

DESCRIPTION

Title of Invention: FILM-TYPE ADHESIVE AGENT, DICING/DIE BONDING INTEGRAL FILM, AND SEMICONDUCTOR DEVICE AND MANUFACTURING METHOD THEREFORE

5 **Technical Field**

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

Background Art

10 [0002] In recent years, stacked MCPs (Multi Chip Packages) in which semiconductor chips are stacked in multiple stages have become widespread, and are mounted as memory semiconductor packages for mobile phones, portable audio devices, and the like. Furthermore, with the multi-functionalization of mobile phones and the like, higher speeds,
15 higher densities, and higher integration of semiconductor packages are also being promoted.

[0003] As a method for manufacturing a semiconductor device (semiconductor package), a method is known in which a dicing/die-bonding integrated film including an adhesive layer and a pressure-sensitive adhesive layer is laminated to the back surface of a
20 semiconductor wafer, and then the semiconductor wafer, the adhesive layer, and a part of the pressure-sensitive adhesive layer are diced and singulated to produce a plurality of singulated semiconductor chips with an adhesive piece. For example, Patent Literatures 1 and 2 disclose a film-shaped adhesive used as an adhesive layer in such a method.
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Citation List

Patent Literature

[0004] Patent Literature 1: WO 2013/133275 A1

Patent Literature 2: WO 2020/013250 A1

Summary of Invention

5 Technical Problem

[0005] By using a semiconductor chip with an adhesive piece, the semiconductor chip and a support member are bonded via the adhesive piece. In the manufacturing of stacked MCPs and the like, since semiconductor chips are stacked in multiple stages, it is required that the
10 film-shaped adhesive that provides the adhesive pieces can also be made thinner (for example, having a thickness of 15 μm or less).

[0006] However, conventional thin film-shaped adhesives may not have sufficient fracture resistance to prevent breakage during processing steps (such as peeling from a support film, or winding the film-shaped adhesive
15 itself), and furthermore, may not have sufficient embeddability to fill in minute steps that may exist on the surface of a support member. Therefore, improvement of these properties is required for thin film-shaped adhesives.
[0007] Therefore, a main object of the present disclosure is to provide a film-shaped adhesive that is excellent in fracture resistance and
20 embeddability even when made into a thin film.

Solution to Problem

[0008] The present inventors have conducted intensive studies to solve the above problem, and as a result, have found that in a film-shaped adhesive containing an epoxy resin, a phenolic resin, and an elastomer, and
25 optionally further containing an inorganic filler, by adjusting the content of the elastomer to a predetermined amount, it is possible to improve

fracture resistance even when the film is made thin, and furthermore, the minimum melt viscosity is lowered and the flowability is improved, thereby making it possible to improve embeddability, and have completed the invention of the present disclosure.

5 [0009] In recent semiconductor devices (semiconductor packages), in a semiconductor chip composed of a circuit layer and a semiconductor layer, the circuit layer tends to be thick and the semiconductor layer tends to be thin. In such a semiconductor package, for example, when connecting semiconductor chips using wire bonding, chip cracks may occur. It is
10 presumed that such chip cracks occur because the semiconductor layer becomes thinner, making the semiconductor chip brittle, and due to vibrations during wire bonding. Since the film-shaped adhesive of the present disclosure has a sufficiently high high-temperature storage modulus after curing (for example, the storage modulus at 150°C of the
15 cured product of the film-shaped adhesive is 40 MPa or more), it can cover the brittleness of the semiconductor chip and is also advantageous in terms of suppressing chip cracks.

[0010] The present disclosure provides the film-shaped adhesive described in [1] to [10], the dicing/die-bonding integrated film described
20 in [11], the semiconductor device described in [12] and [13], and the method for manufacturing a semiconductor device described in [14] to [19].

[1] A film-shaped adhesive containing: an epoxy resin; a phenolic resin; and an elastomer, and optionally further containing an inorganic filler,
25 wherein a content of an inorganic filler is from 0 to 10% by mass, based on a total amount of the film-shaped adhesive, a content of the elastomer

is from 20 to 50% by mass, based on the total amount of the film-shaped adhesive, and the content of the elastomer is from 40 to 60 parts by mass with respect to 100 parts by mass of a total amount of the epoxy resin and the phenolic resin.

5 [2] The film-shaped adhesive according to [1], wherein a total content of the epoxy resin and the phenolic resin is from 40 to 80% by mass, based on the total amount of the film-shaped adhesive.

[3] The film-shaped adhesive according to [1] or [2], wherein the epoxy resin includes a first epoxy resin having a softening point of 40°C or less, and a content of the first epoxy resin is from 5 to 30% by mass, based on
10 the total amount of the film-shaped adhesive.

[4] The film-shaped adhesive according to [3], wherein the epoxy resin further includes a second epoxy resin having a softening point of more than 40°C, and the softening point of the second epoxy resin is 120°C or less.
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[5] The film-shaped adhesive according to any one of [1] to [4], wherein an average particle size of the inorganic filler is 150 nm or less.

[6] The film-shaped adhesive according to any one of [1] to [5], wherein the film-shaped adhesive has a minimum melt viscosity in a range of 60 to 160°C of 3,000 Pa·s or less, and a shear viscosity at 100°C of 3,000 Pa·s or less.
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[7] The film-shaped adhesive according to any one of [1] to [6], wherein a cured product obtained by curing the film-shaped adhesive under conditions of 150°C for 30 minutes has a storage modulus at 150°C of 40 MPa or more.
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[8] The film-shaped adhesive according to any one of [1] to [7], wherein

a thickness of the film-shaped adhesive is from 1 to 15 μm .

[9] The film-shaped adhesive according to any one of [1] to [8], wherein the film-shaped adhesive is used in a manufacturing process of a semiconductor device formed by stacking a plurality of semiconductor chips.

[10] The film-shaped adhesive according to [9], wherein the semiconductor device is a 3D NAND memory.

[11] A dicing/die-bonding integrated film including, in this order: a base layer; a pressure-sensitive adhesive layer; and an adhesive layer consisting of the film-shaped adhesive according to any one of [1] to [8].

[12] A semiconductor device including: a semiconductor chip; a support member on which the semiconductor chip is mounted; and a cured product of the film-shaped adhesive according to any one of [1] to [8], disposed between the semiconductor chip and the support member and bonding the semiconductor chip and the support member.

[13] The semiconductor device according to [12], further including a different semiconductor chip stacked on a surface of the semiconductor chip.

[14] A method of manufacturing a semiconductor device, the method including: laminating the adhesive layer of the dicing/die-bonding integrated film according to [11] onto a semiconductor wafer; producing a plurality of singulated semiconductor chips with an adhesive piece by dicing the semiconductor wafer on which the adhesive layer has been laminated; and bonding a first semiconductor chip with an adhesive piece, which is one of the plurality of semiconductor chips with an adhesive piece and has a first semiconductor chip and a first adhesive piece, to a

support member via the first adhesive piece.

[15] The method according to [14], further including bonding a second semiconductor chip with an adhesive piece, which is another one of the plurality of semiconductor chips with an adhesive piece and has a second semiconductor chip and a second adhesive piece, to a surface of the first semiconductor chip of the first semiconductor chip with an adhesive piece bonded to the support member, via the second adhesive piece.

[16] A method of manufacturing a semiconductor device, the method including: providing a laminate including: the dicing/die-bonding integrated film according to [11]; and a plurality of semiconductor chips provided on the adhesive layer of the dicing/die-bonding integrated film, the plurality of semiconductor chips being formed by singulating a semiconductor wafer; producing a plurality of semiconductor chips with an adhesive piece by irradiating the adhesive layer with a laser through gaps between the plurality of semiconductor chips to singulate the adhesive layer; and bonding a first semiconductor chip with an adhesive piece, which is one of the plurality of semiconductor chips with an adhesive piece and has a first semiconductor chip and a first adhesive piece, to a support member via the first adhesive piece.

[17] The method according to [16], wherein the laminate is produced by a method including: forming grooves along dicing lines on a circuit formation surface of the semiconductor wafer; producing the plurality of semiconductor chips by grinding a back surface of the semiconductor wafer on which the grooves have been formed, the back surface being opposite to the circuit formation surface, to a depth that reaches at least the grooves; and laminating the adhesive layer of the dicing/die-bonding

integrated film onto back surfaces of the plurality of semiconductor chips.
[18] The method according to [16] or [17], further including bonding a
second semiconductor chip with an adhesive piece, which is another one
of the plurality of semiconductor chips with an adhesive piece and has a
5 second semiconductor chip and a second adhesive piece, to a surface of
the first semiconductor chip of the first semiconductor chip with an
adhesive piece bonded to the support member, via the second adhesive
piece.

[19] A method of manufacturing a semiconductor device, including
10 bonding a first semiconductor chip to a support member, or bonding the
first semiconductor chip to a second semiconductor chip by interposing
the film-shaped adhesive according to any one of [1] to [8] between the
first semiconductor chip and the support member, or between the first
semiconductor chip and the second semiconductor chip.

