DESCRIPTION

Title of Invention

PRODUCTION METHOD FOR SEMICONDUCTOR DEVICE, DIE-BONDING FILM, AND DICING/DIE-BONDING INTEGRATED ADHESIVE SHEET

Technical Field

[0001] The present invention relates to a method for producing a semiconductor device, a die-bonding film, and a dicing/die-bonding integrated adhesive sheet.

Background Art

[0002] As a method for producing a semiconductor device, a semiconductor wafer back surface pasting method is generally used. The semiconductor wafer back surface pasting method is a method in which a die-bonding film and a dicing tape are pasted to a back surface of a semiconductor wafer and then a part of the semiconductor wafer, the die-bonding film, and the dicing tape are cut by a dicing step. For example, a method has been proposed in which a die-bonding film is provided on a dicing tape and this is bonded to a semiconductor wafer (see, for example, Patent Literatures 1 to 4).

[0003] However, for the purpose of increasing the storage capacity per one package, recently, the number of chips stacked in the package is increased. According to this, it has been studied that thickness of the semiconductor wafer is reduced by a backgrinding step or the like, and for example, a semiconductor wafer having a thickness of 30 μm or less has been produced. When the semiconductor wafer is thinned, since the semiconductor wafer is easily broken in the dicing step, the production

efficiency may be greatly degraded.

[0004] As a method of individually dividing a relatively thin semiconductor wafer, for example, there has been known a method of individually dividing a semiconductor wafer (stealth dicing) by irradiating the inside of the semiconductor wafer on a line to cut the semiconductor wafer with laser light to form a modified layer, and then expanding the outer periphery (see, for example, Patent Literature 5). In the stealth dicing, even in a case where the thickness of the semiconductor wafer is relatively thin, since there is an effect of reducing defects such as chipping, the production efficiency can be expected to be improved.

[0005] As a dicing/die-bonding integrated adhesive sheet to be used in such stealth dicing, there has been disclosed a semiconductor wafer processing tape that is used when a bonding adhesive layer is cut along a chip by expansion and can be expanded (see, for example, Patent Literature 6).

Citation List

Patent Literature

[0006] Patent Literature 1: JP No. 2002-226796

Patent Literature 2: JP No. 2002-158276

Patent Literature 3: JP No. H02-032181

Patent Literature 4: WO 04/109786

Patent Literature 5: JP No. 2003-338467

Patent Literature 6: JP No. 2011-216508

Summary of Invention

Technical Problem

[0007] However, since the die-bonding film in the dicing/die-bonding

integrated adhesive sheet is usually flexible and has stretch properties, there is a problem in that the die-bonding film is difficult to be divided when the base film is expanded.

[0008] In this regard, a main object of the present invention is to provide a die-bonding film excellent in fracture-cuttability and a method for producing a semiconductor device using the same.

Solution to Problem

[0009] Conventionally, in order to improve the fracture-cuttability of the dicing/die-bonding integrated adhesive sheet, it has been known that an increase in stress due to thermal shrinkage of the base film of the dicing tape is adjusted (see, for example, Patent Literature 6 above). As a result of intensive studies of the present inventors in such a circumstance, it has been found that the elongation at break of the die-bonding film has an influence on fracture-cuttability, thereby completing the present invention.

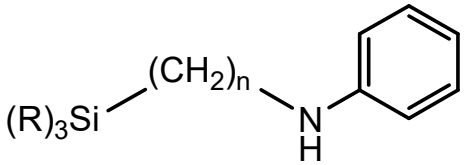
[0010] An aspect of the present invention relates to a method for producing a semiconductor device. This method for producing a semiconductor device includes: preparing a dicing/die-bonding integrated adhesive sheet which includes a bonding adhesive layer composed of a die-bonding film having an elongation at break at -15°C of 5% or less, an adhesive layer, and a base film in this order; preparing a semiconductor wafer and forming a modified layer with respect to the semiconductor wafer; pasting a surface of the bonding adhesive layer of the dicing/die-bonding integrated adhesive sheet to the semiconductor wafer; individually dividing the semiconductor wafer and the bonding adhesive layer by expanding the base film to produce a bonding adhesive

layer-attached semiconductor chip; picking up the bonding adhesive layer-attached semiconductor chip from the adhesive layer; and bonding the bonding adhesive layer-attached semiconductor chip to a support substrate for mounting a semiconductor chip via the bonding adhesive layer. The die-bonding film contains an epoxy resin, an epoxy resin curing agent, and an epoxy group-containing (meth)acrylic copolymer, and a total content of the epoxy resin and the epoxy resin curing agent is 10% by mass or more and less than 30% by mass on the basis of a total amount of the epoxy resin, the epoxy resin curing agent, and the epoxy group-containing (meth)acrylic copolymer.

[0011] A die shear strength at 250°C of the die-bonding film may be 0.7 MPa or more in a cured product of the die-bonding film after this die-bonding film is thermally compressed to a wiring board and cured at 170°C for 3 hours.

[0012] The die-bonding film may further contain a silane coupling agent.

[0013] The silane coupling agent may be a silane coupling agent represented by the following general formula (1):



(1)

where, in general formula (1), R is an alkoxy group and n is an integer of 1 to 3.

[0014] The die-bonding film may further contain an inorganic filler. A content of the inorganic filler may be 25% by mass or more on the basis of a total amount of the die-bonding film.

[0015] A content of the epoxy group-containing (meth)acrylic copolymer

may be 60% by mass or less on the basis of a total amount of the die-bonding film.

[0016] Another aspect of the present invention relates to a die-bonding film for bonding a semiconductor chip to a support member on which the semiconductor chip is mounted. An elongation at break at -15°C of this die-bonding film is 5% or less. Furthermore, this die-bonding film contains an epoxy resin, an epoxy resin curing agent, and an epoxy group-containing (meth)acrylic copolymer, and a total content of the epoxy resin and the epoxy resin curing agent is 10% by mass or more and less than 30% by mass on the basis of a total amount of the epoxy resin, the epoxy resin curing agent, and the epoxy group-containing (meth)acrylic copolymer.

[0017] Still another aspect of the present invention relates to a dicing/die-bonding integrated adhesive sheet. This dicing/die-bonding integrated adhesive sheet includes: a bonding adhesive layer composed of the aforementioned die-bonding film; an adhesive layer; and a base film in this order.

Advantageous Effects of Invention

[0018] According to the present invention, there are provided a die-bonding film excellent in fracture-cuttability and a method for producing a semiconductor device using the same. The die-bonding film according to some embodiments is also excellent in a die shear strength and embeddability. Further, according to the present invention, there is provided a dicing/die-bonding integrated adhesive sheet using such a die-bonding film.

Brief Description of Drawings

[0019] FIG. 1 is a schematic cross-sectional view illustrating an embodiment of a semiconductor device.

FIG. 2 is a schematic cross-sectional view for describing an embodiment of a method for producing a semiconductor device, and FIGS. 2(a), 2(b), 2(c), 2(d), and 2(e) are schematic cross-sectional views illustrating each step.

FIG. 3 is a schematic cross-sectional view for describing an embodiment of a method for producing a semiconductor device, and FIGS. 3(f), 3(g), 3(h), and 3(i) are schematic cross-sectional views illustrating each step.

FIG. 4 is a schematic cross-sectional view illustrating an embodiment of a dicing/die-bonding integrated adhesive sheet.

Description of Embodiments

[0020] Hereinafter, embodiments of the present invention will be described with reference to the drawings as appropriate. However, the present invention is not limited to the following embodiments. In the following embodiments, the constituent elements (including a step or the like) are not always indispensable unless otherwise specified. The sizes of constituent elements in the respective drawings are conceptual, and the relative size relationships between the constituent elements are not restricted to those illustrated in the respective drawings.

