

DESCRIPTION

Title of Invention

BONDING FILM, METHOD FOR EVALUATING SAME, METHOD
5 FOR PRODUCING SEMICONDUCTOR DEVICE AND
INTEGRATED DICING/DIE BONDING FILM

Technical Field

[0001] The present disclosure relates to a bonding film used in a
producing process of a semiconductor device, a method for evaluating
10 the same, a method for producing a semiconductor device, and an
integrated dicing/die bonding film.

Background Art

[0002] In the related art, a semiconductor device is produced via the
following steps. First, a semiconductor wafer is pasted to an adhesive
15 sheet for dicing, and in this state, the semiconductor wafer is singulated
to a semiconductor chip (a dicing step). After that, a picking-up step, a
compressing step, a die bonding step, and the like are implemented.

[0003] Patent Literature 1 discloses a dicing/die bonding film having
both of a function of fixing a semiconductor wafer in a dicing step and a
20 function of bonding a semiconductor chip and a substrate in a die
bonding step. In the dicing step, a bonding adhesive piece-attached
chip is obtained by singulating the semiconductor wafer and a bonding
adhesive layer.

Citation List

Patent Literature

[0004] Patent Literature 1: Japanese Unexamined Patent Publication

No. 2017-216273

Summary of Invention

Technical Problem

[0005] In the related art, as illustrated in FIG. 8, in a case where
5 comparatively thin chips C1 to C4 are arranged in multiple stages on a
substrate 30 via a bonding adhesive layer A, peeling is likely to occur
between the chip C1 in the first stage and the chip C2 in the second
stage due to the warpage stress of the chips C1 to C4. In Patent
Literature 1, it is possible to solve the problem due to the warpage of the
10 chip by setting the tensile storage elastic modulus of a die bonding film
at 150°C before being thermally cured to a predetermined range.

[0006] However, as the thinning of the bonding film (the die bonding
film) progresses, a case increases in which it is not possible to handle
various problems in a semiconductor producing process with the index
15 of the related art. According to the studies of the present inventors, the
physical properties of the bonding film such as a tensile storage elastic
modulus, a shear velocity, and die shear do not necessarily correlate
with a process evaluation result. Therefore, the present inventors have
newly developed a method for evaluating a bonding film useful to
20 suppress the occurrence of peeling in a semiconductor package due to
the warpage of the chip.

[0007] The present disclosure provides a method for evaluating a
bonding film useful to handle a problem of peeling due to the warpage
of a chip in a producing process of a semiconductor device, in which a
25 bonding film with a thickness of 20 μm or less can be an evaluation
target. In addition, the present disclosure provides a bonding film

capable of sufficiently suppressing the occurrence of the peeling, a method for producing a semiconductor device using the same, and an integrated dicing/die bonding film including the bonding film described above.

5 **Solution to Problem**

[0008] One aspect of the present disclosure relates to a method for evaluating a bonding film used in a producing process of a semiconductor device. Such a method for evaluating a bonding film includes a step of performing a tack test with a heated probe, in which a
10 thickness of a bonding film to be an evaluation target is 20 μm or less.

[0009] As a result of observing the sectional surface of a semiconductor package with an electron microscope, the present inventors have found that the mode of the peeling that occurs in the semiconductor package is not the cohesion failure of the bonding film, but is mainly peeling on the
15 interface between the bonding film and a chip. Accordingly, the present inventors have assumed that the peeling occurs within a short period of time after compressing the chip, and have reached recognition that it is necessary to capture the instantaneous adhesive force (the tackiness) of the bonding film. On the basis of such recognition, it has
20 been conceived to evaluate the bonding film by the tack test. Note that, the tack test using the probe can be implemented on the basis of a method described in ASTM D-2979 (Standard Test Method for Pressure-Sensitive Tack of Adhesives Using an Inverted Probe Machine).

[0010] The tack test can be implemented by using a device including a
25 stage for supporting a sample of the bonding film, and a probe movable

with respect to the stage in an up and down direction, of which a temperature can be set. From the viewpoint of acquiring data with less variation, it is preferable to perform the tack test in a state where a resin film is interposed between the stage and the sample. Since a thin bonding film is the evaluation target, in a case where the surfaces of the stage and the probe are not strictly horizontal, the surface of the probe is likely to be in the state of pressing the sample to one side, which makes it difficult to efficiently acquire the data with less variation. By using the resin film, it is possible to avoid a state where the surface of the probe presses the sample to one side. Note that, examples of the resin film include a polyimide film. The polyimide film has appropriate elasticity and heat resistance.

[0011] When the bonding film satisfies both of Conditions 1 and 2 described below, from a correlation between the result of the method for evaluating a bonding film and the presence or absence of peeling in the actually produced semiconductor package, the bonding film can be determined as excellent.

(Condition 1) In the tack test in which a probe temperature is set to 100°C, tack is 2.5 N/5 mmφ or more.

(Condition 2) In the tack test in which a probe temperature is set to 120°C, tack is 2.5 N/5 mmφ or more.

[0012] One aspect of the present disclosure relates to a method for producing a semiconductor device. Such a method for producing a semiconductor device, includes steps of: preparing a laminated film including a bonding film with a thickness of 20 μm or less; pasting the laminated film to a wafer such that the bonding film is in contact with a

surface of the wafer; producing a bonding adhesive piece-attached chip by singulating the wafer and the bonding film; and bonding the bonding adhesive piece-attached chip onto a surface of a substrate or another chip, in which the bonding film is a bonding film determined as excellent in the method for evaluating a bonding film described above. According to such a method, the peeling is less likely to occur inside, and a semiconductor device with high reliability can be produced.

[0013] One aspect of the present disclosure relates to a bonding film used in a producing process of a semiconductor device. The bonding film has a thickness of 20 μm or less, and can be determined as excellent in the method for evaluating a bonding film described above. One aspect of the present disclosure relates to an integrated dicing/die bonding film. Such a film includes: a base material film; a bonding adhesive layer with a thickness of 20 μm or less; and an adhesive layer, in this order, in which the bonding adhesive layer includes a bonding film determined as excellent in the method for evaluating a bonding film described above.

Advantageous Effects of Invention

[0014] According to the present disclosure, the method for evaluating a bonding film useful to handle the problem of the peeling due to the warpage of the semiconductor chip in the producing process of the semiconductor device is provided, in which the bonding film with a thickness of 20 μm or less can be the evaluation target. In addition, according to the present disclosure, the bonding film capable of sufficiently suppressing the occurrence of the peeling, the method for producing a semiconductor device using the same, and the integrated

dicing/die bonding film including the bonding film described above are provided.

Brief Description of Drawings

[0015] FIG. 1 is a sectional view schematically illustrating an example of a device for implementing a tack test.

FIG. 2(a) is a plan view schematically illustrating one embodiment of an integrated dicing/die bonding film according to the present disclosure, and FIG. 2(b) is a schematic sectional view taken along line B-B in FIG. 2(a).

FIG. 3 is a sectional view schematically illustrating one embodiment of a semiconductor device according to the present disclosure.

FIG. 4 is a sectional view schematically illustrating an example of a bonding adhesive piece-attached chip.