15 **Advantageous Effects of Invention**

[0011] According to the present disclosure, a film-shaped adhesive that is
excellent in fracture resistance and embeddability even when made into a
thin film is provided. Some embodiments of the film-shaped adhesive also
tend to be excellent in terms of suppressing chip cracks. Further, according
20 to the present disclosure, a dicing/die-bonding integrated film using such
a film-shaped adhesive, and a semiconductor device and a method for
manufacturing therefore are provided. Furthermore, according to the
present disclosure, a method for manufacturing a semiconductor device
using such a dicing/die-bonding integrated film is provided.

25 **Brief Description of Drawings**

[0012] Fig. 1 is a schematic cross-sectional view showing an embodiment

of a film-shaped adhesive.

Fig. 2 is a schematic cross-sectional view showing an embodiment of a dicing/die-bonding integrated film.

5 Fig. 3 is a schematic cross-sectional view showing an embodiment of a semiconductor device.

Fig. 4 is a schematic cross-sectional view showing another embodiment of a semiconductor device.

Fig. 5 is a schematic cross-sectional view showing another embodiment of a semiconductor device.

10 **Description of Embodiments**

[0013] Hereinafter, embodiments of the present disclosure will be described with appropriate reference to the drawings. However, the present disclosure is not limited to the following embodiments. In the following embodiments, their constituent elements (including steps, etc.)
15 are not essential unless otherwise specified. The size of the constituent elements in each drawing is conceptual, and the relative relationship of the sizes between the constituent elements is not limited to that shown in each drawing.

[0014] The same applies to the numerical values and their ranges in the present disclosure, and they do not limit the present disclosure. In the present specification, a numerical range indicated using "to" indicates a range including the numerical values described before and after "to" as the minimum and maximum values, respectively. In the numerical ranges described stepwise in this specification, the upper or lower limit value
20 described in one numerical range may be replaced with the upper or lower limit value of another stepwise described numerical range. Further, in the
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numerical ranges described in this specification, the upper or lower limit value of the numerical range may be replaced with the value shown in the examples. Further, individually described upper and lower limit values can be arbitrarily combined. Further, "A or B" may include either one of A and B, and may include both. Further, unless otherwise specified, the materials exemplified below may be used alone as one type, or may be used in combination of two or more types. The content of each component in the composition means the total amount of the plurality of substances corresponding to each component present in the composition, unless otherwise specified.

[0015] In the present specification, "(meth)acrylate" means acrylate or a corresponding methacrylate. The same applies to other similar expressions such as (meth)acryloyl group and (meth)acrylic copolymer.

[0016] [Film-shaped adhesive]

Fig. 1 is a schematic cross-sectional view showing an embodiment of a film-shaped adhesive. The film-shaped adhesive 1 (adhesive film) shown in Fig. 1 may be thermosetting, and may be in a semi-cured (B-stage) state and then become a fully cured (C-stage) state after a curing treatment.

[0017] The B-stage means an intermediate stage in the reaction of certain thermosetting resins in which the material swells when in contact with certain liquids and softens when heated, but does not completely dissolve or melt, and the C-stage means the final stage in the reaction of certain thermosetting resins in which the material becomes substantially insoluble and infusible.

[0018] The film-shaped adhesive 1 contains an epoxy resin (hereinafter, may be referred to as "component (A)"), a phenolic resin (hereinafter, may

be referred to as "component (B)"), and an elastomer (hereinafter, may be referred to as "component (C)"), and may further contain an inorganic filler (hereinafter, may be referred to as "component (D)"). In addition to component (A), component (B), component (C), and component (D), the film-shaped adhesive 1 may further contain a coupling agent (hereinafter, may be referred to as "component (E)"), a curing accelerator (hereinafter, may be referred to as "component (F)"), other components, and the like.

[0019] (Component (A): Epoxy resin)

Any epoxy resin having an epoxy group in the molecule can be used as component (A) without particular limitation. Examples of component (A) include bisphenol A type epoxy resins; bisphenol F type epoxy resins; bisphenol S type epoxy resins; phenol novolac type epoxy resins; cresol novolac type epoxy resins; bisphenol A novolac type epoxy resins; bisphenol F novolac type epoxy resins; stilbene type epoxy resins; triazine skeleton-containing epoxy resins; fluorene skeleton-containing epoxy resins; triphenylmethane type epoxy resins; biphenyl type epoxy resins; xylylene type epoxy resins; biphenyl aralkyl type epoxy resins; naphthalene type epoxy resins; and diglycidyl ether compounds of polyfunctional phenols, polycyclic aromatics such as anthracene, and the like. Among these, component (A) may include a cresol novolac type epoxy resin, a bisphenol F type epoxy resin, or a bisphenol A type epoxy resin from the viewpoint of tackiness, flexibility, and the like of the film.

[0020] The epoxy equivalent of component (A) is not particularly limited, but may be 90 to 300 g/eq, 100 to 290 g/eq, or 110 to 280 g/eq. When the epoxy equivalent of component (A) is within such a range, there is a tendency for it to be easy to secure the flowability of the adhesive

composition when forming the film-shaped adhesive while maintaining the bulk strength of the film-shaped adhesive.

5 [0021] Component (A) may include a first epoxy resin having a softening point of 40°C or less (or an epoxy resin that is liquid at 30°C, hereinafter sometimes referred to as "component (Aa)"). Component (A) may be a combination of component (Aa) and a second epoxy resin having a softening point of more than 40°C (or an epoxy resin that is solid at 30°C, hereinafter sometimes referred to as "component (Ab)"). The softening point of component (Ab) may be, for example, 120°C or less, 110°C or less, or 100°C or less. When component (A) includes component (Aa), there is a tendency for the fracture resistance of the film-shaped adhesive to be more easily improved, and for the storage modulus after curing to be more easily improved. Furthermore, when component (A) is a combination of component (Aa) and component (Ab), there is a tendency for thinning to be even more easily achieved.

[0022] In the present specification, the softening point means a value measured by the ring and ball method in accordance with JIS K7234:1986.

20 [0023] Examples of commercially available products of component (Aa) include EXA-830CRP (trade name, manufactured by DIC Corporation, liquid at 30°C), YDF-8170C (trade name, manufactured by NIPPON STEEL Chemical & Material Co., Ltd., liquid at 30°C), and EP-4088S (trade name, manufactured by ADEKA CORPORATION, liquid at 30°C).

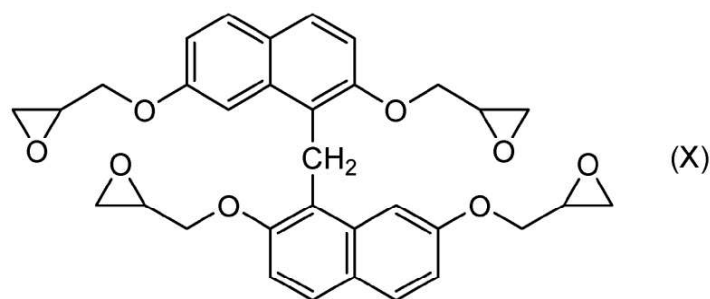
[0024] When component (A) is a combination of component (Aa) and component (Ab), the content of component (Aa) may be, from the viewpoint of fracture resistance, 10% by mass or more, 15% by mass or more, 20% by mass or more, or 25% by mass or more, and 80% by mass

or less, 70% by mass or less, 65% by mass or less, or 60% by mass or less, based on the total amount of component (A). The content of component (Aa) in component (A) in the adhesive composition for forming the film-shaped adhesive may be the same as the above range.

5 [0025] The content of component (Aa) may be from 5 to 30% by mass, from the viewpoint of fracture resistance, based on the total amount of the film-shaped adhesive. The content of component (Aa) may be 7% by mass or more, 10% by mass or more, or 12% by mass or more, and may be 25% by mass or less, 22% by mass or less, or 20% by mass or less, based on
10 the total amount of the film-shaped adhesive. The content of component (Aa) in the adhesive composition for forming the film-shaped adhesive may be the same as the above range.

[0026] In one embodiment, component (Ab) may include a cresol novolac type epoxy resin. In one embodiment, component (Ab) may include a
15 naphthalene type epoxy resin. In one embodiment, component (Ab) may include a cresol novolac type epoxy resin and a naphthalene type epoxy resin. Examples of the naphthalene type epoxy resin include an epoxy resin represented by the following formula (X).

[0027] [Chem. 1]



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[0028] Examples of commercially available products of the naphthalene

type epoxy resin of component (Ab) include HP-4700 (trade name, manufactured by DIC Corporation, softening point: 85 to 95°C), HP-4770 (trade name, manufactured by DIC Corporation, softening point: 67 to 77°C), and HP-4710 (trade name, manufactured by DIC Corporation, softening point: 85 to 105°C).