[0021] The same applies to numerical values and ranges thereof in the present specification, and the present invention is not limited thereby. In the present specification, a numerical range that has been indicated by use of "to" indicates the range that includes the numerical values which are described before and after "to", as the minimum value and the maximum

value, respectively. In a numerical range described in the present specification in a stepwise manner, an upper or lower limit value described in one numerical range may be replaced with an upper or lower limit value in the other numerical range described in a stepwise manner. Furthermore, in a numerical range described in the present specification, an upper or lower limit value of the numerical range may be replaced with a value shown in Examples.

[0022] In the present specification, (meth)acrylate means acrylate or methacrylate corresponding thereto. The same applies to other analogous expressions such as a (meth)acryloyl group and a (meth)acrylic copolymer.

[0023] [Semiconductor device]

FIG. 1 is a schematic cross-sectional view illustrating an embodiment of a semiconductor device. In a semiconductor device 100 illustrated in FIG. 1, a semiconductor chip Wa is bonded to a support substrate 60 for mounting a semiconductor chip via a bonding adhesive layer 30a (or a cured product of the bonding adhesive layer 30a). The semiconductor chip Wa is electrically connected to the support substrate 60 for mounting a semiconductor chip by a wire bond 70. The semiconductor chip Wa is resin-sealed on a surface 60a of the support substrate 60 for mounting a semiconductor chip by a resin sealing material 80. A solder ball 90 for electrical connection with an external substrate (mother board) may be formed on the surface of the support substrate 60 for mounting a semiconductor chip that is opposite to the surface 60a.

[0024] As the semiconductor chip, for example, general semiconductor

chips such as IC, LSI, and VLSI can be used.

[0025] As the support substrate for mounting a semiconductor chip, for example, a lead frame having a die pad, a ceramic substrate, an organic substrate, and the like can be used without limitation of substrate materials. Examples of the ceramic substrate include an alumina substrate and an aluminum nitride substrate. Examples of the organic substrate include an FR-4 substrate obtained by impregnating a glass cloth with an epoxy resin, a BT substrate obtained by impregnating a bismaleimide-triazine resin, and a polyimide film substrate using a polyimide film as a base material.

[0026] As a wiring to be provided in the support substrate for mounting a semiconductor chip, any of a single-sided wiring, a double-sided wiring, or a multi-layer wiring may be employed, and as necessary, a through hole or a non-through hole, which is electrically connected to the support substrate for mounting a semiconductor chip, may be provided. Further, in the case of disposing a wiring outside the semiconductor device, a protective resin layer may be provided.

[0027] [Method for producing semiconductor device (semiconductor package)]

FIGS. 2 and 3 are schematic cross-sectional views for describing an embodiment of a method for producing a semiconductor device. This method for producing a semiconductor device of an embodiment includes: a step of preparing a dicing/die-bonding integrated adhesive sheet which includes a bonding adhesive layer composed of a die-bonding film having an elongation at break at -15°C of 5% or less, an adhesive layer, and a base film in this order (dicing/die-bonding

integrated adhesive sheet preparation step); a step of preparing a semiconductor wafer and forming a modified layer with respect to the semiconductor wafer (modified layer formation step); a step of pasting a surface of the bonding adhesive layer of the dicing/die-bonding integrated adhesive sheet to the semiconductor wafer (wafer lamination step); a step of individually dividing the semiconductor wafer and the bonding adhesive layer by expanding the base film to produce a bonding adhesive layer-attached semiconductor chip (dicing step); a step of picking up the bonding adhesive layer-attached semiconductor chip from the adhesive layer (pickup step); and a step of bonding the bonding adhesive layer-attached semiconductor chip to a support substrate via the bonding adhesive layer (semiconductor chip bonding step).

[0028] <Dicing/die-bonding integrated adhesive sheet preparation step>

FIG. 4 is a schematic cross-sectional view illustrating an embodiment of a dicing/die-bonding integrated adhesive sheet. A dicing/die-bonding integrated adhesive sheet 1 includes a bonding adhesive layer 30, an adhesive layer 20, and a base film 10 in this order.

[0029] (Bonding adhesive layer)

The die-bonding film constituting the bonding adhesive layer 30 is a thermal cure type and may be in a state of a completely cured product (C-stage) through a semi-cured (B-stage) state after the curing treatment.

[0030] An elongation at break at -15°C of the die-bonding film is 5% or less. By using such a die-bonding film, there is a tendency that the die-bonding film is easily fracture-cut at the time of being expanded. The elongation at break at -15°C of the die-bonding film may be 4.5% or less, 4% or less, or 3.5% or less. The elongation at break at -15°C of the die-

bonding film may be, for example, 0.5% or more. Note that, in the present specification, the elongation at break at -15°C means a numerical value measured by the method described in Examples.

[0031] The die-bonding film contains an epoxy resin (hereinafter, referred to as "component (A)" in some cases), an epoxy resin curing agent (hereinafter, referred to as "component (B)" in some cases), and an epoxy group-containing (meth)acrylic copolymer (hereinafter, referred to as "component (C)" in some cases). The die-bonding film may further contain an inorganic filler (hereinafter, referred to as "component (D)" in some cases), and may further contain a silane coupling agent (hereinafter, referred to as "component (E)" in some cases). By adjusting the types and contents of these components, the elongation at break at -15°C of the die-bonding film can be adjusted.

[0032] Component (A): epoxy resin

The component (A) is a component having a property of forming a three-dimensional bond between molecules and being cured by heating or the like, and is a component exhibiting an adhesive action after being curing. The component (A) can be used without particular limitation as long as it has an epoxy group in the molecule. The component (A) may have two or more epoxy groups in the molecule.

[0033] 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 novolak type epoxy resin, a cresol novolak type epoxy resin, a bisphenol A novolak type epoxy resin, a bisphenol F novolak type epoxy resin, a stilbene type epoxy resin, a triazine skeleton-containing epoxy resin, a fluorene skeleton-containing epoxy resin, a triphenolmethane

type epoxy resin, a biphenyl type epoxy resin, a xylylene type epoxy resin, a biphenyl aralkyl type epoxy resin, a naphthalene type epoxy resin, a dicyclopentadiene type epoxy resin, a diglycidyl ether compound of a polyfunctional phenol and a polycyclic aromatic compound, such as anthracene. These may be used alone or in combination of two or more kinds thereof. Of these, the component (A) may be a cresol novolak type epoxy resin, a bisphenol type epoxy resin, or a dicyclopentadiene type epoxy resin from the viewpoint of tackiness, flexibility, or the like of the film.

[0034] The epoxy equivalent of the component (A) is not particularly limited, and may be 90 to 300 g/eq, 110 to 290 g/eq, or 130 to 280 g/eq. When the epoxy equivalent of the component (A) is in such a range, there is a tendency that the elongation at break of the die-bonding film can be adjusted to be lower. As a result, there is a tendency that the finally obtained die-bonding film is easily divided at the time of expansion since stress is more easily concentrated.

[0035] The content of the component (A) may be 1 to 30% by mass on the basis of the total amount of the die-bonding film. When the content of the component (A) is 1% by mass or more on the basis of the total amount of the die-bonding film, there are tendencies that the degree of crosslinking of the film becomes larger, the bulk strength is improved, and the peeling-off from the substrate is less likely to occur, and when the content of the component (A) is 30% by mass or less, there is a tendency that the thermal history resistance and the storage stability of the film are improved. The content of the component (A) may be 2% by mass or more, 3% by mass or more, or 5% by mass or more, and may be 20% by

mass or less, 15% by mass or less, or 10% by mass or less, on the basis of the total amount of the die-bonding film.