FIG. 5(a) and FIG. 5(b) are sectional views schematically illustrating a process of producing the bonding adhesive piece-attached chip illustrated in FIG. 4.

FIG. 6(a) to FIG. 6(c) are sectional views schematically illustrating the process of producing the bonding adhesive piece-attached chip illustrated in FIG. 4.

FIG. 7(a) and FIG. 7(b) are sectional views schematically illustrating a process of producing the semiconductor device illustrated in FIG. 3.

FIG. 8 is a sectional view schematically illustrating a structure in which peeling occurs between a chip in the first stage and a chip in the second stage.

FIG. 9 is a sectional view schematically illustrating structures produced in Examples and Comparative Examples in order to reproduce peeling in a producing process of a semiconductor device.

Description of Embodiments

5 [0016] Hereinafter, an embodiment of the present disclosure will be described in detail, with reference to the drawings. In the following description, the same reference numerals will be applied to the same or corresponding parts, and the repeated description will be omitted. In addition, a positional relationship such as the left, right, top, and bottom
10 is based on a positional relationship illustrated in the drawings, unless otherwise specified. A dimension ratio in the drawings is not limited to the illustrated ratio. In this specification, (meth)acrylate indicates acrylate or methacrylate corresponding thereto. The same applies to other similar expressions such as a (meth)acryloyl group and a
15 (meth)acrylic copolymer.

[0017] In a case where terms such as "left", "right", "front", "back", "up", "down", "upper", and "lower" are used in the description of this specification and the claims, such terms are intended for description and do not necessarily indicate that such a relative position is permanent.

20 In addition, the term "layer" includes not only a structure in which a layer is formed on the entire surface but also a structure in which a layer is formed on a part of the surface when observed as a plan view. "A or B" may include either A or B, or may include both.

[0018] In this specification, the term "step" in this specification
25 includes not only an independent step but also a step that is not explicitly distinguishable from other steps insofar as a desired function

of the step is attained. In addition, a numerical range represented by using "to" indicates a range including numerical values described before and after "to" as the minimum value and the maximum value, respectively.

5 [0019] In this specification, in a case where there are a plurality of substances corresponding to each component in a composition, unless otherwise specified, the content of each component in the composition indicates the total amount of the plurality of substances in the composition. In addition, exemplified materials may be used alone, or
10 two or more types thereof may be used in combination, unless otherwise specified. In addition, in numerical ranges described in stages in this specification, the upper limit value or the lower limit value of a numerical range in a certain stage may be replaced with the upper limit value or the lower limit value of a numerical range in the other stage.
15 In addition, in the numerical range described in this specification, the upper limit value or the lower limit value of the numerical range may be replaced with values described in Examples.

[0020] <Method for evaluating bonding film>

A method for evaluating a bonding film according to this
20 embodiment includes a step of performing a tack test with a heated probe. A bonding film to be an evaluation target is used in a producing process of a semiconductor device. The thickness of the bonding film may be 20 μm or less, 18 μm or less, 15 μm or less, 12 μm or less, or 10 μm or less. The lower limit of the thickness of the bonding film is not
25 particularly limited, and for example, may be 1 μm or 5 μm . By setting the thickness of the bonding film to 20 μm or less, it is possible

to attain a thin semiconductor device, whereas by setting the thickness to 1 μm or more, it is easy to ensure a sufficient bonding strength.

[0021] FIG. 1 is a sectional view schematically illustrating an example of a device for implementing the tack test. A device 10 illustrated in this drawing includes a stage 1, a probe 2, and a pressing jig 3. The probe 2 is pressed against a sample S (the bonding film) on the stage 1, and an adhesive force in a separating process is measured. The probe 2 is movable with respect to the stage 1 in an up and down direction, of which the temperature can be set. The tip portion of the probe 2 contains stainless steel, and has a cylindrical shape. The tip surface of the probe 2 is sufficiently flat and smooth. The pressing jig 3 is for pressing the sample S such that the sample S on the stage is not pasted to the probe 2 and moved to upward. By converting a load applied to the probe 2 into an electrical signal, it is possible to obtain data of the adhesive force of the sample. The tack test can be implemented by using a commercially available device (for example, a tacking tester TAC1000 (Product Name), manufactured by RHESCA Co., LTD.).

[0022] The condition of the tack test may be in the following range.

- Temperature of stage 1: 20 to 25°C (a room temperature)
- Temperature of probe 2: 80 to 140°C
- Approaching rate of probe 2: 0.5 to 2.0 mm/second
- Pressurizing force: 0.05 to 0.2 MPa
- Pressurizing time: 0.5 to 5 seconds
- Separating rate of probe 2: 0.5 to 5.0 mm/second

[0023] From the viewpoint of acquiring data with less variation, as illustrated in FIG. 1, it is preferable to perform the tack test in the state

of interposing a polyimide film 5 (a resin film) between the stage 1 and the sample S. The thickness of the polyimide film 5, for example, may be 50 to 200 μm , or 100 to 150 μm . The tensile elastic modulus of the polyimide film 5, for example, is 2.5 to 4.5 GPa. Such a tensile elastic modulus indicates a value measured on the basis of a method described in ASTM D-882. The heat resistance temperature of the polyimide film 5, for example, is 250 to 320°C. Note that, here, the case of using the polyimide film 5 is exemplified, but other resin films may be used. The resin films may have the same degree of elasticity as that of the polyimide film and heat resistance higher than or equal to the set temperature of the probe, and specific examples thereof include an aramid film, a polyphenylene sulfide film, a polyethylene naphthalate film, a polyethylene terephthalate film, and the like.

[0024] When the bonding film satisfies both of Conditions 1 and 2 described below, from a correlation between the result of the method for evaluating a bonding film using the tack test and the presence or absence of peeling in the actually produced semiconductor package, the bonding film can be determined as excellent.

(Condition 1) In the tack test in which a probe temperature is set to 100°C, tack is 2.5 N/5 mm ϕ or more.

(Condition 2) In the tack test in which a probe temperature is set to 120°C, tack is 2.5 N/5 mm ϕ or more.

[0025] In a case where it is determined whether the bonding film satisfies Conditions 1 and 2, the tack test is implemented in the following condition.

· Temperature of stage 1: 25°C

- Temperature of probe 2: 100°C or 120°C
- Approaching rate of probe 2: 1.0 mm/second
- Pressurizing force: 0.1 MPa
- Pressurizing time: 1.0 second
- 5 · Separating rate of Probe 2: 1.0 mm/second
- Tip Surface of probe 2: in the shape of a circle with a diameter of 5 mm

[0026] In the tack test where the probe temperature is set to 100°C, as described above, the tack is 2.5 N/5 mmφ or more (Condition 1), and
10 the value may be 3.0 N/5 mmφ or more. The upper limit value of the value, for example, is 6.0 N/5 mmφ. In the tack test where the probe temperature is set to 120°C, as described above, the tack is 2.5 N/5 mmφ or more (Condition 2), and the value may be 3.0 N/5 mmφ or more. The upper limit value of the value, for example, is 6.0 N/5
15 mmφ.