[0029] When component (A) is a combination of component (Aa) and component (Ab), the content of component (Ab) may be 20% by mass or more, 30% by mass or more, 35% by mass or more, or 40% by mass or more, and 90% by mass or less, 85% by mass or less, 80% by mass or less, or 75% by mass or less, based on the total amount of component (A). The content of component (Ab) in component (A) in the adhesive composition for forming the film-shaped adhesive may be the same as the above range.

[0030] The content of component (A) may be from 15 to 55% by mass, from the viewpoint of fracture resistance, based on the total amount of the film-shaped adhesive. The content of component (A) may be 20% by mass or more, 25% by mass or more, or 30% by mass or more, and may be 50% by mass or less, 45% by mass or less, or 40% by mass or less, based on the total amount of the film-shaped adhesive. The content of component (A) in the adhesive composition for forming the film-shaped adhesive may be the same as the above range.

[0031] (Component (B): Phenolic resin)

Component (B) can be a component that acts as a curing agent for component (A), that is, a curing agent for the epoxy resin. By the film-shaped adhesive containing component (B), the film-shaped adhesive becomes highly cross-linked, and the storage modulus after curing can be improved.

[0032] Any component (B) having a phenolic hydroxyl group in the molecule can be used without particular limitation. Component (B) can be a polycondensation product of phenols such as phenol, cresol, resorcinol, catechol, bisphenol A, bisphenol F, phenylphenol, and aminophenol and/or naphthols such as α -naphthol, β -naphthol, and dihydroxynaphthalene with aldehydes such as formaldehyde. The polycondensation is usually carried out in the presence of a catalyst such as an acid or a base. A phenolic resin obtained using an acid catalyst is particularly called a novolac type phenolic resin. Examples of the novolac type phenolic resin include phenol/formaldehyde novolac resin, cresol/formaldehyde novolac resin, xylenol/formaldehyde novolac resin, resorcinol/formaldehyde novolac resin, and phenol-naphthol/formaldehyde novolac resin. Further, examples of the phenolic resin also include phenol aralkyl resins, naphthol aralkyl resins, biphenyl aralkyl type phenolic resins, and phenyl aralkyl type phenolic resins synthesized from phenols and/or naphthols such as allylated bisphenol A, allylated bisphenol F, allylated naphthalenediol, phenol novolac, and phenol, and dimethoxyparaxylene or bis(methoxymethyl)biphenyl.

[0033] The hydroxyl equivalent of component (B) is not particularly limited, but may be, for example, 80 to 250 g/eq, 90 to 200 g/eq, or 100 to 180 g/eq. When the hydroxyl equivalent of component (B) is 80 g/eq or more, the storage modulus tends to be further improved, and when it is 250 g/eq or less, it becomes possible to prevent defects due to the generation of foaming, outgassing, and the like.

[0034] The softening point of component (B) is not particularly limited, but may be, for example, 50 to 140°C, 55 to 115°C, or 60 to 100°C.

[0035] The ratio of the epoxy equivalent of component (A) to the hydroxyl equivalent of component (B) (epoxy equivalent of component (A) / hydroxyl equivalent of component (B)) may be from 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 the equivalent ratio is 0.30/0.70 or more, more sufficient curability tends to be obtained. When the equivalent ratio is 0.70/0.30 or less, it is possible to prevent the viscosity from becoming too high, and more sufficient flowability can be obtained.

[0036] The total content of component (A) and component (B) may be from 40 to 80% by mass, based on the total amount of the film-shaped adhesive. When the total content of component (A) and component (B) is 40% by mass or more, based on the total amount of the film-shaped adhesive, the storage modulus after curing tends to be more easily improved, and when it is 80% by mass or less, the handleability tends to be more excellent. The total content of component (A) and component (B) may be 45% by mass or more, 50% by mass or more, or 55% by mass or more, and may be 75% by mass or less, 72% by mass or less, or 70% by mass or less, based on the total amount of the film-shaped adhesive. The total content of component (A) and component (B) in the adhesive composition for forming the film-shaped adhesive may be the same as the above range.

[0037] (Component (C): Elastomer)
Examples of component (C) include acrylic resins, polyester resins, polyamide resins, polyimide resins, silicone resins, butadiene resins; modified products of these resins, and the like. Among these, component

(C) may be an acrylic resin (acrylic rubber) having a structural unit derived from a (meth)acrylic acid ester as a main component, because it has few ionic impurities and is more excellent in heat resistance, it is easier to ensure the connection reliability of the semiconductor device, and it is more excellent in flowability. The content of the structural unit derived from a (meth)acrylic acid ester in component (C) may be, for example, 70% by mass or more, 80% by mass or more, or 90% by mass or more, based on the total amount of structural units. The acrylic resin (acrylic rubber) may be one that includes a structural unit derived from a (meth)acrylic acid ester having a crosslinkable functional group such as an epoxy group, an alcoholic or phenolic hydroxyl group, or a carboxyl group.

[0038] The glass transition temperature (T_g) of component (C) may be from -30 to 30°C. When the T_g of component (C) is -30°C or more, it becomes possible to further improve the pressure-sensitive adhesive force of the film-shaped adhesive, and furthermore, there is a tendency to be able to prevent the flexibility of the film-shaped adhesive from becoming too high. When the T_g of component (C) is 30°C or less, a decrease in the flexibility of the film-shaped adhesive can be suppressed, and there is a tendency for it to be excellent in break strength when a thin film is formed and also excellent in processability. The glass transition temperature (T_g) of component (C) may be -20°C or more or -10°C or more, and may be 25°C or less or 20°C or less. Here, T_g means a value measured using a DSC (differential scanning calorimeter) (for example, Thermo Plus 2, manufactured by Rigaku Corporation). The T_g of component (C) can be adjusted to a desired range by adjusting the type and content of the

structural units constituting component (C) (in the case where component (C) is an acrylic resin (acrylic rubber), the structural units derived from (meth)acrylic acid ester).

[0039] The weight-average molecular weight (Mw) of component (C) may be 100,000 or more, 300,000 or more, or 500,000 or more, and may be 3,000,000 or less, 2,000,000 or less, or 1,000,000 or less. When the Mw of component (C) is within such a range, it is possible to appropriately control film formability, film strength, pliability, tackiness, and the like, and it is excellent in reflow properties, and embeddability can be improved.

Here, Mw means a value measured by gel permeation chromatography (GPC) and converted using a calibration curve based on standard polystyrene. In addition, when a plurality of peaks are observed in GPC, the weight-average molecular weight attributable to the peak with the highest peak intensity is defined as the weight-average molecular weight in this specification.

[0040] Examples of commercially available products of component (C) include SG-70L, SG-708-6, WS-023 EK30, SG-P3, SG-280 EK23, SG-80H, HTR-860P, HTR-860P-3, HTR-860P-3CSP, HTR-860P-3CSP-3DB, and HTR-860P-30B (all manufactured by Nagase ChemteX Corporation), and KH-CT-865 (manufactured by Resonac Corporation).

[0041] The content of component (C) is from 20 to 50% by mass, based on the total amount of the film-shaped adhesive. When the content of component (C) is 20% by mass or more, based on the total amount of the film-shaped adhesive, there is a tendency for it to be excellent in thin film formability and also excellent in fracture resistance when a thin film is formed. When the content of component (C) is 50% by mass or less, based

on the total amount of the film-shaped adhesive, the minimum melt viscosity is lowered and the flowability is improved, thereby making it possible to improve embeddability, and there is a tendency for the storage modulus after curing to be more easily improved. The content of component (C) may be 22% by mass or more, 25% by mass or more, or 28% by mass or more, and may be 45% by mass or less, 40% by mass or less, or 38% by mass or less, based on the total amount of the film-shaped adhesive. The content of component (C) in the adhesive composition for forming the film-shaped adhesive may be the same as the above range.

[0042] The content of component (C) is from 40 to 60 parts by mass with respect to 100 parts by mass of the total amount of component (A) and component (B). When the content of component (C) is 40 parts by mass or more with respect to 100 parts by mass of the total amount of component (A) and component (B), there is a tendency for it to be excellent in thin film formability and also excellent in fracture resistance when a thin film is formed. When the content of component (C) is 60 parts by mass or less with respect to 100 parts by mass of the total amount of component (A) and component (B), the minimum melt viscosity is lowered and the flowability is improved, thereby making it possible to improve embeddability, and there is a tendency for the storage modulus after curing to be more easily improved. The content of component (C) may be 42 parts by mass or more or 45 parts by mass or more, and may be 57 parts by mass or less or 55 parts by mass or less, with respect to 100 parts by mass of the total amount of component (A) and component (B). The content of component (C) with respect to component (A) and component (B) when forming the film-shaped adhesive may be the same

as the above range.

[0043] (Component (D): Inorganic filler)

The film-shaped adhesive 1 may further contain component (D). That is, the film-shaped adhesive 1 may exist in an embodiment that contains component (D) and an embodiment that does not substantially contain component (D).

