chip with an adhesive layer piece having a first semiconductor chip and an adhesive layer piece attached to the first semiconductor chip; and

bonding the first semiconductor chip to a substrate on which a second semiconductor chip is mounted, with the adhesive layer piece of the first semiconductor chip with an adhesive layer piece,

wherein the second semiconductor chip is embedded by the adhesive layer piece of the first semiconductor chip with an adhesive layer piece.

[Claim 9] A method for manufacturing a semiconductor device, comprising:

disposing a semiconductor wafer on the adhesive layer of the dicing/die bonding integrated film according to claim 7;

singulating the semiconductor wafer and the adhesive layer;

irradiating the pressure-sensitive adhesive layer of the dicing film with ultraviolet rays via the base material layer;

picking up, from the pressure-sensitive adhesive layer, a first

semiconductor chip with an adhesive layer piece having a first semiconductor chip and an adhesive layer piece attached to the first semiconductor chip; and

bonding the first semiconductor chip to a second semiconductor chip, with the adhesive layer piece of the first semiconductor chip with an adhesive layer piece,

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

part or all of the wire is embedded by the adhesive layer piece of the first semiconductor chip with an adhesive layer piece.