[0027] <Integrated dicing/die bonding film>

A bonding adhesive film satisfying both of Conditions 1 and 2 can be applied to a bonding adhesive layer of an integrated dicing/die bonding film. FIG. 2(a) is a plan view schematically illustrating an
20 integrated dicing/die bonding film according to this embodiment, and FIG. 2(b) is a schematic sectional view taken along line B-B in FIG. 2(a). An integrated dicing/die bonding film 20 (hereinafter, simply referred to as the "film 20", in some cases) includes a base material film 11, an adhesive layer 13, and a bonding adhesive layer 15, in this order.
25 The bonding adhesive layer 15 includes the bonding adhesive film satisfying both of Conditions 1 and 2 described above. In this

embodiment, a mode is exemplified in which one laminate of the adhesive layer 13 and the bonding adhesive layer 15 is formed on the square base material film 11, but the base material film 11 may have a predetermined length (for example, 100 m or more) and the laminates of the adhesive layer 13 and the bonding adhesive layer 15 may be arranged at a predetermined interval in the longitudinal direction of the base material film.

[0028] Examples of the base material film 11 include a plastic film such as a polytetrafluoroethylene film, a polyethylene terephthalate film, a polyethylene film, a polypropylene film, a polymethyl pentene film, and a polyimide film. The base material film 11 may be subjected to a surface treatment such as primer coating, a UV treatment, a corona discharge treatment, a grinding treatment, and an etching treatment, as necessary.

[0029] The adhesive layer 13 includes a first surface F1 facing the base material film 11, and a second surface F2 on the opposite side. The adhesive layer 13, for example, is formed via a step of applying a coating liquid containing a resin composition with an appropriate adhesive force to the surface of the plastic film described above. The adhesive layer 13, for example, may have properties that the adhesive force is decreased by the irradiation of an ultraviolet ray.

[0030] The bonding adhesive layer 15 is provided to cover the center portion of the second surface F2 of the adhesive layer 13. As described above, the bonding adhesive layer 15 includes the bonding adhesive film (a film-shaped bonding adhesive) satisfying both of Conditions 1 and 2. The bonding adhesive layer 15 contains a

thermosetting resin composition and has an excellent adhesive force (tackiness). By producing the semiconductor device using the bonding adhesive layer 15, it is possible to sufficiently suppress the peeling due to the warpage of a chip, in the semiconductor device.

5 [0031] The bonding adhesive layer 15, for example, contains a thermosetting resin (hereinafter, may be referred to as a "component (A)"), a curing agent (hereinafter, may be referred to as a "component (B)"), and an elastomer (hereinafter, may be referred to as a "component (C)"). The bonding adhesive layer 15 may further contain an inorganic
10 filler (hereinafter, may be referred to as a "component (D)"), a coupling agent (hereinafter, may be referred to as a "component (E)"), a curing accelerator (hereinafter, may be referred to as a "component (F)"), and other components, in addition to the component (A), the component (B), and the component (C). The bonding adhesive layer 15 may be in a
15 completely cured (C stage) state after a curing treatment, via a semi-cured (B stage) state.

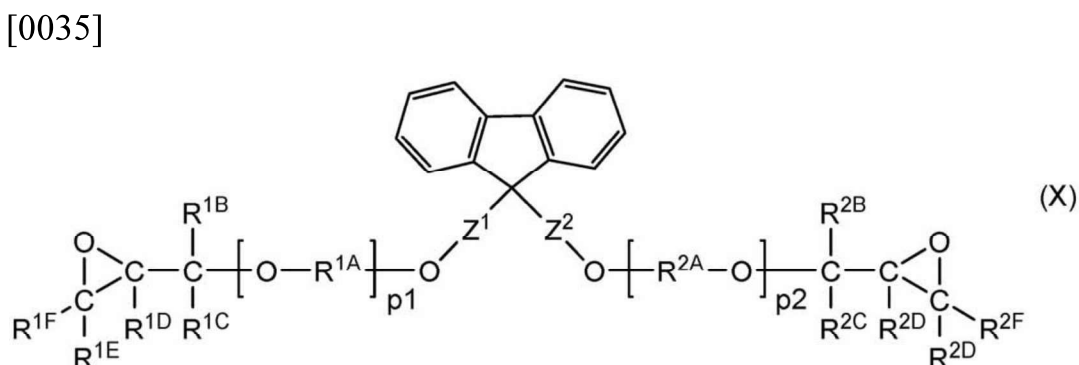
[0032] Component (A): Thermosetting Resin

From the viewpoint of bonding properties, the component (A) may contain an epoxy resin, or may contain one type or two or more
20 types of epoxy resins. The bonding adhesive layer 15, for example, contains an epoxy resin having a fluorene skeleton (hereinafter, may be referred to as a "component (A1)"), as the component (A).

[0033] The component (A1), for example, is a compound having a fluorene skeleton and an epoxy group in molecules. The component
25 (A1) can be used without any particular limitation insofar as the compound satisfies such a condition. By containing the component

(A1) as the thermosetting resin, the bonding adhesive layer 15 can be excellent in dividing properties due to cooling expansion and can also be excellent in the bonding properties to a wafer. The inventors of the present disclosure consider the reason that such an effect is obtained as follows. Since the fluorene skeleton has a rigid and sterically bulky structure, it is assumed that the molecules of other materials can be moved into the gap of the structure. Accordingly, it is considered that the component (A1) is easily mixed with an elastomer (for example, acrylic rubber), and modifies the properties of the elastomer to being hard and easy to cut from being soft and hard to cut. Accordingly, it is considered that the elastic modulus is improved, and the bonding properties to the wafer are also improved.

[0034] The component (A1), for example, may be an epoxy resin represented by General Formula (X) described below.



[0036] In Formula (X), Z^1 and Z^2 each independently represent a divalent aromatic hydrocarbon group. Z^1 and Z^2 may be the same or different from each other, but may be the same. Examples of the divalent aromatic hydrocarbon group include groups obtained by removing two hydrogen atoms directly bonded to carbon atoms configuring a ring from monocyclic aromatic hydrocarbon (examples

thereof include benzene), or polycyclic aromatic hydrocarbon (examples thereof include dicyclic aromatic hydrocarbon such as naphthalene and indene; tricyclic aromatic hydrocarbon such as anthracene, phenanthrene, dihydrophenanthrene, and fluorene; tetracyclic aromatic hydrocarbon such as benzoanthracene, benzophenanthrene, benzofluorene, pyrene, and fluoranthene). The divalent aromatic hydrocarbon group includes groups (for example, a biphenyl diyl group, a terphenyl diyl group, and the like) obtained by removing two hydrogen atoms directly bonded to carbon atoms configuring a ring from aromatic hydrocarbon obtained by linking a plurality of aromatic hydrocarbons. The divalent aromatic hydrocarbon group may be a benzene diyl group (a phenylene group) or naphthalene diyl (a naphthalene group).

[0037] The fluorene skeleton in the epoxy resin represented by Formula (X), and the divalent aromatic hydrocarbon group represented by Z^1 and Z^2 may have a substituent. Examples of the substituent include an alkyl group such as a methyl group, an ethyl group, and a propyl group; a cycloalkyl group such as a cyclopentyl group and a cyclohexyl group; an aryl group such as a phenyl group and a naphthyl group; an aralkyl group such as a benzyl group; an acyl group such as an acetyl group, a propionyl group, and a benzoyl group; an alkoxy group such as a methoxy group, an ethoxy group, a propyl oxy group, and an isopropyl oxy group; an alkoxycarbonyl group such as a methoxycarbonyl group and an ethoxycarbonyl group; a cyano group; a carboxyl group; a nitro group; an amino group; a substituted amino group (for example, a mono- or dialkyl amino group, and the like); a halogen atom such as a

fluorine atom and a chlorine atom.