[0044] Examples of 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 whiskers, boron nitride, silica, and the like. Among these, component (D) may be silica from the viewpoint of adjusting the melt viscosity. The shape of component (D) is not particularly limited, but may be spherical.

[0045] The average particle size of component (D) may be 700 nm or less, and may be 600 nm or less, 500 nm or less, 400 nm or less, 300 nm or less, 200 nm or less, or 150 nm or less, from the viewpoint of flowability and storage modulus. The average particle size of component (D) may be, for example, 10 nm or more. Here, the average particle size means the particle diameter at 50% cumulative frequency in the particle size distribution obtained by a laser diffraction/scattering method. The average particle size of component (D) can also be determined by using the film-shaped adhesive containing component (D). In this case, a dispersion is prepared by heating the film-shaped adhesive to decompose the resin components and dispersing the resulting residue in a solvent, and the average particle size of component (D) can be determined from the particle size distribution obtained by applying the laser diffraction/scattering method

to this dispersion.

[0046] The content of component (D) may be from 0 to 10% by mass, based on the total amount of the film-shaped adhesive. When the content of component (D) is within such a range, there is a tendency for thinning to be even more possible. In one embodiment, the content of component (D) may be 7% by mass or less, 5% by mass or less, 3% by mass or less, or 1% by mass or less, based on the total amount of the film-shaped adhesive. In one embodiment, the content of component (D) may be 0% by mass or more, more than 0% by mass, 1% by mass or more, 3% by mass or more, or 5% by mass or more, based on the total amount of the film-shaped adhesive. In one embodiment, the content of component (D) may be 0% by mass, based on the total amount of the film-shaped adhesive. The content of component (D) in the adhesive composition for forming the film-shaped adhesive may be the same as the above range.

[0047] (Component (E): Coupling agent)

Component (E) may be a silane coupling agent. Examples of the silane coupling agent include γ -ureidopropyltriethoxysilane, γ -mercaptopropyltrimethoxysilane, 3-phenylaminopropyltrimethoxysilane, 3-(2-aminoethyl)aminopropyltrimethoxysilane, and the like.

[0048] (Component (F): Curing accelerator)

Examples of component (F) include imidazole compounds and their derivatives, organophosphorus compounds, secondary amines, tertiary amines, quaternary ammonium salts, and the like. Among these, component (F) may be an imidazole compound or a derivative thereof from the viewpoint of reactivity.

[0049] Examples of imidazole compounds include 2-methylimidazole, 1-

benzyl-2-methylimidazole, 2-phenylimidazole, 1-cyanoethyl-2-phenylimidazole, 1-cyanoethyl-2-methylimidazole, and the like.

[0050] Other components

5 The film-shaped adhesive may further contain other components. Examples of other components include pigments, ion scavengers, antioxidants, and the like.

[0051] The total content of component (E), component (F), and other components may be 0.1% by mass or more, 0.3% by mass or more, or 0.5% by mass or more, and may be 30% by mass or less, 20% by mass or less, 10% by mass or less, or 5% by mass or less, based on the total mass of the film-shaped adhesive. The total content of component (E), component (F), and other components in the adhesive composition for forming the film-shaped adhesive may be the same as the above range.

15 [0052] The thickness of the film-shaped adhesive 1 may be from 1 to 15 μm . The thickness of the film-shaped adhesive 1 may be 12 μm or less, 10 μm or less, 8 μm or less, or 7 μm or less. The thickness of the film-shaped adhesive 1 can be determined, for example, by measuring the thickness at five locations on a cross-section of the film-shaped adhesive 1 with a scanning electron microscope photograph and calculating the average of the measured values.

20 [0053] The storage modulus at 150°C of a cured product obtained by curing the film-shaped adhesive 1 under conditions of 150°C for 30 minutes may be 40 MPa or more, 45 MPa or more, 50 MPa or more, 55 MPa or more, 60 MPa or more, 65 MPa or more, 70 MPa or more, 75 MPa or more, 80 MPa or more, 85 MPa or more, 90 MPa or more, 95 MPa or more, or 100 MPa or more. When the storage modulus is 40 MPa or more,

it is possible to cover the brittleness of the semiconductor chip due to thinning, and as a result, it becomes possible to suppress the occurrence of chip cracks. The upper limit of the storage modulus is not particularly limited, but may be, for example, 500 MPa or less, 300 MPa or less, or 250 MPa or less.

[0054] In the present specification, the storage modulus at 150°C of a cured product obtained by curing the film-shaped adhesive under conditions of 150°C for 30 minutes can be measured, for example, by the following method. A sample for measurement is prepared by laminating a plurality of 10 µm thick film-shaped adhesives to a thickness of about 160 µm, and cutting this into a size of 4 mm width × 33 mm length. After curing the prepared sample under conditions of 150°C for 30 minutes, the cured sample is set in a dynamic mechanical analyzer, a tensile load is applied, and the viscoelasticity is measured in a temperature-dependent measurement mode under conditions of a frequency of 10 Hz, a heating rate of 3°C/min, and a temperature range of 30 to 300°C. Here, the value of the storage modulus at 150°C is taken as the storage modulus at 150°C.

[0055] The minimum melt viscosity of the film-shaped adhesive 1 in the range of 60 to 160°C may be, for example, 3,000 Pa·s or less. When the minimum melt viscosity is 3,000 Pa·s or less, the flowability of the film-shaped adhesive is improved, and the embeddability tends to be improved. The minimum melt viscosity may be, for example, 2,800 Pa·s or less, 2,500 Pa·s or less, or 2,200 Pa·s or less. The lower limit of the minimum melt viscosity may be, for example, 500 Pa·s or more, 700 Pa·s or more, or 900 Pa·s or more.

[0056] The shear viscosity (melt viscosity) of the film-shaped adhesive 1

at 100°C may be, for example, 3,000 Pa·s or less from the viewpoint of more excellent embeddability. The shear viscosity (melt viscosity) at 100°C may be, for example, 2,800 Pa·s or less or 2,600 Pa·s or less. The lower limit of the shear viscosity (melt viscosity) at 100°C may be, for example, 500 Pa·s or more, 800 Pa·s or more, or 1,000 Pa·s or more.

[0057] In the present specification, the minimum melt viscosity in the range of 60 to 160°C or the shear viscosity (melt viscosity) at 100°C can be measured as follows. First, a laminate is obtained by laminating the film-shaped adhesive with a laminator so that the thickness becomes 1000 μm (1 mm) or more. A measurement sample having a circular surface with a diameter of 9 mm is punched out from the obtained laminate, and for the obtained measurement sample, measurement is performed using a viscoelasticity measurement apparatus under the conditions of a measurement temperature of 60 to 160°C, a heating rate of 5°C/min, a strain of 5%, a measurement frequency of 4 Hz, and an initial load of 10 g, and the minimum melt viscosity, which is the lowest value within the measurement temperature range, and the melt viscosity at 100°C are derived.

[0058] The film-shaped adhesive 1 (adhesive film) shown in Fig. 1 is formed by molding an adhesive composition containing component (A), component (B), component (C), component (D), component (E), component (F), other components, and the like into a film shape. Such a film-shaped adhesive 1 can be formed by applying the adhesive composition to a support film. In the formation of the film-shaped adhesive 1, a varnish (adhesive varnish) containing the adhesive composition and a solvent may be used. When using an adhesive varnish,

the film-shaped adhesive 1 can be obtained by preparing an adhesive varnish by mixing or kneading the contained components in a solvent, applying the obtained adhesive varnish to a support film, and removing the solvent by heating and drying.

5 [0059] The support film is not particularly limited as long as it can withstand the above-mentioned heating and drying, but may be, for example, a polyester film, a polypropylene film, a polyethylene terephthalate film, a polyimide film, a polyetherimide film, a polyethylene naphthalate film, a polymethylpentene film, or the like. The support film
10 may be a multilayer film combining two or more types, or may be one whose surface is treated with a release agent such as a silicone-based or silica-based agent. The thickness of the support film may be, for example, from 10 to 200 μm or from 20 to 170 μm .

[0060] Mixing or kneading can be performed by using a conventional
15 disperser such as a stirrer, a mortar, a three-roll mill, or a ball mill, and combining these as appropriate.

[0061] The solvent used for preparing the adhesive varnish is not limited as long as it can uniformly dissolve, knead, or disperse each component, and conventionally known solvents can be used. Examples of such
20 solvents include ketone-based solvents such as acetone, methyl ethyl ketone, methyl isobutyl ketone, and cyclohexanone, as well as dimethylformamide, dimethylacetamide, N-methylpyrrolidone, toluene, and xylene. The solvent may be methyl ethyl ketone or cyclohexanone from the viewpoint of drying speed and cost.

25 [0062] As a method for applying the adhesive varnish to the support film, a known method can be used, for example, a knife coat method, a roll coat

method, a spray coat method, a gravure coat method, a bar coat method, a curtain coat method, or the like can be used. The heating and drying conditions are not particularly limited as long as the used solvent sufficiently volatilizes, but may be 50 to 150°C for 1 to 30 minutes.