[0036] Component (B): epoxy resin curing agent

The component (B) may be, for example, a phenolic resin that may be a curing agent for an epoxy resin. The phenolic resin can be used without particular limitation as long as it has a phenolic hydroxyl group in the molecule. Examples of the phenolic resin include novolak type phenolic resins obtained by condensation or co-condensation of phenols such as phenol, cresol, resorcin, catechol, bisphenol A, bisphenol F, phenylphenol, and aminophenol and/or naphthols such as α-naphthol, β-naphthol, and dihydroxynaphthalene with a compound having an aldehyde group such as formaldehyde in the presence of an acidic catalyst; and phenol aralkyl resins and naphthol aralkyl resins synthesized from phenols such as allylated bisphenol A, allylated bisphenol F, allylated naphthalene diol, phenol novolak, phenol and/or naphthols with dimethoxyparaxylene or bis(methoxymethyl)biphenyl, a biphenyl aralkyl type phenolic resin, and a phenyl aralkyl type phenolic resin. These may be used alone or in combination of two or more kinds thereof.

[0037] The hydroxyl equivalent of the phenolic resin may be 40 to 300 g/eq, 70 to 290 g/eq, or 100 to 280 g/eq. When the hydroxyl equivalent of the phenolic resin is 40 g/eq or more, there is a tendency that the storage elastic modulus of the film is further improved, and when the hydroxyl equivalent thereof is 300 g/eq or less, defects caused by generation of foam, outgas, or the like can be prevented.

[0038] The ratio of the epoxy equivalent of the component (A) and the hydroxyl equivalent of the phenolic resin (the epoxy equivalent of the

component (A)/the hydroxyl equivalent of the phenolic resin) may be 0.30/0.70 to 0.70/0.30, 0.35/0.65 to 0.65/0.35, 0.40/0.60 to 0.60/0.40, or 0.45/0.55 to 0.55/0.45, from the viewpoint of curability. When this equivalent ratio is 0.30/0.70 or more, more sufficient curability tends to be obtainable. When this equivalent ratio is 0.70/0.30 or less, an excessive increase in viscosity can be prevented and more sufficient fluidity can be obtained.

[0039] The content of the component (B) may be 1 to 30% by mass on the basis of the total amount of the die-bonding film. When the content of the component (B) is 1% by mass or more on the basis of the total amount of the die-bonding film, there are tendencies that the degree of crosslinking of the film becomes larger, the bulk strength is improved, and the peeling-off from the substrate is less likely to occur, and when the content of the component (B) is 30% by mass or less, there is a tendency that the thermal history resistance and the storage stability of the film are improved. The content of the component (B) may be 2% by mass or more, 3% by mass or more, or 5% by mass or more, and may be 20% by mass or less, 15% by mass or less, or 10% by mass or less, on the basis of the total amount of the die-bonding film.

[0040] The total content of the component (A) and the component (B) may be 25% by mass or less on the basis of the total amount of the die-bonding film. The total content of the component (A) and the component (B) may be 20% by mass or less, 18% by mass or less or 15% by mass or less on the basis of the total amount of the die-bonding film. The total content of the component (A) and the component (B) may be 3% by mass or more, 5% by mass or more, or 7% by mass or more on the

basis of the total amount of the die-bonding film.

[0041] Component (C): epoxy group-containing (meth)acrylic copolymer

The (meth)acrylic copolymer means a polymer containing a structural unit derived from a (meth)acrylic acid ester. The epoxy group-containing (meth)acrylic copolymer is a polymer containing a structural unit derived from (meth)acrylic acid ester having an epoxy group, as a structural unit. Furthermore, the (meth)acrylic copolymer may be acrylic rubber such as a copolymer of (meth)acrylic acid ester and acrylonitrile. These may be used alone or in combination of two or more kinds thereof.

[0042] Examples of commercially available products of the component (C) include "SG-70L", "SG-708-6", "WS-023 EK30", "SG-280 EK23", "HTR-860P-3", "HTR-860P-3CSP", and "HTR-860P-3CSP-3DB" (all manufactured by Nagase ChemteX Corporation).

[0043] The glass transition temperature (Tg) of the component (C) may be -50°C to 50°C or -30°C to 20°C. When the Tg of the acrylic resin is -50°C or higher, there is a tendency that handling property is further improved since the tackiness of the die-bonding film is lowered. When the Tg of the acrylic resin is 50°C or lower, there is a tendency that the fluidity of the adhesive composition when the die-bonding film is formed can be further sufficiently secured. Herein, the glass transition temperature (Tg) of the component (C) means a value measured using DSC (differential scanning calorimeter) (for example, "Thermo Plus 2" manufactured by Rigaku Corporation).

[0044] The weight average molecular weight (Mw) of the component (C)

may be 50000 to 1200000, 100000 to 1200000, or 300000 to 900000. When the weight average molecular weight of the component (C) is 50000 or more, film formability tends to be further excellent. When the weight average molecular weight of the component (C) is 1200000 or less, there is a tendency that the fluidity of the adhesive composition when the die-bonding film is formed is further excellent. Note that, the weight average molecular weight (Mw) is a value as measured by gel permeation chromatography (GPC) and converted using a calibration curve of standard polystyrene.

[0045] A measurement apparatus, measurement conditions, and the like of the weight average molecular weight (Mw) of the component (C) are as follows.

Pump: L-6000 (manufactured by Hitachi, Ltd.)

Column: Column in which Gelpack GL-R440 (manufactured by Hitachi Chemical Co., Ltd.), Gelpack GL-R450 (manufactured by Hitachi Chemical Co., Ltd.), and Gelpack GL-R400M (manufactured by Hitachi Chemical Co., Ltd.) (each having a size of 10.7 mm (diameter) × 300 mm) are connected in this order

Eluent: Tetrahydrofuran (hereinafter, referred to as "THF")

Sample: Solution obtained by dissolving 120 mg of a sample in 5 mL of THF

Flow rate: 1.75 mL/min

[0046] The total content of the component (A) and the component (B) is 10% by mass or more and less than 30% by mass on the basis of the total amount of the component (A), the component (B), and the component (C). When the total content of the component (A) and the component

(B) is less than 30% by mass on the basis of the total amount of the component (A), the component (B), and the component (C), there is a tendency that the elongation at break of the die-bonding film can be adjusted to be low. As a result, there is a tendency that the finally obtained die-bonding film is easily divided at the time of expansion since stress is more easily concentrated. When the total content of the component (A) and the component (B) is 10% by mass or more on the basis of the total amount of the component (A), the component (B), and the component (C), there is a tendency that a higher die shear strength is exhibited in a cured product of the die-bonding film after the die-bonding film is thermally compressed to a wiring board and cured at 170°C for 3 hours. The total content of the component (A) and the component (B) may be 28% by mass or less, 25% by mass or less, 22% by mass or less, or 20% by mass or less, and may be 12% by mass or more or 15% by mass or more, on the basis of the total amount of the component (A), the component (B), and the component (C).

[0047] The content of the component (C) may be more than 70% by mass and 90% by mass or less on the basis of the total amount of the component (A), the component (B), and the component (C). When the content of the component (C) is more than 70% by mass on the basis of the total amount of the component (A), the component (B), and the component (C), there is a tendency that a step difference of the substrate when the die-bonding film is thermally compressed to a wiring board and molded is easily embedded. When the content of the component (C) is 90% by mass or less on the basis of the total amount of the component (A), the component (B), and the component (C), there is a tendency that the

elongation at break of the die-bonding film can be adjusted to be low. As a result, there is a tendency that the finally obtained die-bonding film is easily divided at the time of expansion since stress is more easily concentrated. The content of the component (C) may be 72% by mass or more, 75% by mass or more, 78% by mass or more, or 80% by mass or more, and may be 88% by mass or less or 85% by mass or less, on the basis of the total amount of the component (A), the component (B), and the component (C).