[0038] In Formula (X), R^{1A} and R^{2A} each independently represent an alkylene group having 1 to 10 carbon atoms. R^{1A} and R^{2A} may be the same or different from each other, but may be the same. Examples of the alkylene group include a linear or branched alkylene group having 1 to 10 carbon atoms, such as a methylene group, an ethylene group, a propylene group, a trimethylene group, a tetramethylene group, and a hexamethylene group. The alkylene group may be an alkylene group having 2 to 6 carbon atoms, or may be an alkylene group having 2 or 3 carbon atoms.

[0039] In Formula (X), $p1$ and $p2$ each independently represent an integer of 0 or more. $p1$ and $p2$ may be the same or different from each other, but may be the same. $p1$ and $p2$ may be an integer of 0 to 4, or may be an integer of 1 to 4.

[0040] In Formula (X), R^{1B} , R^{1C} , R^{1D} , R^{1E} , R^{1F} , R^{2B} , R^{2C} , R^{2D} , R^{2E} , and R^{2F} each independently represent a hydrogen atom or an alkyl group having 1 to 6 carbon atoms. R^{1B} , R^{1C} , R^{1D} , R^{1E} , R^{1F} , R^{2B} , R^{2C} , R^{2D} , R^{2E} , and R^{2F} may be the same or different from each other. Examples of the alkyl group having 1 to 6 carbon atoms include a methyl group, an ethyl group, a propyl group, an isopropyl group, a butyl group, an isobutyl group, a s-butyl group, a t-butyl group, a pentyl group, and a hexyl group. R^{1B} , R^{1C} , R^{1D} , R^{1E} , R^{1F} , R^{2B} , R^{2C} , R^{2D} , R^{2E} , and R^{2F} may be a hydrogen atom or an alkyl group having 1 to 3 carbon atoms, or may be a hydrogen atom.

[0041] Examples of a commercially available product of the epoxy resin represented by General Formula (X) include PG-100, EG-200, and

CG-500 (Product Name, all are manufactured by Osaka Gas Chemicals Co., Ltd.).

[0042] The epoxy equivalent of the component (A1) is not particularly limited, and may be 80 to 600 g/eq, 100 to 500 g/eq, or 200 to 400 g/eq.

5 In a case where the epoxy equivalent of the component (A1) is in such a range, there is a tendency that more excellent reactivity and fluidity are obtained.

[0043] The content of the component (A1) may be 40 to 100% by mass, on the basis of the total mass of the component (A). In a case where
10 the content of the component (A1) is in such a range, there is a tendency that the effect of the present disclosure is more remarkable. The content of the component (A1) may be 50% by mass or more, 60% by mass or more, 70% by mass or more, or 80% by mass or more, on the basis of the total mass of the component (A).

15 [0044] The content of the component (A1) may be 1% by mass or more, 3% by mass or more, or 5% by mass or more, and may be 30% by mass or less, 20% by mass or less, or 15% by mass or less, on the basis of the total mass of the bonding adhesive layer 15. In a case where the content of the component (A1) is 1% by mass or more, on the basis of
20 the total mass of the bonding adhesive layer 15, there is a tendency that an elastic modulus after curing is more excellent. In a case where the content of the component (A1) is 30% by mass or less, on the basis of the total mass of the bonding adhesive layer 15, there is a tendency that flexibility before curing is more excellent.

25 [0045] The component (A) may further contain an epoxy resin not having a fluorene skeleton in molecules (hereinafter, may be referred to

as a "component (A2)") in addition to the component (A1). Examples of the component (A2) 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 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; a diglycidyl ether compound of polyfunctional phenols and polycyclic aromatics such as anthracene. Among them, the component (A2) may contain the cresol novolac-type epoxy resin.

[0046] The epoxy equivalent of the component (A2) is not particularly limited, and may be 80 to 600 g/eq, 100 to 500 g/eq, or 200 to 400 g/eq.

In a case where the epoxy equivalent of the component (A1) is in such a range, there is a tendency that more excellent reactivity and fluidity are obtained.

[0047] The content of the component (A2) may be 0 to 60% by mass, on the basis of the total mass of the component (A). The content of the component (A2) may be 50% by mass or less, 40% by mass or less, 30% by mass or less, or 20% by mass or less, on the basis of the total mass of the component (A).

[0048] The content of the component (A) may be 1% by mass or more, 3% by mass or more, or 5% by mass or more, and may be 30% by mass or less, 20% by mass or less, or 15% by mass or less, on the basis of the total mass of the bonding adhesive layer 15. In a case where the

content of the component (A) is 1% by mass or more, on the basis of the total mass of the bonding adhesive layer 15, there is a tendency that the elastic modulus after curing is more excellent. In a case where the content of the component (A) is 30% by mass or less, on the basis of the total mass of the bonding adhesive layer 15, there is a tendency that the flexibility before curing is more excellent.

[0049] Component (B): Curing Agent

As the curing agent of the component (A), generally used curing agents can be used. In a case where the component (A) contains the epoxy resin (including one type or two or more types of epoxy resins), examples of the component (B) include a phenolic resin, an ester compound, aromatic amine, aliphatic amine, and an acid anhydride. Among them, from the viewpoint of reactivity and temporal stability, the component (B) may be the phenolic resin.

[0050] The phenolic resin can be used without any particular limitation insofar as the resin has a phenolic hydroxyl group in molecules. Examples of the phenolic resin include a novolac-type phenolic resin obtained by condensing or co-condensing phenols such as phenol, cresol, resorcinol, 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, in the presence of an acidic catalyst, a phenol aralkyl resin, a naphthol aralkyl resin, a biphenyl aralkyl-type phenolic resin, and a phenyl aralkyl-type phenolic resin, synthesized from phenols such as allylated bisphenol A, allylated bisphenol F, allylated naphthalenediol, phenol novolac, and phenol and/or naphthols, and dimethoxyparaxylene

or bis(methoxymethyl) biphenyl.

[0051] The hydroxyl group equivalent of the phenolic resin may be 70 g/eq or more, or 70 to 300 g/eq. In a case where the hydroxyl group equivalent of the phenolic resin is 70 g/eq or more, there is a tendency that a storage modulus is further improved, and in a case where the hydroxyl group equivalent is 300 g/eq or less, it is possible to prevent problems due to the occurrence of foaming, outgasing, or the like.

[0052] The softening point of the phenolic resin may be 90°C or higher, 95°C or higher, 100°C or higher, 105°C or higher, 110°C or higher, or 115°C or higher. The upper limit of the softening point of the phenolic resin, for example, may be 200°C or lower. Note that, the softening point is based on JIS K7234, and indicates a value measured by a ring and ball method.

[0053] The content of the component (B) may be 1% by mass or more, 2% by mass or more, or 3% 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 mass of the bonding adhesive layer 15.