5 [0063] Since the film-shaped adhesive 1 can be made into a thin film, it can be suitably used in a manufacturing process of a semiconductor device formed by stacking a plurality of semiconductor chips. In this case, the semiconductor device may be a stacked MCP, and may be a 3D NAND memory.

10 [0064] [Dicing/die-bonding integrated film]

Fig. 2 is a schematic cross-sectional view showing an embodiment of a dicing/die-bonding integrated film. The dicing/die-bonding integrated film 10 shown in Fig. 2 includes a base layer 2, a pressure-sensitive adhesive layer 3, and an adhesive layer 1A consisting of the above-described film-shaped adhesive 1, in this order. The laminate composed of the base layer 2 and the pressure-sensitive adhesive layer 3 can be a dicing film 4. Using such a dicing/die-bonding integrated film 10 makes it possible to improve work efficiency because the lamination step onto a semiconductor wafer is performed only once. The dicing/die-bonding integrated film may be in the form of a film, a sheet, a tape, or the like.

20 [0065] The dicing film 4 includes a base layer 2 and a pressure-sensitive adhesive layer 3 provided on the base layer 2.

[0066] Examples of the base layer 2 include plastic films such as a polytetrafluoroethylene film, a polyethylene terephthalate film, a polyethylene film, a polypropylene film, a polymethylpentene film, a polyimide film, and an ethylene vinyl acetate copolymer. These base

layers 2 may be a multilayer film combining two or more types. These base layers 2 may be subjected to surface treatment such as primer application, UV treatment, corona discharge treatment, polishing treatment, or etching treatment, as necessary.

5 [0067] The pressure-sensitive adhesive layer 3 is a layer consisting of a pressure-sensitive adhesive. The pressure-sensitive adhesive is not particularly limited as long as it has sufficient pressure-sensitive adhesive force so that semiconductor chips do not scatter during the dicing step, and has a low pressure-sensitive adhesive force to the extent that it does not
10 damage the semiconductor chips in the subsequent pickup step of the semiconductor chips, and conventionally known ones in the field of dicing films can be used. The pressure-sensitive adhesive may be either a radiation-curable type or a non-radiation-curable type. A non-radiation-curable pressure-sensitive adhesive is a pressure-sensitive adhesive that
15 exhibits a certain tackiness with a short period of pressure. On the other hand, a radiation-curable pressure-sensitive adhesive is a pressure-sensitive adhesive that has the property of decreasing in tackiness upon irradiation with radiation (for example, ultraviolet rays).

[0068] The thickness of the dicing film 4 (base layer 2 and pressure-sensitive adhesive layer 3) may be from 60 to 150 μm or from 70 to 130 μm from the viewpoint of economy and film handleability.

[0069] The dicing/die-bonding integrated film 10 can be obtained, for example, by providing the film-shaped adhesive 1 and the dicing film 4, and laminating the film-shaped adhesive 1 and the pressure-sensitive
25 adhesive layer 3 of the dicing film 4 together. The dicing/die-bonding integrated film 10 can also be obtained, for example, by providing the

dicing film 4 and applying the adhesive composition (adhesive varnish) onto the pressure-sensitive adhesive layer 3 of the dicing film 4 in the same manner as the method for forming the above-described film-shaped adhesive 1.

5 [0070] When laminating the film-shaped adhesive 1 and the pressure-sensitive adhesive layer 3 of the dicing film 4, the dicing/die-bonding integrated film 10 can be formed by laminating the film-shaped adhesive 1 onto the dicing film 4 under predetermined conditions (for example, room temperature (20°C) or a heated state) using a roll laminator, a vacuum laminator, or the like. The dicing/die-bonding integrated film 10 may be formed using a roll laminator in a heated state because it can be manufactured continuously and is excellent in efficiency.

10 [0071] The film-shaped adhesive and the dicing/die-bonding integrated film may be used in a manufacturing process of a semiconductor device, and may be used in a manufacturing process of a semiconductor device formed by stacking a plurality of semiconductor chips. The film-shaped adhesive and the dicing/die-bonding integrated film may be used in a manufacturing process of a semiconductor device including obtaining a semiconductor chip with an adhesive piece by laminating the film-shaped adhesive or the adhesive layer of the dicing/die-bonding integrated film onto a semiconductor wafer or an already singulated semiconductor chip and dividing it by a rotary blade, laser, or stretching, and bonding the semiconductor chip with an adhesive piece onto a support member or another semiconductor chip via the adhesive piece.

20 [0072] The film-shaped adhesive is also suitably used as an adhesive for bonding semiconductor chips to each other in a stacked MCP (for example,

a 3D NAND memory), which is a semiconductor device formed by stacking a plurality of semiconductor chips.

[0073] The film-shaped adhesive can also be used, for example, as a protective sheet for protecting the back surface of a semiconductor chip of a flip-chip type semiconductor device, a sealing sheet for sealing between the surface of the semiconductor chip of a flip-chip type semiconductor device and an adherend, and the like.

[0074] A semiconductor device manufactured using the film-shaped adhesive and the dicing/die-bonding integrated film will be specifically described below with reference to the drawings. In recent years, semiconductor devices with various structures have been proposed, and the application of the film-shaped adhesive and the dicing/die-bonding integrated film of the present embodiment is not limited to the semiconductor devices with the structures described below.

[0075] [Semiconductor Device]

Fig. 3 is a schematic cross-sectional view showing an embodiment of a semiconductor device. The semiconductor device 100 shown in Fig. 3 includes a semiconductor chip 11 (first semiconductor chip), a support member 12 on which the semiconductor chip 11 is mounted, and an adhesive member 15. The adhesive member 15 is provided between the semiconductor chip 11 and the support member 12, and bonds the semiconductor chip 11 and the support member 12. The adhesive member 15 is a cured product of the adhesive composition (cured product of the film-shaped adhesive). A connection terminal (not shown) of the semiconductor chip 11 is electrically connected to an external connection terminal (not shown) via a bonding wire 13 and is sealed with an

encapsulant 14.

[0076] Fig. 4 is a schematic cross-sectional view showing another embodiment of a semiconductor device. In the semiconductor device 110 shown in Fig. 4, a first-stage semiconductor chip 11a (first semiconductor chip) is bonded to a support member 12 on which terminals 16 are formed, by an adhesive member 15a (cured product of the adhesive composition (cured product of the film-shaped adhesive)), and a second-stage semiconductor chip 11b (second semiconductor chip) is further bonded on the first-stage semiconductor chip 11a by an adhesive member 15b (cured product of the adhesive composition (cured product of the film-shaped adhesive)). Connection terminals (not shown) of the first-stage semiconductor chip 11a and the second-stage semiconductor chip 11b are electrically connected to an external connection terminal via a bonding wire 13 and are sealed with an encapsulant 14. It can also be said that the semiconductor device 110 shown in Fig. 4 further includes another semiconductor chip (11b) stacked on the surface of the semiconductor chip (11a) in the semiconductor device 100 shown in Fig. 3.

[0077] Fig. 5 is a schematic cross-sectional view showing another embodiment of a semiconductor device. The semiconductor device 120 shown in Fig. 5 includes a support member 12, and semiconductor chips 11a (first semiconductor chip), 11b (second semiconductor chip), 11c (third semiconductor chip), and 11d (fourth semiconductor chip) stacked on the support member 12. The four semiconductor chips 11a, 11b, 11c, and 11d are stacked at positions shifted from each other in the lateral direction (direction orthogonal to the stacking direction) for connection with connection terminals (not shown) formed on the surface of the

support member 12 (see Fig. 5). The semiconductor chip 11a is bonded to the support member 12 by an adhesive member 15a (cured product of the adhesive composition (cured product of the film-shaped adhesive)), and adhesive members 15b, 15c, and 15d (cured products of the adhesive composition (cured products of the film-shaped adhesive)) are also interposed between the three semiconductor chips 11b, 11c, and 11d, respectively. It can also be said that the semiconductor device 120 shown in Fig. 5 further includes other semiconductor chips (11b, 11c, 11d) stacked on the surface of the semiconductor chip (11a) in the semiconductor device 100 shown in Fig. 3.

[0078] Although the semiconductor device (semiconductor package) has been described in detail with respect to the embodiments of the present disclosure above, the present disclosure is not limited to the above embodiments. For example, in Fig. 5, a semiconductor device in an embodiment where four semiconductor chips are stacked is illustrated, but the number of stacked semiconductor chips is not limited to this. Further, in Fig. 5, a semiconductor device in an embodiment where the semiconductor chips are stacked at positions shifted from each other in the lateral direction (direction orthogonal to the stacking direction) is illustrated, but it may be a semiconductor device in an embodiment where the semiconductor chips are stacked at positions not shifted from each other in the lateral direction (direction orthogonal to the stacking direction).