[0048] The content of the component (C) may be 60% by mass or less on the basis of the total amount of the die-bonding film. When the content of the component (C) is 60% by mass or less on the basis of the total amount of the die-bonding film, there is a tendency that the elongation at break of the die-bonding film can be adjusted to be lower. As a result, there is a tendency that the finally obtained die-bonding film is easily divided at the time of expansion since stress is more easily concentrated. The content of the component (C) may be 58% by mass or less on the basis of the total amount of the die-bonding film. The content of the component (C) may be 35% by mass or more, 40% by mass or more, or 45% by mass or more on the basis of the total amount of the die-bonding film.

[0049] Component (D): inorganic filler

Examples of the component (D) 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, crystalline silica, and amorphous silica. These may be used

alone or in combination of two or more kinds thereof. Among these, the component (D) may be silica.

[0050] When the average particle diameter of the component (D) is relatively large, there is a tendency that the elongation at break of the die-bonding film can be adjusted to be lower. As a result, there is a tendency that the finally obtained die-bonding film is easily divided at the time of expansion since stress is more easily concentrated. The average particle diameter of the component (D) may be 0.1 to 1.0 μm. The average particle diameter of the component (D) may be 0.2 μm or more, 0.3 μm or more, or 0.4 μm or more, and may be 0.9 μm or less, 0.8 μm or less, or 0.7 μm or less. Herein, the average particle diameter means a value obtained by conversion from a BET specific surface area.

[0051] The shape of the component (D) may be a spherical shape. Note that, the spherical shape is a concept including a perfect spherical shape.

[0052] The component (D) may be subjected to a surface treatment by a surface treatment agent from the viewpoints of compatibility of the surface of the component (D) with a solvent, other components, or the like and a bonding strength. As the surface treatment agent, for example, a silane-based coupling agent or the like is exemplified. Examples of a functional group of the silane-based coupling agent include a vinyl group, a (meth)acryloyl group, an epoxy group, a mercapto group, an amino group, a diamino group, an alkoxy group, and an ethoxy group.

[0053] The content of the component (D) may be 25% by mass or more on the basis of a total amount of the die-bonding film. When the content of the component (D) is 25% by mass or more on the basis of the total

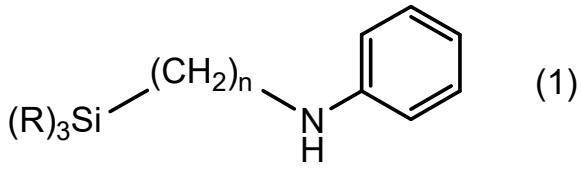
amount of the die-bonding film, there is a tendency that the elongation at break of the die-bonding film can be adjusted to be lower. As a result, there is a tendency that the finally obtained die-bonding film is easily divided at the time of expansion since stress is more easily concentrated. The content of the component (D) may be 26% by mass or more or 28% by mass or more on the basis of the total amount of the die-bonding film. The content of the component (D) may be 50% by mass or less, 45% by mass or less, or 40% by mass or less on the basis of the total amount of the die-bonding film. Furthermore, in a case where the die-bonding film contains the component (D), the total content of the component (A), the component (B), and the component (C) may be 75% by mass or less, 74% by mass or less, or 72% by mass or less, and may be 50% by mass or more, 55% by mass or more, or 60% by mass or more, on the basis of the total amount of the die-bonding film.

[0054] The mass ratio of the component (D) to the component (C) (the mass of the component (D)/the mass of the component (C)) may be 0.30 or more, 0.35 or more, 0.40 or more, 0.45 or more, or 0.50 or more. When the mass ratio of the component (D) to the component (C) (the mass of the component (D)/the mass of the component (C)) is 0.30 or more, there is a tendency that the elongation at break of the die-bonding film can be adjusted to be low. As a result, there is a tendency that the finally obtained die-bonding film is easily divided at the time of expansion since stress is more easily concentrated. The mass ratio of the component (D) to the component (C) (the mass of the component (D)/the mass of the component (C)) may be, for example, 0.80 or less, 0.70 or less, or 0.60 or less.

[0055] Component (E): silane coupling agent

When the die-bonding film contains the component (E), there is a tendency that an interfacial bond between different types of components can be further enhanced. The component (E) may be a silane coupling agent represented by general formula (1) below.

[0056]



(1)

[0057] In general formula (1), R is an alkoxy group such as a methoxy group or an ethoxy group and n is an integer of 1 to 3.

[0058] Examples of the silane coupling agent represented by general formula (1) include anilinopropyltrimethoxysilane, anilinopropyltriethoxysilane, anilinoethyltrimethoxysilane, anilinoethyltriethoxysilane, anilinomethyltrimethoxysilane, and anilinomethyltriethoxysilane.

[0059] The component (E) may contain a silane coupling agent other than the silane coupling agent represented by general formula (1). Examples of such a silane coupling agent include vinyl trichlorosilane, vinyl triethoxysilane, vinyl-tris(β-methoxyethoxy)silane, γ-methacryloxypropyltrimethoxysilane, β-(3,4-epoxy cyclohexyl)ethyltrimethoxysilane, γ-glycidoxypropyltrimethoxysilane, γ-glycidoxypropylmethyldimethoxysilane, vinyltriacetoxysilane, γ-mercaptopropyltrimethoxysilane, γ-aminopropyltrimethoxysilane, γ-aminopropylmethyldimethoxysilane, γ-aminopropyltriethoxysilane, γ-aminopropylmethyldiethoxysilane, γ-(N,N-

dimethyl)aminopropyltrimethoxysilane, γ-(N,N-diethyl)aminopropyltrimethoxysilane, γ-(N,N-dibutyl)aminopropyltrimethoxysilane, γ-(N-methyl)anilinopropyltrimethoxysilane, γ-(N-ethyl)anilinopropyltrimethoxysilane, γ-(N,N-dimethyl)aminopropyltriethoxysilane, γ-(N,N-diethyl)aminopropyltriethoxysilane, γ-(N,N-dibutyl)aminopropyltriethoxysilane, γ-(N-methyl)anilinopropyltriethoxysilane, γ-(N-ethyl)anilinopropyltriethoxysilane, γ-(N,N-dimethyl)aminopropylmethyldimethoxysilane, γ-(N,N-diethyl)aminopropylmethyldimethoxysilane, γ-(N,N-dibutyl)aminopropylmethyldimethoxysilane, γ-(N-methyl)anilinopropylmethyldimethoxysilane, γ-(N-ethyl)anilinopropylmethyldimethoxysilane, N-(trimethoxysilylpropyl)ethylenediamine, N-(dimethoxymethylsilyl isopropyl)ethylenediamine, methyltrimethoxysilane, dimethyldimethoxysilane, methyltriethoxysilane, γ-chloropropyltrimethoxysilane, hexamethyldisilane, vinyl trimethoxysilane, γ-mercaptopropylmethyldimethoxysilane, and γ-ureidopropyltriethoxysilane. These may be used alone or in combination of two or more kinds thereof.

[0060] The content of the component (E) may be 0.01 to 3.0% by mass on the basis of the total amount of the die-bonding film. When the content of the component (E) is in such a range, there is a tendency that an interfacial bond between different types of components can be further

enhanced.

[0061] The mass ratio of the silane coupling agent represented by general formula (1) with respect to the component (E) (the mass of the silane coupling agent represented by general formula (1)/the total mass of the component (E)) may be 0.5 or more, 0.6 or more, 0.7 or more, 0.8 or more, or 0.85 or more.

[0062] The die-bonding film may further contain a curing accelerator (hereinafter, referred to as "component (F)" in some cases).