[0054] In a case where the component (A) is the epoxy resin, and the component (B) is the phenolic resin, a ratio (Epoxy Equivalent of Epoxy Resin/Hydroxyl Group Equivalent of Phenolic Resin) of the epoxy equivalent of the epoxy resin to the hydroxyl group 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 curing properties. In a case where the equivalent ratio is 0.30/0.70 or more (the epoxy equivalent of the epoxy resin is 0.30 or more), there is a tendency that more sufficient curing properties are obtained. In a

case where the equivalent ratio is 0.70/0.30 or less (the epoxy equivalent of the epoxy resin is 0.70 or less), it is possible to prevent an excessive increase in a viscosity, and to obtain more sufficient fluidity.

[0055] The total content of the component (A) and component (B) may be 1% by mass or more, 5% by mass or more, or 10% by mass or more, on the basis of the total mass of the bonding adhesive layer 15. In a case where the total content of the component (A) and the component (B) is in such a range, there is a tendency that the bonding properties are further improved. From the viewpoint of handleability, the total content of the component (A) and the component (B) may be 40% by mass or less, 30% by mass or less, or 20% by mass or less, on the basis of the total mass of the bonding adhesive layer 15.

[0056] Component (C): Elastomer

Examples of the component (C) include an acrylic resin, a polyester resin, a polyamide resin, a polyimide resin, a silicone resin, a butadiene resin; and a modified resin thereof. Only one type of elastomer may be used, or two or more types thereof may be used in combination. Among them, the component (C) may be an acrylic resin (acrylic rubber) having a constituent unit derived from (meth)acrylic ester as a main component, from the viewpoint that there are less ionic impurities, the heat resistance is more excellent, it is easier to ensure the connection reliability of the semiconductor device, and the fluidity is more excellent. The content of the constituent unit derived from the (meth)acrylic ester in the component (C), for example, may be 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 constituent units. The acrylic resin (the

acrylic rubber) may have a constituent unit derived from (meth)acrylic ester having a crosslinkable functional group such as an epoxy group, an alcoholic or phenolic hydroxyl group, and a carboxyl group.

[0057] The glass transition temperature (T_g) of the component (C) may be 5°C or higher, or 10°C or higher. In a case where T_g of the component (C) is 5°C or higher, there is a tendency that it is possible to further improve the bonding properties of the bonding adhesive layer 15 and to prevent an excessive increase in the flexibility of the bonding adhesive layer 15. Accordingly, it is easy to cut the bonding adhesive layer 15 when dicing the wafer, and it is possible to prevent the occurrence of burr. The upper limit of T_g of the component (C) is not particularly limited, and for example, may be 55°C or lower, 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 T_g of the component (C) is 55°C or lower, there is a tendency that it is possible to suppress a decrease in the flexibility of the bonding adhesive layer 15. Accordingly, when the bonding adhesive layer 15 is pasted to the wafer, there is a tendency that it is easy to sufficiently fill voids. In addition, it is possible to prevent chipping due to a decrease in the adhesiveness to the wafer when dicing the wafer. Here, the glass transition temperature (T_g) indicates a value measured by using differential scanning calorimetry (DSC) (for example, Thermo Plus 2, manufactured by Rigaku Corporation). T_g of the component (C) can be adjusted to a desired range by adjusting the type and the content of the constituent unit configuring the component (C) (in a case where the component (C) is the acrylic resin (the acrylic rubber), the constituent unit derived from the (meth)acrylic ester).

[0058] The weight average molecular weight (Mw) of the component (C) may be 100000 or more, 300000 or more, or 500000 or more, and may be 3000000 or less, 2000000 or less, or 1000000 or less. In a case where Mw of the component (C) is in such a range, it is possible to suitably control film formability, a film strength, flexibility, tackiness, and the like, reflow properties are excellent, and it is possible to improve filling properties. Here, Mw indicates a value measured by gel permeation chromatography (GPC) and converted by using a calibration curve of standard polystyrene.

[0059] Examples of a commercially available product of the component (C) include SG-P3, SG-80H (all are manufactured by Nagase ChemteX Corporation), and KH-CT-865 (manufactured by Hitachi Chemical Company, Ltd.).

[0060] The content of the component (C) may be 30% by mass or more, 40% by mass or more, or 45% by mass or more, on the basis of the total mass of the bonding adhesive layer 15. In a case where the content of the component (C) is in such a range, there is a tendency that thin film coatability is more excellent. The content of the component (C) may be 80% by mass or less, 70% by mass or less, or 65% by mass or less, on the basis of the total mass of the bonding adhesive layer 15. In a case where the content of the component (C) is in such a range, there is a tendency that it is possible to sufficiently ensure the content of the component (A) and the component (B), and to attain compatibility with other properties.

[0061] 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, an aluminum borate whisker, nitride borate, and silica. Only one type of inorganic filler may be used, or two or more types thereof may be used in combination. Among them, the component (D) may be the silica, from the viewpoint of adjusting a melt viscosity. The shape of the component (D) is not particularly limited, and may be a spherical shape.

[0062] The average particle diameter of the component (D) may be 0.7 μm or less, 0.6 μm or less, or 0.5 μm or less, from the viewpoint of the fluidity and the storage modulus. The average particle diameter of the component (D), for example, may be 0.01 μm or more. Here, the average particle diameter indicates a value obtained by being converted from a BET specific surface area.

[0063] The content of the component (D) may be 60% by mass or less, 50% by mass or less, or 45% by mass or less, on the basis of the total mass of the bonding adhesive layer 15. In a case where the content of the component (D) is in such a range, there is a tendency that the thin film coatability is more excellent. The content of the component (D) may be 10% by mass or more, 15% by mass or more, or 20% by mass or more, on the basis of the total mass of the bonding adhesive layer 15.

[0064] Component (E): Coupling Agent

The component (E) may be a silane coupling agent. Examples of the silane coupling agent include γ -ureidopropyl triethoxy silane, γ -mercaptopropyl trimethoxy silane, 3-phenyl aminopropyl trimethoxy silane, and 3-(2-aminoethyl) aminopropyl trimethoxy silane.

[0065] Component (F): Curing Accelerator

Examples of the component (F) include imidazoles and a derivative thereof, an organic phosphoric compound, secondary amines, tertiary amines, and a quaternary ammonium salt. Only one type of curing accelerator may be used, or two or more types thereof may be used in combination. Among them, the component (F) may be the imidazoles and the derivative thereof, from the viewpoint of the reactivity.

[0066] Examples of the imidazoles include 2-methyl imidazole, 1-benzyl-2-methyl imidazole, 1-cyanoethyl-2-phenyl imidazole, and 1-cyanoethyl-2-methyl imidazole. Only one type of imidazole may be used, or two or more types thereof may be used in combination.

[0067] The bonding adhesive layer 15 may further contain other components. Examples of the other components include a pigment, an ion scavenger, and an antioxidant.

[0068] The total content of the component (E), the component (F), 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 20% by mass or less, 10% by mass or less, or 5% by mass or less, on the basis of the total mass of the bonding adhesive layer 15.