[0079] [Method for Manufacturing a Semiconductor Device]
The semiconductor device (semiconductor package) shown in Fig. 3, Fig. 4, and Fig. 5 can be obtained by a method including interposing the above-

described film-shaped adhesive between a semiconductor chip (first semiconductor chip) and a support member, or between a semiconductor chip (first semiconductor chip) and a semiconductor chip (second semiconductor chip), and bonding the semiconductor chip (first semiconductor chip) and the support member, or the semiconductor chip (first semiconductor chip) and the semiconductor chip (second semiconductor chip). More specifically, it can be obtained by interposing the above-described film-shaped adhesive between a semiconductor chip and a support member, or between a semiconductor chip (first semiconductor chip) and a semiconductor chip (second semiconductor chip), thermocompression bonding them to bond them together, and then, as necessary, undergoing a thermal curing step, a wire bonding step, an encapsulation step with an encapsulant, a heating-melting step including reflow by solder, and the like.

[0080] As a method for interposing the film-shaped adhesive between a semiconductor chip (first semiconductor chip) and a support member, or between a semiconductor chip (first semiconductor chip) and a semiconductor chip (second semiconductor chip), it may be a method of preparing a semiconductor chip with an adhesive piece in advance and then laminating it onto a support member or another semiconductor chip, as will be described later.

[0081] Next, an embodiment of a method for manufacturing a semiconductor device using the dicing/die-bonding integrated film shown in Fig. 2 will be described. Note that the method for manufacturing a semiconductor device using the dicing/die-bonding integrated film is not limited to the method for manufacturing a semiconductor device described

below.

[0082] One embodiment of the method for manufacturing a semiconductor device includes, for example, laminating a semiconductor wafer onto the adhesive layer of the above-described dicing/die-bonding integrated film (lamination step); producing a plurality of singulated semiconductor chips with an adhesive piece by dicing the semiconductor wafer on which the adhesive layer has been laminated (dicing step); and bonding a first semiconductor chip with an adhesive piece, which is one of the semiconductor chips with an adhesive piece and has a first semiconductor chip and a first adhesive piece, to a support member via the first adhesive piece (bonding a semiconductor chip with an adhesive piece to a support member via the adhesive piece) (first bonding step). Another embodiment of the method for manufacturing a semiconductor device includes, for example, providing a laminate including the above-described dicing/die-bonding integrated film and a plurality of semiconductor chips provided on the adhesive layer of the dicing/die-bonding integrated film, the plurality of semiconductor chips being formed by singulating a semiconductor wafer (laminate providing step); producing a semiconductor chip with an adhesive piece by irradiating the adhesive layer with a laser through gaps between the plurality of semiconductor chips to singulate the adhesive layer (adhesive layer singulation step); and bonding a first semiconductor chip with an adhesive piece, which is one of the semiconductor chips with an adhesive piece and has a first semiconductor chip and a first adhesive piece, to a support member via the first adhesive piece (bonding a semiconductor chip with an adhesive piece to a support member via the adhesive piece) (first

bonding step).

[0083] The method of manufacturing a semiconductor device, further including bonding a second semiconductor chip with an adhesive piece, which is another one of the plurality of semiconductor chips with an adhesive piece and has a second semiconductor chip and a second adhesive piece, to a surface of the first semiconductor chip of the first semiconductor chip with an adhesive piece bonded to the support member, via the second adhesive piece. This step (referred to as a "second bonding step") is bonding another semiconductor chip with an adhesive piece to a surface of the semiconductor chip bonded to the support member, via the adhesive piece that the other semiconductor chip with an adhesive piece has.

[0084] The lamination step is pressure-bonding a semiconductor wafer to the adhesive layer 1A of the dicing/die-bonding integrated film 10 and laminating it by adhesive retention. This step may be performed while pressing with a pressing means such as a pressure-bonding roll.

[0085] Examples of the semiconductor wafer include compound semiconductors such as single-crystal silicon, polycrystalline silicon, various ceramics, and gallium arsenide.

[0086] The dicing step is dicing the semiconductor wafer. Thereby, the semiconductor wafer can be diced to a predetermined size to produce a plurality of singulated semiconductor chips with an adhesive piece. Dicing can be performed, for example, from the circuit surface side of the semiconductor wafer according to a conventional method. In this step, for example, a method called full cut in which an incision is made down to the dicing film, a method in which a half-cut is made in the semiconductor

wafer and it is divided by cooling and pulling, a method of dividing by laser, and the like can be adopted. The dicing apparatus used in this step is not particularly limited, and a conventionally known one can be used.

5 [0087] The semiconductor chip is composed of, for example, a circuit layer and a semiconductor layer (for example, a compound semiconductor such as single-crystal silicon, polycrystalline silicon, various ceramics, or gallium arsenide). Examples of the semiconductor chip include ICs (integrated circuits) and the like. Examples of the support member include lead frames such as a 42-alloy lead frame and a copper lead frame; plastic
10 films such as a polyimide resin and an epoxy resin; modified plastic films obtained by impregnating a base material such as a glass nonwoven fabric with a plastic such as a polyimide resin or an epoxy resin and curing it; and ceramics such as alumina.

[0088] The laminate providing step is providing a laminate including a
15 dicing/die-bonding integrated film and a plurality of semiconductor chips provided on the adhesive layer of the dicing/die-bonding integrated film, the plurality of semiconductor chips being formed by singulating a semiconductor wafer. In this step, the method is not particularly limited as long as a laminate having a predetermined configuration can be obtained.
20 The laminate may be a laminate produced by a method including forming grooves along dicing lines on a circuit formation surface of a semiconductor wafer (step (a)); producing a plurality of semiconductor chips by grinding a back surface of the semiconductor wafer on which the grooves have been formed, the back surface being opposite to the circuit
25 formation surface, to a depth that reaches at least the grooves (step (b)); and laminating the adhesive layer of the dicing/die-bonding integrated

film onto back surfaces of the plurality of semiconductor chips (step (c)).

[0089] In step (a), grooves are formed along dicing lines on a circuit formation surface of a semiconductor wafer. As the semiconductor wafer, for example, the same ones as described above can be exemplified. A semiconductor wafer usually has a circuit formation surface and a back surface opposite to the circuit formation surface.

[0090] The thickness of the semiconductor wafer is greater than the thickness of the semiconductor chip. The thickness of the semiconductor wafer may be, for example, from 50 to 3000 μm , from 100 to 2000 μm , or from 200 to 1500 μm .

[0091] The grooves are formed by performing half-cut dicing using a dicing blade along the dicing lines of the semiconductor wafer. Half-cut dicing means dicing to a predetermined depth so as not to completely cut the semiconductor wafer. Half-cut dicing with a dicing blade can be performed using a commercially available dicing saw. The grooves are formed on the circuit formation surface of the semiconductor wafer, for example, so as to form a grid pattern in a plan view.

[0092] In step (b), a plurality of semiconductor chips are produced by grinding a back surface of the semiconductor wafer on which the grooves have been formed, the back surface being opposite to the circuit formation surface, to a depth that reaches at least the grooves.

[0093] In step (b), first, a backgrind tape is laminated onto the circuit formation surface of the semiconductor wafer on which the grooves have been formed. As the backgrind tape, a backgrind tape used in the field can be used, and for example, it may be a backgrind tape including a pressure-sensitive adhesive layer including an ultraviolet-curable pressure-sensitive

adhesive.

5 [0094] Subsequently, the back surface of the semiconductor wafer on which the grooves have been formed is ground. Grinding the back surface of the semiconductor wafer on which the grooves have been formed can be performed using a general grinder. By grinding the back surface in this way, a plurality of semiconductor chips having a thickness thinner than the thickness of the semiconductor wafer can be produced. A semiconductor chip usually has a circuit formation surface and a back surface opposite to the circuit formation surface. The thickness of the semiconductor chip is smaller than the thickness of the semiconductor wafer. The thickness of the semiconductor chip may be, for example, from 10 to 200 μm , and may be from 20 to 100 μm . Note that the thicknesses of the semiconductor chips may all be the same or may be different from each other.

15 [0095] In step (c), the adhesive layer of the above-described dicing/die-bonding integrated film is laminated onto the back surfaces of the plurality of semiconductor chips obtained above. In this way, a laminate A having a base layer, a pressure-sensitive adhesive layer, an adhesive layer, a plurality of semiconductor chips, and a backgrind tape in this order can be obtained.

20 [0096] Subsequently, a laminate can be obtained by peeling the backgrind tape from the laminate A. When the backgrind tape includes a pressure-sensitive adhesive layer including an ultraviolet-curable pressure-sensitive adhesive, the backgrind tape can be efficiently peeled from the laminate A by irradiating the pressure-sensitive adhesive layer of the backgrind tape with ultraviolet rays to cure the pressure-sensitive adhesive layer and

reduce its pressure-sensitive adhesive force.

5 [0097] The adhesive layer singulation step produces a semiconductor chip with an adhesive piece, which has a semiconductor chip and an adhesive piece, by irradiating the adhesive layer with a laser through gaps between the plurality of semiconductor chips to singulate the adhesive layer.