[0063] Component (F): curing accelerator

When the die-bonding film contains the component (F), there is a tendency that both the adhesiveness and the shortened process time can be further achieved. Examples of the component (F) include imidazoles and derivatives thereof, an organic phosphorus-based compound, secondary amines, tertiary amines, and a quaternary ammonium salt. These may be used alone or in combination of two or more kinds thereof. Of these, the component (F) may be imidazoles and derivatives thereof from the viewpoint of reactivity.

[0064] Examples of the imidazoles include 2-methylimidazole, 1-benzyl-2-methylimidazole, 1-cyanoethyl-2-phenylimidazole, and 1-cyanoethyl-2-methylimidazole. These may be used alone or in combination of two or more kinds thereof.

[0065] The content of the component (F) may be 0.001 to 1% by mass on the basis of the total amount of the die-bonding film. When the content of the component (F) is in such a range, there is a tendency that storage stability can be improved while both the adhesiveness and the shortened process time can be achieved.

[0066] Other components

The die-bonding film may further contain an antioxidant agent, a rheological control agent, a leveling agent, and the like as other components. The content of these components may be 0.01 to 3% by mass on the basis of the total amount of the die-bonding film.

[0067] The die-bonding film can be produced by forming an adhesive composition containing the component (A) to the component (C) mentioned above, and as necessary, the component (D) to the component (F), and other components into a film shape. Such a die-bonding film can be formed by applying the adhesive composition to a support film. The adhesive composition may be used as a varnish of the adhesive composition diluted with a solvent. In the case of using the varnish of the adhesive composition, the die-bonding film can be formed by applying the varnish of the adhesive composition to a support film and heating and drying the solvent.

[0068] The solvent is not particularly limited as long as it can dissolve a component other than the component (D). Examples of the solvent include aromatic hydrocarbons such as toluene, xylene, mesitylene, cumene, and p-cymene; aliphatic hydrocarbons such as hexane and heptane; cyclic alkanes such as methylcyclohexane; cyclic ethers such as tetrahydrofuran and 1,4-dioxane; ketones such as acetone, methyl ethyl ketone, methyl isobutyl ketone, cyclohexanone, and 4-hydroxy-4-methyl-2-pentanone; esters such as methyl acetate, ethyl acetate, butyl acetate, methyl lactate, ethyl lactate, and γ-butyrolactone; carbonic esters such as ethylene carbonate and propylene carbonate; and amides such as N,N-dimethyl formamide, N,N-dimethyl acetamide, and N-methyl-2-

pyrrolidone. These may be used alone or in combination of two or more kinds thereof. Among these, from the viewpoints of solubility and a boiling point, the solvent may be toluene, xylene, methyl ethyl ketone, methyl isobutyl ketone, or cyclohexanone. The solid component concentration in the varnish of the adhesive composition may be 10 to 80% by mass on the basis of the total mass of the varnish of the adhesive composition.

[0069] The varnish of the adhesive composition can be prepared by mixing and kneading the component (A) to the component (C), and as necessary, the component (D) to the component (F), other components, and a solvent. Note that, the order of mixing and kneading of each component is not particularly limited, and can be appropriately set. The mixing and kneading can be performed by appropriately combining dispersers such as ordinary stirrers, milling machines, three-roll mills, ball mills, and bead mills. After a varnish of an adhesive composition is prepared, air bubbles in the varnish may be removed by vacuum deaeration or the like.

[0070] The support film is not particularly limited, and examples thereof include films of polytetrafluoroethylene, polyethylene, polypropylene, polymethylpentene, polyethylene terephthalate, polyimide, and the like. The thickness of the support film may be, for example, 10 to 200 μm or 20 to 170 μm.

[0071] As the method of applying the varnish of the adhesive composition to the support film, known methods can be used, and examples thereof include a knife coating method, a roll coating method, a spray coating method, a gravure coating method, a bar coating method,

and a curtain coating method. The heating and drying condition is not particularly limited as long as it is a condition that the used solvent volatilizes sufficiently, and for example, heating and drying may be performed, for example, at 50°C to 200°C for 0.1 to 90 minutes.

[0072] The thickness of the die-bonding film can be appropriately adjusted according to use applications. The thickness of the die-bonding film may be 3 to 40 μm, 5 to 35 μm, or 7 to 30 μm.

[0073] A die shear strength at 250°C of the die-bonding film may be 0.7 MPa or more in a cured product of the die-bonding film after this die-bonding film is thermally compressed to a wiring board and cured at 170°C for 3 hours. When the die shear strength at 250°C is 0.7 MPa or more, it is possible to prevent that peeling-off between the die-bonding film and the substrate at the time of conveying the substrate occurs, and foreign substances are mixed between the semiconductor wafer and the die-bonding film at the time of molding. The die shear strength at 250°C may be 0.8 MPa or more, 1.0 MPa or more, or 1.2 MPa or more. The upper limit of the die shear strength at 250°C is not particularly limited, and may be, for example, 3 MPa or less.

[0074] The obtained die-bonding film can be used as the bonding adhesive layer 30 without any changes.

[0075] (Adhesive layer and Base film)

The adhesive layer 20 and the base film 10 can use a laminate in which the adhesive layer 20 is provided on the base film 10, that is, the dicing tape.

[0076] The adhesive layer 20 may be a layer that is cured by high energy rays or heat (that is, whose adhesive force can be controlled), a layer that

is cured by high energy rays, or a layer that is cured by ultraviolet rays. As the adhesive constituting the adhesive layer, an adhesive that is generally used in the dicing tape field can be used. As the adhesive, an adhesive whose adhesive force with respect to the bonding adhesive layer 30 is reduced by irradiation of high energy rays can be appropriately selected.

[0077] As the base film 10, a base film that is generally used in the dicing tape field can be used. The base material of the base film 10 is not particularly limited as long as it can be expanded in the dicing step, and examples thereof include polyolefins such as crystalline polypropylene, amorphous polypropylene, high-density polyethylene, intermediate-density polyethylene, low-density polyethylene, very low-density polyethylene, low-density linear polyethylene, polybutene, and polymethylpentene, an ethylene-vinyl acetate copolymer, an ionomer resin, an ethylene-(meth)acrylic acid copolymer, an ethylene-(meth)acrylic acid ester (random or alternating) copolymer, an ethylene-butene copolymer, an ethylene-hexene copolymer, polyurethane, polyesters such as polyethylene terephthalate and polyethylene naphthalate, polycarbonate, polyimide, polyetheretherketone, polyetherimide, polyamide, whole aromatic polyamide, polyphenylsulfide, aramid (paper), glass, glass cloth, a fluorine resin, polyvinyl chloride, polyvinylidene chloride, a cellulose-based resin, and a silicone resin. Among these, from the viewpoint of properties such as Young's modulus, stress relaxation properties, and a melting point, the base material of the base film 10 may be polypropylene, a polyethylene-polypropylene random copolymer, a polyethylene-polypropylene block

copolymer, an ethylene-vinyl acetate copolymer, an ionomer resin, or an ethylene-(meth)acrylic acid copolymer.

[0078] By pasting the die-bonding film and the adhesive layer of the dicing tape, the dicing/die-bonding integrated adhesive sheet 1 including the bonding adhesive layer 30, the adhesive layer 20, and the base film 10 in this order can be obtained.

[0079] <Modified layer formation step>

First, a semiconductor wafer W1 having a thickness H1 is prepared. The thickness H1 of the semiconductor wafer W1 forming a modified layer may exceed 35 μm. Subsequently, a protective film 2 is pasted on one main surface of the semiconductor wafer W1 (see FIG. 2(a)). The surface to which the protective film 2 is pasted may be a circuit surface of the semiconductor wafer W1. The protective film 2 is a back grinding tape to be used in backgrinding of the semiconductor wafer. Subsequently, the inside of the semiconductor wafer W1 is irradiated with laser light to form a modified layer 4 (see FIG. 2(b)) and the surface (rear surface) of the semiconductor wafer W1 opposite to the surface to which the protective film 2 is stuck is subjected to backgrinding or polishing, thereby producing the semiconductor wafer W2 having the modified layer 4 (see FIG. 2(c)). A thickness H2 of the semiconductor wafer W2 thus obtained may be 35 μm or less.