[0069] <Semiconductor device>

FIG. 3 is a sectional view schematically illustrating a semiconductor device according to this embodiment. A semiconductor device 50 illustrated in this drawing includes a substrate 30, four chips C1, C2, C3, and C4 laminated on the surface of the substrate 30, wires W1, W2, W3, and W4 for electrically connecting an electrode (not

illustrated) on the surface of the substrate 30 and four chips C1, C2, C3, and C4, and a sealing layer 35 sealing the constituents described above.

[0070] The substrate 30, for example, is an organic substrate, and may be a metal substrate such as a lead frame. From the viewpoint of suppressing the warpage of the semiconductor device 50, the thickness of the substrate 30, for example, is 70 to 140 μm , and may be 80 to 100 μm .

[0071] Four chips C1, C2, C3, and C4 are laminated via a cured material 15c of a bonding adhesive piece 15p. The shapes of the chips C1, C2, C3, and C4 in the plan view, for example, are a square shape or a rectangular shape. The areas of the chips C1, C2, C3, and C4 in the plan view are 30 to 250 mm^2 , and may be 40 to 200 mm^2 or 50 to 150 mm^2 . Each of the lengths of one side of the chips C1, C2, C3, and C4 in the plan view, for example, are 6.0 mm or more, and may be 7.0 to 18 mm or 8.0 to 15 mm. The thicknesses of the chips C1, C2, C3, and C4, for example, are 10 to 150 μm , and may be 20 to 80 μm . Note that, each of the lengths of one side of four chips C1, C2, C3, and C4 may be the same, or may be different from each other, and the same applies to the thickness. In addition, four chips C1, C2, C3, and C4 may have a comparatively small size. That is, the areas of the chips C1, C2, C3, and C4 may be less than 30 mm^2 , and for example, may be 0.1 to 20 mm^2 or 1 to 15 mm^2 .

[0072] <Bonding adhesive piece-attached chip>

FIG. 4 is a sectional view schematically illustrating an example of a bonding adhesive piece-attached chip. A bonding adhesive piece-attached chip 25 illustrated in FIG. 4 includes the bonding

adhesive piece 15p and a chip C. As illustrated in this drawing, the bonding adhesive piece 15p and the chip C1 have substantially the same size. The same applies to the bonding adhesive piece 15p and the chips C2, C3, and C4.

5 [0073] An example of a method for producing the bonding adhesive piece-attached chip 25 will be described. First, a protective film (also referred to as a BG tape) is pasted to a circuit surface Wa of a wafer W. The wafer W is irradiated with laser to form a plurality of lines L to be cut (stealth dicing). After that, as necessary, the wafer W is subjected
10 to a treatment such as back grinding and polishing. Note that, here, the stealth dicing using the laser is exemplified, but instead of the stealth dicing, the wafer W may be subjected to half cutting with a blade. The half cutting indicates forming a notch corresponding to the line L to be cut of the wafer W without cutting the wafer W. The wafer W may be
15 monocrystalline silicon, or may be a compound semiconductor such as polycrystalline silicon, various ceramics, and gallium arsenide.

[0074] Next, as illustrated in FIG. 5(a), the film 20 is pasted such that the bonding adhesive layer 15 is in contact with a back surface Wb of the wafer W. In addition, a dicing ring DR is pasted to a peripheral
20 portion 13a of the adhesive layer 13. After that, the wafer W and the bonding adhesive layer 15 are singulated by cooling expansion in a temperature condition of 0 to -15°C. That is, as illustrated in FIG. 5(b), a tension is applied to the base material film 11 by thrusting up an inside region 11a of the dicing ring DR in the base material film 11 with a ring
25 Ra. Accordingly, the wafer W is divided along the line L to be cut, and in accordance with this, the bonding adhesive layer 15 is divided to the

bonding adhesive pieces 15p. A plurality of chips 25 with a bonding adhesive piece are obtained on the surface of the adhesive layer 13. The bonding adhesive piece-attached chip 25 includes the chip C and the bonding adhesive piece 15p.

5 [0075] The inside region 11a is contracted by heating the inside region 11a of the dicing ring DR in the base material film 11. FIG. 6(a) is a sectional view schematically illustrating a state where the inside region 11a is heated by the blow of a heater H. By contracting the inside region 11a in a circular pattern and applying a tension to the base material film 11, it is possible to increase an interval between the adjacent chips 25 with a bonding adhesive piece. Accordingly, it is possible to further suppress the occurrence of a pickup error, and to improve the visibility of the bonding adhesive piece-attached chip 25 in a picking-up step.

10 [0076] Next, as illustrated in FIG. 6(b), the adhesive force of the adhesive layer 13 is decreased by the irradiation of active energy (for example, an ultraviolet ray UV). The irradiation dose of the active energy ray with respect to the adhesive layer 13, for example, is 10 to 1000 mJ/cm², and may be 100 to 700 mJ/cm² or 200 to 500 mJ/cm².

15 After that, as illustrated in FIG. 6(c), by thrusting up the bonding adhesive piece-attached chip 25 with a thrusting jig 42, the bonding adhesive piece-attached chip 25 is peeled off from the adhesive layer 13, and the bonding adhesive piece-attached chip 25 is picked up by being sucked with a suction collet 44.

20 [0077] <Method for producing semiconductor device>

A method for producing the semiconductor device 50 will be

described. First, as illustrated in FIG. 7(a), the chip C1 in the first stage is compressed onto the surface of the substrate 30. That is, the chip C1 is compressed into a predetermined position of the substrate 30 via the bonding adhesive piece 15p of the bonding adhesive piece-attached chip 25. It is preferable that such a compressing treatment, for example, is implemented in a condition of 80 to 180°C and 0.01 to 0.50 MPa for 0.5 to 3.0 seconds. Next, the bonding adhesive piece 15p is cured by heating. It is preferable that such a curing treatment, for example, is implemented in a condition of 60 to 175°C and 0.01 to 1.0 MPa for 5 minutes or longer. Accordingly, the bonding adhesive piece 15p is cured to be the cured material 15c. From the viewpoint of reducing the voids, the curing treatment of the bonding adhesive piece 15p may be implemented in a pressurized atmosphere.

[0078] As with the installation of the chip C1 on the substrate 30, the chip C2 in the second stage is installed on the surface of the chip C1. Further, the chips C3 and C4 in the third stage and the fourth stage are installed to produce a structure 40 illustrated in FIG. 7(b). The chips C1, C2, C3, and C4 and the substrate 30 are electrically connected by the wires W1, W2, W3, and W4, and then, the chips and the wires are sealed with the sealing layer 35 to complete the semiconductor device 50 illustrated in FIG. 3.

[0079] The embodiment of the present disclosure has been described in detail, but the present invention is not limited to the embodiment described above. For example, in the embodiment described above, a case has been exemplified in which the wafer W is singulated by the

stealth dicing, but the wafer W may be singulated by using a blade.

Examples

[0080] Hereinafter, the present disclosure will be described in more detail on the basis of examples, but the present invention is not limited to the examples. Note that, unless otherwise specified, all chemicals used were reagents.

[0081] (Examples 1 and 2 and Comparative Examples 1 and 2)

<Preparation of Bonding Adhesive Varnish>

Cyclohexanone was added to a mixture containing a component (A), a component (B), and a component (D) in accordance with components and contents (Unit: parts by mass) shown in Table 1, and was stirred and mixed. A component (C) was added thereto in accordance with the components and the contents (Unit: parts by mass) shown in Table 1, and was stirred, and a component (E) and a component (F) were further added, and were stirred until each of the components was homogeneous to prepare a bonding adhesive varnish. Note that, each of the components shown in Table 1 indicates the followings, and numerical values shown in Table 1 indicate parts by mass of a solid content.