[0098] The plurality of semiconductor chips formed by singulating a semiconductor wafer usually have gaps between the plurality of semiconductor chips. By irradiating the adhesive layer with a laser through the gaps, adhesive layer pieces having a shape similar to the shape of the semiconductor chips in a plan view can be obtained.

10 [0099] The laser irradiation is performed, for example, from the semiconductor chip side through the gaps between the plurality of semiconductor chips. The laser irradiation can be performed using a commercially available laser saw. The frequency of the laser may be, for example, from 30 to 250 kHz, from 50 to 200 kHz, or from 80 to 120 kHz. The output of the laser may be, for example, from 0.05 to 2.0 W, from 0.1 to 1.0 W, or from 0.2 to 0.5 W. The feed speed in the laser irradiation may be, for example, from 20 to 500 mm/s, from 50 to 400 mm/s, or from 100 to 300 mm/s.

20 [0100] The method for manufacturing a semiconductor device may include a pickup step as necessary. The pickup step is picking up a semiconductor chip with an adhesive piece in order to peel the semiconductor chip with an adhesive piece that is adhesively fixed to the dicing/die-bonding integrated film or the dicing film. The pickup method is not particularly limited, and various conventionally known methods can be adopted. Examples of such a method include a method of pushing up

individual semiconductor chips with an adhesive piece from the dicing/die-bonding integrated film or dicing film side with a needle, and picking up the pushed-up semiconductor chip with an adhesive piece with a pickup device.

5 [0101] Here, the pickup can be performed after irradiating the pressure-sensitive adhesive layer with radiation when the pressure-sensitive adhesive layer is of a radiation (for example, ultraviolet) curable type. This reduces the pressure-sensitive adhesive force of the pressure-sensitive adhesive layer to the adhesive piece, facilitating the peeling of the semiconductor chip with an adhesive piece. As a result, pickup becomes possible without damaging the semiconductor chip with an adhesive piece.

10 [0102] The first bonding step is bonding the first semiconductor chip with an adhesive piece, formed by dicing, to a support member for mounting a semiconductor chip, via the first adhesive piece. The method for manufacturing a semiconductor device may, as necessary, include bonding a second semiconductor chip with an adhesive piece to the surface of the semiconductor chip bonded to the support member, via the second adhesive piece (second bonding step). Both bondings can be performed by thermocompression. The thermocompression conditions are not particularly limited and can be set as needed. The thermocompression conditions may be, for example, a temperature of 80 to 160°C, a load of 5 to 15 N, and a time of 1 to 10 seconds. Note that, as the support member, the same support members as described above can be exemplified.

20 [0103] The method for manufacturing a semiconductor device may, as necessary, include further thermally curing the adhesive piece (the first adhesive piece in the first semiconductor chip with an adhesive piece, and

the second adhesive piece in the second semiconductor chip with an adhesive piece) or the film-shaped adhesive (thermal curing step). By further thermally curing the adhesive piece (the first adhesive piece in the first semiconductor chip with an adhesive piece, and the second adhesive piece in the second semiconductor chip with an adhesive piece) that bonds the semiconductor chip (first semiconductor chip) and the support member, as well as the semiconductor chip (first semiconductor chip) and the semiconductor chip (second semiconductor chip), a stronger adhesive fixation becomes possible. When performing thermal curing, pressure may be applied simultaneously to effect curing. The heating temperature in this step can be appropriately changed depending on the constituent components of the adhesive piece. The heating temperature may be, for example, from 60 to 200°C or from 100 to 180°C. Note that the temperature or pressure may be changed in stages. The heating time may be, for example, from 1 to 120 minutes or from 15 to 60 minutes.

[0104] The method for manufacturing a semiconductor device may, as necessary, include electrically connecting the first semiconductor chip and the second semiconductor chip to the support member with bonding wires, more specifically, electrically connecting an electrode pad on the semiconductor chip and the tip of a terminal portion (inner lead) of the support member with a bonding wire (wire bonding step). As the bonding wire, for example, a gold wire, an aluminum wire, a copper wire, or the like is used. The temperature during wire bonding may be in the range of 80 to 250°C or 80 to 220°C. The heating time may be from several seconds to several minutes. The wire bonding may be performed by the combined use of vibrational energy from ultrasonic waves and thermocompression

energy from applied pressure in a state heated within the above temperature range.

5 [0105] The method for manufacturing a semiconductor device may, as necessary, include encapsulating the semiconductor chip with an encapsulant (encapsulation step). This step is performed to protect the semiconductor chip or bonding wires mounted on the support member. This step can be performed by molding a resin for encapsulation (encapsulating resin) with a mold. The encapsulating resin may be, for example, an epoxy-based resin. The support member and residue are
10 embedded by the heat and pressure during encapsulation, and peeling due to bubbles at the adhesive interface can be prevented.

[0106] The method for manufacturing a semiconductor device may, as necessary, include completely curing the insufficiently cured encapsulating resin in the encapsulation step (post-curing step). In the
15 encapsulation step, even if the adhesive piece is not thermally cured, in this step, the adhesive piece can be thermally cured and adhesively fixed along with the curing of the encapsulating resin. The heating temperature in this step can be appropriately set depending on the type of encapsulating resin, and may be, for example, in the range of 165 to 185°C, and the
20 heating time may be about 0.5 to 8 hours.

[0107] The method for manufacturing a semiconductor device may, as necessary, include heating the semiconductor chip with an adhesive piece bonded to the support member using a reflow furnace (heating-melting step). In this step, the resin-encapsulated semiconductor device may be
25 surface-mounted on the support member. As a method for surface mounting, for example, reflow soldering, in which solder is supplied onto

a printed wiring board in advance and then heated and melted by hot air or the like to perform soldering, can be mentioned. Examples of the heating method include hot air reflow, infrared reflow, and the like. The heating method may be one that heats the whole or one that heats locally.
5 The heating temperature may be, for example, in the range of 240 to 280°C.

Examples

[0108] Hereinafter, the present disclosure will be specifically described based on examples, but the present disclosure is not limited thereto.

[0109]

10 [Production of Film-shaped adhesive]

(Examples 1 to 6 and Comparative Examples 1 and 2)

<Preparation of Adhesive Varnish>

With the components and contents (unit: parts by mass) shown in Table 1, cyclohexanone was added to a mixture consisting of component (A),
15 component (B), component (D), and component (E), and the mixture was stirred and mixed. To this, component (C) was added with the component and content (unit: parts by mass) shown in Table 1 and stirred, and component (F) was further added and stirred until each component became uniform, to prepare adhesive varnishes of Examples 1 to 6 and
20 Comparative Examples 1 and 2. Note that each component shown in Table 1 means the following, and the numerical values shown in Table 1 mean parts by mass of the components excluding solvents and the like.

[0110] Component (A): Epoxy resin

Component (A): Epoxy resin

25 Component (Aa): First epoxy resin

(Aa-1) EXA-830CRP (trade name, manufactured by DIC Corporation,

- bisphenol F type epoxy resin, epoxy equivalent: 160 g/eq, liquid at 30°C)
- Component (Ab): Second epoxy resin
- (Ab-1) HP-4710 (trade name, manufactured by DIC Corporation, epoxy resin represented by the above formula (X), epoxy equivalent: 170 g/eq, softening point: 85 to 105°C)
- (Ab-2) N-500P-10 (trade name, manufactured by DIC Corporation, o-cresol novolac type epoxy resin, epoxy equivalent: 204 g/eq, softening point: 75 to 85°C)
- [0111] Component (B): Phenolic resin
- (B-1) MEH-7800M (trade name, manufactured by Meiwa Plastic Industries, Ltd. (now UBE Corporation), phenylaralkyl type phenolic resin, hydroxyl equivalent: 174 g/eq, softening point: 80°C)
- [0112] Component (C): Elastomer
- (C-1) HTR-860P-3CSP (trade name, manufactured by Nagase ChemteX Corporation, acrylic rubber, glass transition temperature: -7°C, weight-average molecular weight: 800,000)
- [0113] Component (D): Inorganic filler
- (D-1) Silica filler dispersion (manufactured by Admatechs Company, Limited, cyclohexanone dispersion of silica filler, average particle size: 100 nm)
- [0114] Component (E): Coupling agent
- (E-1) A-189 (trade name, manufactured by Momentive Performance Materials Japan LLC, γ -mercaptopropyltrimethoxysilane)
- (E-2) A-1160 (trade name, manufactured by Momentive Performance Materials Japan LLC, γ -ureidopropyltriethoxysilane)
- [0115] Component (F): Curing accelerator

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

[0116] <Production of Film-shaped adhesive>

5 The adhesive varnishes of Examples 1 to 6 and Comparative Examples 1 and 2 were filtered through a 500-mesh filter and vacuum-degassed. A polyethylene terephthalate (PET) film with a thickness of 38 μm that had been subjected to a release treatment was prepared as a support film, and the adhesive varnish after vacuum degassing was applied onto the PET film. The applied adhesive varnish was heated and dried at 90°C for 5
10 minutes, and then at 130°C for 5 minutes, to obtain the film-shaped adhesives of Examples 1 to 6 and Comparative Examples 1 and 2 in a B-stage state. For each of the Examples and Comparative Examples, two types of film-shaped adhesives with different thicknesses (3 μm and 10 μm) were prepared. The thickness of the film-shaped adhesive was
15 adjusted by the coating amount of the adhesive varnish.