[0080] <Wafer lamination step>

Then, the bonding adhesive layer 30 of the dicing/die-bonding integrated adhesive sheet 1 is disposed in a predetermined apparatus. Subsequently, the dicing/die-bonding integrated adhesive sheet 1 is pasted to a main surface Ws of the semiconductor wafer W2 via the

bonding adhesive layer 30 (see FIG. 2(d)), and the protective film 2 of the semiconductor wafer W2 is peeled off (see FIG. 2(e)).

[0081] <Dicing step>

Next, the semiconductor wafer W2 is divided with the modified layer 4 by expanding the base film 10 in a cooling condition. Thereby, the semiconductor wafer W2 and the bonding adhesive layer 30 are individually divided to produce a bonding adhesive layer-attached semiconductor chip (see FIG. 3(f)). The condition for expanding the base film 10 may be a cooling condition of 0°C or lower.

[0082] <Ultraviolet irradiation step>

The adhesive layer 20 may be irradiated with ultraviolet rays as necessary (see FIG. 3(g)). In a case where the adhesive in the adhesive layer 20 is cured by ultraviolet rays, this adhesive layer 20 is cured, and thereby the adhesive force between the adhesive layer 20 and the bonding adhesive layer 30 can be reduced. In ultraviolet irradiation, ultraviolet rays having a wavelength of 200 to 400 nm may be used. The ultraviolet irradiation conditions may be adjusted so that the illumination and the amount of irradiation are adjusted to be 30 to 240 mW/cm^2 and 200 to 500 mJ, respectively.

[0083] <Pickup step>

Next, by expanding the base film 10, while the diced bonding adhesive layer-attached semiconductor chips 50 are separated from each other, the bonding adhesive layer-attached semiconductor chip 50, which has been thrust up by a needle 42 from the side of the base film 10, is sucked by a suction collet 44 so as to be picked up from an adhesive cured product layer 20ac (see FIG. 3(h)). Note that, the bonding adhesive

layer-attached semiconductor chip 50 has the semiconductor chip Wa and the bonding adhesive layer 30a. The semiconductor chip Wa is obtained by dividing the semiconductor wafer W2 by dicing, and the bonding adhesive layer 30a is obtained by dividing the bonding adhesive layer 30 by dicing. The adhesive cured product layer 20ac is obtained by dividing the adhesive cured product layer, which is obtained by curing the adhesive layer, by dicing. The adhesive cured product layer 20ac may remain on the base film 10 when the bonding adhesive layer-attached semiconductor chip 50 is picked up. In the pickup step, it is not necessary to expand the base layer, but by expanding the base layer, pickup property can be further improved.

[0084] <Semiconductor chip bonding step>

Next, after picking up the bonding adhesive layer-attached semiconductor chip 50, the bonding adhesive layer-attached semiconductor chip 50 is bonded to the support substrate 60 for mounting a semiconductor chip via the bonding adhesive layer 30a (see FIG. 3(i)). A plurality of the bonding adhesive layer-attached semiconductor chips 50 may be bonded to the support substrate 60 for mounting a semiconductor chip. The bonding adhesive layer 30a may be cured, for example, by heating at 120°C to 150°C for 0.5 to 6 hours.

[0085] A semiconductor device illustrated in FIG. 1 can be produced by the production method including the above-described steps and further including a step in which the semiconductor chip Wa and the support substrate 60 for mounting a semiconductor chip are electrically connected by the wire bond 70 and a step in which the semiconductor chip Wa is resin-sealed on the surface 60a of the support substrate 60 for mounting

a semiconductor chip using the resin sealing material 80.

[0086] [Die-bonding film]

A die-bonding film of an embodiment is used for bonding a semiconductor chip to a support member on which the semiconductor chip is mounted, an elongation at break at -15°C of this die-bonding film is 5% or less. This die-bonding film contains an epoxy resin, an epoxy resin curing agent, and an epoxy group-containing (meth)acrylic copolymer, and a total content of the epoxy resin and the epoxy resin curing agent is 10% by mass or more and less than 30% by mass on the basis of a total amount of the epoxy resin, the epoxy resin curing agent, and the epoxy group-containing (meth)acrylic copolymer. The components contained in the die-bonding film, the content, and the like are the same as the components, the content, and the like exemplified in the aforementioned bonding adhesive layer. Therefore, herein the duplicate description will be omitted.

[0087] [Dicing/die-bonding integrated adhesive sheet]

A dicing/die-bonding integrated adhesive sheet of an embodiment includes: a bonding adhesive layer composed of the aforementioned die-bonding film; an adhesive layer; and a base film in this order.

Examples

[0088] Hereinafter, the present invention will be more specifically described by means of Examples. However, the present invention is not limited to these Examples.

[0089] <Production of die-bonding film>

A varnish of the adhesive composition was prepared by the following procedure. The type and content (solid content amount) of

each component is as shown in Table 1. First, (A) an epoxy resin, (B) an epoxy resin curing agent, (D) an inorganic filler, and (E) a silane coupling agent were mixed and cyclohexanone was added thereto and stirred. Subsequently, (C) an epoxy group-containing (meth)acrylic copolymer and (F) a curing accelerator were added and subjected to vacuum deaeration to thereby a varnish of an adhesive composition.

[0090] Note that, respective components in Table 1 are as follows.

[0091] Component (A): epoxy resin

(A1) Cresol novolak type epoxy resin (manufactured by NIPPON STEEL Chemical & Material CO., LTD., trade name "YDCN-700-10", epoxy equivalent: 210 g/eq)

[0092] Component (B): epoxy resin curing agent

(B1) Phenol aralkyl type phenolic resin (manufactured by Mitsui Chemicals, Inc., trade name "MILEX XLC-LL", softening point: 77°C, hydroxyl equivalent: 176 g/eq)

(B2) Biphenyl aralkyl type phenolic resin (manufactured by Nippon Kayaku Co., Ltd., trade name "KAYAHARD GPH-103", softening point: 99°C to 106°C, hydroxyl equivalent: 220 to 240 g/eq)

[0093] Component (C): epoxy group-containing (meth)acrylic copolymer

(C1) Acrylic rubber (manufactured by Nagase ChemteX Corporation, trade name "HTR-860P-3", weight average molecular weight: 800000, glass transition temperature: -13°C, butyl acrylate : ethyl acrylate : acrylonitrile : glycidyl methacrylate = 39.4 : 29.3 : 30.3 : 3.0 (mass ratio))

[0094] Component (D): inorganic filler

(D1) Silica filler (manufactured by Admatechs Company Limited, trade name "SC2050", average particle diameter: 0.5 μm, spherical silica including a perfect spherical shape)

(D2) Silica filler (manufactured by Admatechs Company Limited, trade name "YA050", average particle diameter: 0.05 μm, spherical silica including a perfect spherical shape)

[0095] Component (E): silane coupling agent

(E1) γ-Mercaptopropyltrimethoxysilane (manufactured by Momentive Performance Materials Japan LLC, trade name "A-189")

(E2) 3-(N-phenyl)aminopropyltrimethoxysilane (anilinopropyltrimethoxysilane) (manufactured by Momentive Performance Materials Japan LLC, trade name "Y9669", in general formula (1), all of R = a methoxy group, a silane coupling agent of n = 3)

(E3) Anilinomethyltrimethoxysilane (manufactured by Shin-Etsu Chemical Co., Ltd., trade name "X12-1191", in general formula (1), all of R = a methoxy group, a silane coupling agent of n = 1)

[0096] Component (F): curing accelerator

(F1) 1-Cyanoethyl-2-phenylimidazole (manufactured by SHIKOKU CHEMICALS CORPORATION, trade name "CUREZOL 2PZ-CN")

[0097] Then, the obtained varnish of the adhesive composition was applied onto a polyethylene terephthalate (PET) film having a thickness of 38 μm and subjected to a mold release treatment at the support film. The applied varnish was heated and dried at 90°C for 5 minutes and 130°C for 5 minutes. In this way, die-bonding films of Examples 1 to 3 and Comparative Examples 1 and 2 each having a thickness shown in

Table 1 and being in a semi-cured (B-stage) state were obtained on the support film.