[0082] Component (A): an epoxy resin

Component (A1): an epoxy resin having a fluorene skeleton

(A1-1) PG-100 (Product Name, manufactured by Osaka Gas Chemicals Co., Ltd., an epoxy resin having a fluorene skeleton, Epoxy Equivalent: 260 g/eq)

(A1-2) CG-500 (Product Name, manufactured by Osaka Gas Chemicals Co., Ltd., an epoxy resin having a fluorene skeleton, Epoxy

Equivalent: 310 g/eq)

Component (A2): an epoxy resin not having a fluorene skeleton

(A2-1) N-500P-10 (Product Name, manufactured by DIC Corporation, an o-cresol novolac-type epoxy resin, Epoxy Equivalent: 204 g/eq)

(A2-2) EXA-830CRP (Product Name, manufactured by Nippon Steel & Sumikin Chemical Co., Ltd., a bisphenol F-type epoxy resin, Epoxy Equivalent: 159 g/eq)

[0083] Component (B): a curing agent

(B-1) PSM-4326 (Product Name, manufactured by Gun Ei Chemical Industry Co., Ltd., a phenol novolac-type phenolic resin, Hydroxyl Group Equivalent: 105 g/eq, Softening Point: 118 to 122°C)

(B-2) GPH-103 (Product Name, manufactured by Nippon Kayaku Co., Ltd., a biphenyl aralkyl-type phenolic resin, Hydroxyl Group Equivalent: 220 to 240 g/eq, Softening Point: 99 to 106°C)

(B-3) MEH-7800M (Product Name, manufactured by Meiwa Chemical Co. Ltd., a phenol novolac-type phenolic resin, Hydroxyl Group Equivalent: 175 g/eq, Softening Point: 78°C)

[0084] Component (C): an elastomer

(C-1) acrylic rubber in which in acrylic rubber of a methyl ethyl ketone solution of acrylic rubber (SG-P3 (Product Name, manufactured by Nagase ChemteX Corporation), a part of the constituent units of the acrylic rubber is changed, Weight Average Molecular Weight: 800000, Tg: 12°C)

[0085] Component (D): an inorganic filler

(D-1) R972 (Product Name, manufactured by NIPPON

AEROSIL CO., LTD., silica particles, Average Particle Diameter: 0.016 μm)

(D-2) SC2050-HLG (Product Name, manufactured by ADMATECHS COMPANY LIMITED, a silica filler dispersion, Average Particle Diameter: 0.50 μm)

(D-3) Prototype Silica Filler (a prototype, manufactured by ADMATECHS COMPANY LIMITED, a silica filler dispersion, Average Particle Diameter: 0.2 μm)

[0086] Component (E): a coupling agent

(E-1) Y-9669 (Product Name, manufactured by Momentive Performance Materials Japan, 3-phenyl aminopropyl trimethoxy silane)

(E-2) A-189 (Product Name, manufactured by Nippon Unicar Company Limited, γ -mercaptopropyl trimethoxy silane)

(E-3) Z-6119 (Product Name, manufactured by Dow Corning Toray Co., Ltd., ureidopropyl triethoxy silane)

[0087] Component (F): a curing accelerator

(F-1) 2PZ-CN (Product Name, manufactured by SHIKOKU CHEMICALS CORPORATION, 1-cyanoethyl-2-phenyl imidazole)

[0088] [Table 1]

			Example 1	Example 2	Comparative Example 1	Comparative Example 2
(A)	(A1)	(A1-1)	10.6	-	-	-
		(A1-2)	-	12.6	-	-
	(A2)	(A2-1)	-	-	5.9	17.0
		(A2-2)	-	-	-	10.4
(B)		(B-1)	4.3	4.0	-	-
		(B-2)	-	-	3.5	-
		(B-3)	-	-	2.7	22.2
(C)		(C-1)	59.3	66.0	56.7	45.0
(D)		(D-1)	-	-	-	5.0
		(D-2)	-	-	29.6	-
		(D-3)	25.4	17.0	-	-
(E)		(E-1)	-	-	1.20	-
		(E-2)	0.40	0.40	0.40	0.10
		(E-3)	-	-	-	0.20
(F)		(F-1)	0.01	0.01	0.01	0.10

[0089] <Production of Bonding Film>

The produced bonding adhesive varnish was filtered with a 100-mesh filter, and was subjected to vacuum defoaming. As a support film, a polyethylene terephthalate (PET) film with a thickness of 38 μm , subjected to a release treatment, was prepared, and the bonding adhesive varnish after vacuum defoaming was applied onto the PET film. The applied bonding adhesive varnish was heated and dried in two stages of 90°C for 5 minutes, and then, 130°C for 5 minutes, to obtain bonding films (Thickness: 10 μm) of Examples 1 and 2 and Comparative Examples 1 and 2 in the state of B stage.

[0090] <Production of Dicing Film>

[Synthesis of Acrylic Copolymer]

A copolymer was obtained by solution radical polymerization using the following components as raw materials and ethyl acetate as a solvent.

· 2-Ethyl Hexyl Acrylate: 78 parts by mass

· 2-Hydroxyethyl Acrylate: 20 parts by mass

· Methacrylic Acid: 2 parts by mass

8 parts by mass of 2-methacryloyl oxyethyl isocyanate reacted with the acrylic copolymer to synthesize a radiation-reactive acrylic copolymer having a carbon-carbon double bond. In the reaction described above, 0.05 parts by mass of hydroquinone monomethyl ether was used as a polymerization inhibitor. The weight average molecular weight of the synthesized acrylic copolymer was measured by GPC, and was 800000.

[0091] The acrylic copolymer obtained as described above, 8.0 parts by mass of a polyisocyanate compound (Product Name: CORONATE L, manufactured by Nippon Polyurethane) as a curing agent, in terms of solid content, and 0.5 parts by mass of 1-hydroxycyclohexyl phenyl ketone as a photopolymerization initiator were mixed to prepare a radiation-curable adhesive solution. Next, the radiation-curable adhesive solution obtained as described above was applied onto a polyethylene terephthalate peeling film (Thickness: 38 μm) and dried such that a thickness after drying was 10 μm . After that, an ionomer resin film (HIMILAN 1855, a thickness of 90 μm) in which one surface was subjected to a corona discharge treatment, and the molecules of an ethylene-methacrylic acid copolymer were crosslinked with metal ions was pasted to the adhesive layer. The pasted sample was aged in a thermostatic chamber at 40°C for 72 hours to produce a dicing film.

[0092] <Production of Integrated Dicing/Die Bonding Film>

Each of the bonding films according to Examples and Comparative Examples was pasted to the adhesive layer of the dicing

film obtained as described above to obtain integrated dicing/die bonding films according to Examples and Comparative Examples.

[0093] [Tack Test]

A sample for implementing a tack test was prepared in the following procedure.

(1) The integrated dicing/die bonding film was irradiated with an ultraviolet ray from the dicing film side to decrease the adhesive force of the dicing film. The irradiation condition of the ultraviolet ray was as follows.