[0098] <Measurement of elongation at break at -15°C >

Each of the die-bonding films of Examples 1 to 3 and Comparative Examples 1 and 2 was cut into a size of a width of 10 mm and a length of 100 mm to produce a strip sample for measuring an elongation at break. The support film of the sample for measurement was peeled off and removed, and then set in Tensilon (manufactured by SHIMADZU CORPORATION, trade name "UTM-III-500") such that a distance between jigs became 40 mm. Thereafter, the film was cooled to -15°C, the film length was measured while the film was pulled at a rate of 50 mm/min, and the film length at the time point of the film being broken was read. The elongation at break was calculated from the film length at the time point of being broken and the initial film length (40 mm) on the basis of the following formula. Results are shown in Table 1.

Elongation at break (%) = (Film length at the time point of being broken - Initial film length (40 mm))/Initial film length (40 mm) × 100

[0099] <Production of dicing/die-bonding integrated adhesive sheet>

A dicing tape that is a laminate of an adhesive layer and a base film was produced by applying an ultraviolet curable adhesive (thickness: 10 μm) to a base film containing an ionomer-based resin (thickness: 100 μm, diameter: 370 mm). Next, the support film-attached die-bonding films of Examples 1 to 3 and Comparative Examples 1 and 2 (thickness: Table 1, diameter: 312 mm) were prepared, the ultraviolet curable adhesive of the dicing tape and the die-bonding film were pasted to be in

contact with each other, and thereby dicing/die-bonding integrated adhesive sheets of Examples 1 to 3 and Comparative Examples 1 and 2 including the bonding adhesive layer (die-bonding film), the adhesive layer (ultraviolet curable adhesive), and the base film in this order were produced.

[0100] <Evaluation of fracture-cuttability>

A semiconductor wafer having a thickness of 50 μm and a diameter of 300 mm was prepared. A modified layer was formed on the semiconductor wafer so as to obtain a semiconductor chip having a size of 4 mm × 12 mm by using a stealth dicing laser saw (manufactured by DISCO Corporation, apparatus name "DFL7361"). Next, the thickness of the semiconductor wafer was adjusted to 25 μm by performing backgrinding using a backgrinding apparatus (manufactured by DISCO Corporation, apparatus name "DGP8761"). The support film of each of the dicing/die-bonding integrated adhesive sheets of Examples 1 to 3 and Comparative Examples 1 and 2 was peeled off, and the adhesive layer (die-bonding film) of each of the dicing/die-bonding integrated adhesive sheets was laminated and pasted to the semiconductor wafer whose thickness was adjusted to 25 μm, at 70°C using a lamination apparatus (manufactured by DISCO Corporation, apparatus name "DFM2800"). The semiconductor wafer to which the dicing/die-bonding integrated adhesive sheet was pasted was fixed, the dicing tape was expanded at -15°C using an expansion apparatus (manufactured by DISCO Corporation, apparatus name "DDS2300"), and the bonding adhesive layer and the semiconductor wafer was individually divided into bonding adhesive layer-attached semiconductor chips having a size of 4 mm × 12

mm. At this time, expansion conditions were adjusted so that the expansion rate became 100 mm/sec and the expansion amount became 8 mm. The individually-divided semiconductor chip was observed, a case where both of the bonding adhesive layer and the semiconductor wafer were cut at the same time but the proportion thereof was 90% or more of the entirety was regarded as good fracture-cuttability and evaluated as "A", and a case where the proportion thereof was less than 90% was regarded as poor fracture-cuttability and evaluated as "B". Results are shown in Table 1.

[0101] <Measurement of die shear strength>

The die shear strength of the die-bonding film was measured using the dicing/die-bonding integrated adhesive sheets of Examples 1 to 3 excellent in fracture-cuttability. The semiconductor chip used for measuring the die shear strength was produced as follows. A semiconductor wafer having a thickness of 400 μm was prepared, the die-bonding film side of each of the dicing/die-bonding integrated adhesive sheets of Examples 1 to 3 was laminated to the semiconductor wafer at a stage temperature of 70°C, and thereby a dicing sample was produced. The obtained dicing sample was cut using a full auto dicer DFD-6361 (manufactured by DISCO Corporation). The cutting was performed by a step cutting manner using two blades, and dicing blades ZH05-SD2000-N1-70-FF and ZH05-SD4000-N1-70-EE (both manufactured by DISCO Corporation) were used. The cutting conditions were set such that the number of revolutions of the blade was 4000 rpm, the cutting speed was 50 mm/sec, and the chip size was 5 mm × 5 mm. Regarding the cutting, the first cutting was performed so that about 200 μm of the semiconductor

wafer remained, and the second cutting was performed so that about 20 μm of cuts were formed in the dicing tape. Next, the adhesive layer composed of an ultraviolet curable adhesive was irradiated with ultraviolet rays to cure the adhesive layer. Then, the semiconductor chip to be picked up was picked up using a pickup collet. In the pickup, the semiconductor chip was thrust up using five pins in total of one pin at the center and four pins at four corners. The pickup conditions were set such that the thrust-up rate was 20 mm/sec and the thrust-up height was 450 μm. In this way, die-bonding film-attached semiconductor chips of Examples 1 to 3 were obtained. Each of the obtained die-bonding film-attached semiconductor chips of Examples 1 to 3 was compressed to a wiring board (solder resist-attached organic substrate, solder resist: TAIYO HOLDINGS CO., LTD., trade name "AUS308", irregularities on the substrate: about 6 μm) under the conditions of a temperature of 120°C, a pressure of 0.1 MPa, and a time of 1.0 second, and cured at 170°C for 3 hours to produce a sample of a cured product of the die-bonding film, and the die shear strength was measured at a measurement temperature of 250°C using a universal bond tester (manufactured by Nordson Advanced Technology (Japan) K.K). Results are shown in Table 1.

[0102] <Evaluation of embeddability>

The embeddability of the die-bonding film was evaluated using the dicing/die-bonding integrated adhesive sheets of Examples 1 to 3 excellent in fracture-cuttability. Die-bonding film-attached semiconductor chips of Examples 1 to 3 for evaluating embeddability were produced in the same manner as in production of the semiconductor

chip used in measurement of the die shear strength, except that a semiconductor wafer having a thickness of 75 μm was prepared and the chip size was adjusted to 7.5 mm × 7.5 mm. A sample obtained by pasting each of the die-bonding film-attached semiconductor chips of Examples 1 to 3 to a wiring board (solder resist-attached organic substrate, solder resist: TAIYO HOLDINGS CO., LTD., trade name "AUS308", irregularities on the substrate: about 6 μm) under the conditions of a temperature of 120°C, a pressure of 0.15 MPa, and a time of 1.0 second was produced, and this sample was cured by being heated at 150°C for 6 hours on a hot plate. Thereafter, the semiconductor chip was sealed under the conditions of 175°C, 6.9 MPa, and 120 seconds using a sealing material for molding (manufactured by Hitachi Chemical Co., Ltd., trade name "CEL-9700HF") to produce a package for evaluation. The wiring board of the package for evaluation was observed with a scanning acoustic microscope to check the embeddability of irregularities on the substrate. A case where there was no void in irregularities on the substrate was regarded as good embeddability and evaluated as "A", and a case where there were voids was regarded as poor embeddability and evaluated as "B". Results are shown in Table 1.