- Intensity of Ultraviolet Ray: 100 mW/cm^2
- Irradiation Dose of Ultraviolet Ray: 150 mJ/cm^2

(2) The integrated dicing/die bonding film was laminated on a polyimide film such that the bonding film was in contact with the surface of the polyimide film. As the polyimide film, the following was used. A laminating condition was as follows.

(Polyimide Film)

· Kapton 500H (Product Name, manufactured by DUPONT-TORAY CO., LTD.)

- Thickness: $125 \mu\text{m}$
- Tensile Elastic Modulus: 3.35 GPa
- Heat Resistance Temperature: 270°C

(Laminating Condition)

- Temperature: 65°C
- Rate: 5 mm/second

(3) After laminating, in order to increase adhesiveness between the polyimide film and the bonding film, the laminate was left to stand

for 1 day at a room temperature.

(4) The laminate was cut to have a size of Length of 40 mm × Width of 40 mm, and the dicing film was peeled off. Accordingly, for Examples and Comparative Examples, a plurality of samples were obtained, respectively.

[0094] In a state where the bonding film was placed to be the upper surface, the sample was set on a stage of a tacking tester (TAC1000 (Product Name), manufactured by RHESCA Co., LTD.). Each of the bonding films according to Examples and Comparative Examples was subjected to the tack test in the following condition.

- Temperature of stage: 25°C
- Temperature of probe: 100°C or 120°C
- Approaching rate of probe: 1.0 mm/second
- Pressurizing force: 0.1 MPa
- Pressurizing time: 1.0 second
- Separating rate of probe: 1.0 mm/second
- Tip Surface of probe: in the shape of a circle with a diameter of 5 mm
- Material of Probe: SUS304

[0095] For each of Examples and Comparative Examples, the measurement was implemented 9 times, and the average value of seven measured values excluding the maximum value and the minimum value was set to tack (N/5 mmφ). The results are shown in Table 2.

[0096] [Table 2]

Probe temperature	Tack [N/5 mmφ]			
	Example 1	Example 2	Comparative Example 1	Comparative Example 2
100°C	3.92	3.75	1.73	2.66
120°C	3.82	4.16	1.97	2.16

[0097] As shown in Table 2, both of the bonding films according to Examples 1 and 2 satisfy Conditions 1 and 2, and are determined as excellent. The bonding film according to Comparative Example 1 does not satisfy both of Conditions 1 and 2. The bonding film according to Comparative Example 2 satisfies Condition 1, but does not satisfy Condition 2.

[0098] [Reproduction of Peeling in Producing Process of Semiconductor Device]

In order to reproduce peeling in a producing process of a semiconductor device, the integrated dicing/die bonding film according to Example 1 was used, and a bonding adhesive piece-attached chip, having a configuration illustrated in FIG. 4, was produced via the steps illustrated in FIG. 5 and FIG. 6. The size of the chip was as follows.

- Thickness: 36 μm
- Length: 6 mm
- Width: 12 mm

[0099] Eight chips with a bonding adhesive piece were used, and a structure having a configuration illustrated in FIG. 9 was produced. A structure 90 in FIG. 9 includes the substrate 30, a silicon spacer 32, and chips S1 to S8 with a bonding adhesive piece in eight stages. The compressing condition of the bonding adhesive piece-attached chip was the following two conditions, and two structures were produced.

- 120°C/15 N/1 second
- 120°C/7.5 N/1 second

[0100] Structures according to Example 2 and Comparative Examples 1 and 2 were produced as described above, except that the integrated dicing/die bonding films according to Example 2 and Comparative Examples 1 and 2 were used. For the structures according to Examples and Comparative Examples, in order to evaluate the adhesion of the chip S1 with a bonding adhesive piece in the first stage from the surface of the silicon spacer, a separation distance D illustrated in FIG. 9 was measured. The results are shown in Table 3.

[0101] [Table 3]

Compressing condition	Separation distance D [μm]			
	Example 1	Example 2	Comparative Example 1	Comparative Example 2
120°C/15 N/1 second	0	0	39	43
120°C/7.5 N/1 second	29	26	83	65

[0102] In the structures according to Examples 1 and 2, even though the thickness of the bonding adhesive layer was 10 μm , the separation distance D was 30 μm or less, which made it possible to suppress the peeling. In contrast, in the structures according to Comparative Examples 1 and 2, the separation distance D was greater than 30 μm , which did not make it possible to sufficiently suppress the peeling with the bonding adhesive layer having a thickness of 10 μm . The evaluation results shown in Table 2 are consistent with the results shown in Table 3.

Reference Signs List

[0103] 1: stage, 2: probe, 3: pressing jig, 5: polyimide film (resin film), 10: device for implementing tack test, 11: base material film, 13:

adhesive layer, 15: bonding adhesive layer, 15c: cured material of
bonding adhesive piece, 15p: bonding adhesive piece, 20: integrated
dicing/die bonding film, 25: bonding adhesive piece-attached chip, 30:
substrate, 35: sealing layer, 40: structure, 50: semiconductor device, C,
5 C1, C2, C3, C4: chip, S: sample, W: wafer.

CLAIMS

[Claim 1] A method for evaluating a bonding film used in a producing process of a semiconductor device, the method comprising

a step of performing a tack test with a heated probe,

5 wherein a thickness of a bonding film to be an evaluation target is 20 μm or less.

[Claim 2] The method for evaluating a bonding film according to claim 1,

10 wherein a device is used in the tack test, the device comprising a stage for supporting a sample of the bonding film, and a probe movable with respect to the stage in an up and down direction, of which a temperature can be set, and

the tack test is performed in a state of interposing a resin film between the stage and the sample.

15 [Claim 3] The method for evaluating a bonding film according to claim 1 or 2,

wherein when the bonding film satisfies both of Conditions 1 and 2 described below, the bonding film is determined as excellent.

20 (Condition 1) In the tack test in which a probe temperature is set to 100°C, tack is 2.5 N/5 mm ϕ or more.

(Condition 2) In the tack test in which a probe temperature is set to 120°C, tack is 2.5 N/5 mm ϕ or more.

[Claim 4] A method for producing a semiconductor device, comprising steps of:

25 preparing a laminated film comprising a bonding film with a thickness of 20 μm or less;

pasting the laminated film to a wafer such that the bonding film is in contact with a surface of the wafer;

producing a bonding adhesive piece-attached chip by singulating the wafer and the bonding film; and

5 bonding the bonding adhesive piece-attached chip onto a surface of a substrate or another chip,

 wherein the bonding film is a bonding film determined as excellent in the method for evaluating a bonding film according to claim 3.

10 [Claim 5] A bonding film used in a producing process of a semiconductor device,

 wherein the bonding film has a thickness of 20 μm or less, and

 the bonding film is determined as excellent in the method for evaluating a bonding film according to claim 3.

15 [Claim 6] An integrated dicing/die bonding film, comprising:

 a base material film;

 a bonding adhesive layer with a thickness of 20 μm or less; and

 an adhesive layer, in this order,

 wherein the bonding adhesive layer comprises a bonding film
20 determined as excellent in the method for evaluating a bonding film according to claim 3.