[0103] Table 1

		Exam. 1	Exam. 2	Exam. 3	Comp. Exam. 1	Comp. Exam. 2
Component (A)	(A1)	6	6	6	7	7
Component (B)	(B1)	3	3	3	3	3
	(B2)	3	3	3	4	4
Component (C)	(C1)	56	56	56	68	68
Component (D)	(D1)	29	29	29	-	16
	(D2)	-	-	-	16	-
Component (E)	(E1)	0.3	0.3	0.3	0.4	0.4
	(E2)	2.0	-	2.0	1.2	-
	(E3)	-	2.0	-	-	-
Component (F)	(F1)	0.01	0.01	0.01	0.01	0.01
Content (%) of Component (C) (on the basis of the total amount of the die-bonding film)		56.4	56.4	56.4	68.2	69.1
Content (%) of Component (D) (on the basis of the total amount of the die-bonding film)		29.2	29.2	29.2	16.1	16.3
[(A) + (B)]/[(A) + (B) + (C)] × 100 (%)		17.6	17.6	17.6	17.1	17.1
(D)/(C)		0.52	0.52	0.52	0.24	0.24
Thickness (μm) of die-bonding film		30	30	7	30	30
Elongation at break at -15°C		3.4	2.7	3.4	5.1	5.5
Fracture-cuttability		A	A	A	B	B
Die shear strength (250°C) (MPa)		2.0	2.0	1.3	-	-
Embeddability		A	A	A	-	-

[0104] The die-bonding films of Examples 1 to 3 having an elongation at break at -15°C of 5% or less were excellent in fracture-cuttability when being expanded as compared to the die-bonding films of Comparative Examples 1 and 2 having an elongation at break at -15°C of more than 5%. Furthermore, it was found that the die-bonding films of Examples 1 to 3 are excellent also in the die shear strength and embeddability.

[0105] As described above, it was confirmed that the die-bonding film of the present invention is excellent in fracture-cuttability.

Reference Signs List

[0106] 1: dicing/die-bonding integrated adhesive sheet, 2: protective film, 4: modified layer, 10: base film, 20: adhesive layer, 20ac: adhesive cured product layer, 30, 30a: bonding adhesive layer, 42: needle, 44: suction collet, 50: bonding adhesive layer-attached semiconductor chip, 70: wire bond, 60: support substrate for mounting semiconductor chip, 80: resin sealing material, 90: solder ball, W1, W2: semiconductor wafer, H1: thickness of semiconductor wafer W1, H2: thickness of semiconductor wafer W2, 100: semiconductor device.

CLAIMS

[Claim 1] A method for producing a semiconductor device, the method comprising:

preparing a dicing/die-bonding integrated adhesive sheet which includes a bonding adhesive layer composed of a die-bonding film having an elongation at break at -15°C of 5% or less, an adhesive layer, and a base film in this order;

preparing a semiconductor wafer and forming a modified layer with respect to the semiconductor wafer;

pasting a surface of the bonding adhesive layer of the dicing/die-bonding integrated adhesive sheet to the semiconductor wafer;

individually dividing the semiconductor wafer and the bonding adhesive layer by expanding the base film to produce a bonding adhesive layer-attached semiconductor chip;

picking up the bonding adhesive layer-attached semiconductor chip from the adhesive layer; and

bonding the bonding adhesive layer-attached semiconductor chip to a support substrate for mounting a semiconductor chip via the bonding adhesive layer,

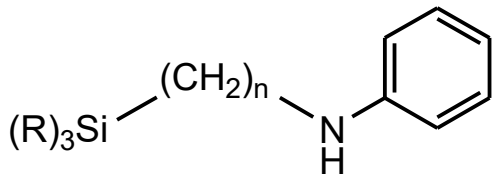
wherein the die-bonding film comprises an epoxy resin, an epoxy resin curing agent, an epoxy group-containing (meth)acrylic copolymer, an inorganic filler, a silane coupling agent and a curing accelerator,

a total content of the epoxy resin and the epoxy resin curing agent is 10% by mass or more and less than 30% by mass on the basis of a total amount of the epoxy resin, the epoxy resin curing agent, and the epoxy group-containing (meth)acrylic copolymer, and a mass ratio of the

inorganic filler to the epoxy group-containing (meth)acrylic copolymer is 0.30 or more.

[Claim 2] The method for producing a semiconductor device according to claim 1, wherein a die shear strength at 250°C of the die-bonding film is 0.7 MPa or more in a cured product of the die-bonding film after the die-bonding film is thermally compressed to a wiring board and cured at 170°C for 3 hours.

[Claim 3] The method for producing a semiconductor device according to claim 1, wherein the silane coupling agent is a silane coupling agent represented by the following general formula (1):



(1)

where, in general formula (1), R is an alkoxy group and n is an integer of 1 to 3.

[Claim 4] The method for producing a semiconductor device according to any one of claims 1 to 3, wherein a content of the inorganic filler is 25% by mass or more on the basis of a total amount of the die-bonding film.

[Claim 5] The method for producing a semiconductor device according to any one of claims 1 to 4, wherein a content of the epoxy group-containing (meth)acrylic copolymer is 60% by mass or less on the basis of a total amount of the die-bonding film.

[Claim 6] A die-bonding film for bonding a semiconductor chip to a support member on which the semiconductor chip is mounted,

an elongation at break at -15°C of the die-bonding film being 5%

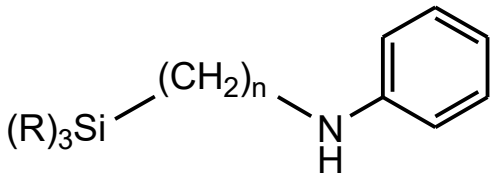
or less,

the die-bonding film comprising: an epoxy resin; an epoxy resin curing agent; an epoxy group-containing (meth)acrylic copolymer; an inorganic filler; a silane coupling agent; and a curing accelerator,

wherein a total content of the epoxy resin and the epoxy resin curing agent is 10% by mass or more and less than 30% by mass on the basis of a total amount of the epoxy resin, the epoxy resin curing agent, and the epoxy group-containing (meth)acrylic copolymer, and wherein a mass ratio of the inorganic filler to the epoxy group-containing (meth)acrylic copolymer is 0.30 or more.

[Claim 7] The die-bonding film according to claim 6, wherein a die shear strength at 250°C of the die-bonding film is 0.7 MPa or more in a cured product of the die-bonding film after the die-bonding film is thermally compressed to a wiring board and cured at 170°C for 3 hours.

[Claim 8] The die-bonding film according to claim 6, wherein the silane coupling agent is a silane coupling agent represented by the following general formula (1):



(1)

where, in general formula (1), R is an alkoxy group and n is an integer of 1 to 3.

[Claim 9] The die-bonding film according to any one of claims 6 to 8, wherein a content of the inorganic filler is 25% by mass or more on the basis of a total amount of the die-bonding film.

[Claim 10] The die-bonding film according to any one of claims 6 to

9, wherein a content of the epoxy group-containing (meth)acrylic copolymer is 60% by mass or less on the basis of a total amount of the die-bonding film.

[Claim 11] A dicing/die-bonding integrated adhesive sheet comprising, in the following order:

a bonding adhesive layer composed of the die-bonding film according to any one of claims 6 to 10;

an adhesive layer; and

a base film.