[0117] [Evaluation of Film-shaped adhesive]

<Evaluation of Fracture resistance>

The film-shaped adhesives of Examples 1 to 6 and Comparative Examples 1 and 2 with a thickness of 3 μm , provided on a support film (PET film),
20 were cut into a length of 100 mm and a width of 20 mm to be used as test pieces. Cellophane tape was attached to the end of the test piece on the film-shaped adhesive side, the film-shaped adhesive was peeled off from the support film (PET film) together with the cellophane tape, and the state of the peeled film-shaped adhesive was observed. Cases where the entire
25 film-shaped adhesive could be peeled off without any breakage were evaluated as "A" for excellent fracture resistance, cases where 80% or

more could be peeled off without breakage were evaluated as "B", and cases where less than 80% could be peeled off without breakage were evaluated as "C". The results are shown in Table 1.

[0118] <Measurement of Shear Viscosity (Melt Viscosity)>

5 A plurality of the film-shaped adhesives of Examples 1 to 6 and Comparative Examples 1 and 2 were laminated at 70°C, respectively, to form a laminate having a thickness of 1000 μm (1 mm) or more. A measurement sample having a circular surface with a diameter of 9 mm was punched out from the laminate, and the measurement sample was
10 mounted on a circular aluminum plate jig with a diameter of 8 mm. Using an ARES (manufactured by TA Instruments Japan Inc.), the shear viscosity of the measurement sample was measured under the following conditions. From the measurement results, the minimum value of the shear viscosity (minimum melt viscosity) in the range of 60 to 160°C and the shear
15 viscosity at 100°C were derived. For the minimum melt viscosity and the shear viscosity at 100°C, a smaller numerical value (for example, 3000 Pa·s or less (minimum melt viscosity), and 3000 Pa·s or less (shear viscosity at 100°C)) means higher flowability and excellent embeddability. The results are shown in Table 1.

20 (Measurement Conditions)

- Measurement temperature: 60 to 160°C
- Heating rate: 5°C/min
- Strain: 5%
- Frequency: 4 Hz
- 25 • Initial load: 10 g

[0119] <Measurement of High-Temperature Storage Modulus after

Curing>

Using the film-shaped adhesives of Examples 1 to 6 and Comparative Examples 1 and 2, the high-temperature storage modulus after curing was measured. The high-temperature storage modulus after curing was measured by the following method. That is, a sample for measurement was prepared by laminating a plurality of film-shaped adhesives with a thickness of 10 μm to a thickness of about 160 μm , and cutting this into a size of 4 mm in width $\times$ 33 mm in length. After curing the prepared sample under the conditions of 150°C for 30 minutes, the cured sample was set in a dynamic mechanical analyzer (Rheogel E-4000, manufactured by UBM Co., Ltd.), and the viscoelasticity was measured in a temperature-dependent measurement mode by applying a tensile load under the conditions of a frequency of 10 Hz, a heating rate of 3°C/min, and a temperature range of 30 to 300°C, and the value of the storage modulus at 150°C was taken as the high-temperature storage modulus. For the high-temperature storage modulus, a larger numerical value (for example, 40 MPa or more) means that the occurrence of chip cracks can be suppressed. The results are shown in Table 1.

[0120] [Table 1]

	Comp. Exam. 1	Comp. Exam. 2	Exam. 1	Exam. 2	Exam. 3	Exam. 4	Exam. 5	Exam. 6
	(Aa-1)	10.4	10.4	24.6	12.0	15.0	16.0	19.0
(A)	(Ab-1)	-	-	-	-	-	-	7.0
	(Ab-2)	28.6	16.9	9.9	24.0	23.5	19.5	6.0
(B)	(B-1)	30.7	22.2	30.2	28.8	31.3	29.2	23.1
(C)	(C-1)	25.0	45.0	30.0	35.0	30.0	30.0	28.7
(D)	(D-1)	5.1	5.1	5.1	-	-	5.1	35.0
(E)	(E-1)	0.09	0.09	0.09	0.09	0.09	0.09	-
	(E-2)	-	0.18	-	-	-	-	0.09
(F)	(F-1)	0.11	0.11	0.16	0.15	0.16	0.15	-
(C)/[(A)+(B)]*100 (parts by mass)		35.9	91.0	46.4	54.0	43.0	46.4	0.15
Fracture resistance	C	A	A	A	A	A	A	54.0
Minimum melt viscosity (Pa·s)	1036	5628	1519	1551	974	1529	1545	B
Shear viscosity at 100°C (Pa·s)	1964	6325	2114	2126	1536	2301	2304	2073
High-temperature (150°C) storage modulus (MPa)	14.5	12.3	17.0	71.0	204.8	73.5	40.2	2558
								Not measured

[0121] As shown in Table 1, the film-shaped adhesives of Examples 1 to 6, in which the content of the elastomer satisfies the predetermined requirements, were superior in terms of both fracture resistance and embeddability compared to the film-shaped adhesives of Comparative Examples 1 and 2, in which the content of the elastomer does not satisfy the predetermined requirements. Furthermore, the film-shaped adhesives of Examples 2 to 5 had a sufficiently high high-temperature storage modulus after curing, suggesting that the occurrence of chip cracks can be suppressed. From these results, it was confirmed that the film-shaped adhesive of the present disclosure is excellent in fracture resistance and embeddability even when made into a thin film.

Reference Signs List

[0122] 1... film-shaped adhesive, 1A... adhesive layer, 2... base layer, 3... pressure-sensitive adhesive layer, 4... dicing film, 10... dicing/die-bonding integrated film, 11, 11a, 11b, 11c, 11d... semiconductor chip, 12... support member, 13... bonding wire, 14... encapsulant, 15, 15a, 15b, 15c, 15d... adhesive member, 16... terminal, 100, 110, 120... semiconductor device.

CLAIMS

[Claim 1] A film-shaped adhesive comprising: an epoxy resin; a phenolic resin; and an elastomer, and optionally further comprising an inorganic filler, wherein

5 a content of an inorganic filler is from 0 to 10% by mass, based on a total amount of the film-shaped adhesive,

a content of the elastomer is from 20 to 50% by mass, based on the total amount of the film-shaped adhesive, and

10 the content of the elastomer is from 40 to 60 parts by mass with respect to 100 parts by mass of a total amount of the epoxy resin and the phenolic resin.

[Claim 2] The film-shaped adhesive according to claim 1, wherein a total content of the epoxy resin and the phenolic resin is from 40 to 80% by mass, based on the total amount of the film-shaped adhesive.

15 [Claim 3] The film-shaped adhesive according to claim 1 or 2, wherein

the epoxy resin includes a first epoxy resin having a softening point of 40°C or less, and

20 a content of the first epoxy resin is from 5 to 30% by mass, based on the total amount of the film-shaped adhesive.

[Claim 4] The film-shaped adhesive according to claim 3, wherein

the epoxy resin further includes a second epoxy resin having a softening point of more than 40°C, and

the softening point of the second epoxy resin is 120°C or less.

25 [Claim 5] The film-shaped adhesive according to claim 1 or 2, wherein an average particle size of the inorganic filler is 150 nm or less.

- [Claim 6] The film-shaped adhesive according to claim 1 or 2, wherein the film-shaped adhesive has a minimum melt viscosity in a range of 60 to 160°C of 3,000 Pa·s or less, and a shear viscosity at 100°C of 3,000 Pa·s or less.
- 5 [Claim 7] The film-shaped adhesive according to claim 1 or 2, wherein a cured product obtained by curing the film-shaped adhesive under conditions of 150°C for 30 minutes has a storage modulus at 150°C of 40 MPa or more.
- [Claim 8] The film-shaped adhesive according to claim 1 or 2,
10 wherein a thickness of the film-shaped adhesive is from 1 to 15 μm.
- [Claim 9] The film-shaped adhesive according to claim 1 or 2, wherein the film-shaped adhesive is used in a manufacturing process of a semiconductor device formed by stacking a plurality of semiconductor chips.
- 15 [Claim 10] The film-shaped adhesive according to claim 9, wherein the semiconductor device is a 3D NAND memory.
- [Claim 11] A dicing/die-bonding integrated film comprising, in this order:
a base layer; a pressure-sensitive adhesive layer; and
20 an adhesive layer consisting of the film-shaped adhesive according to claim 1 or 2.
- [Claim 12] A semiconductor device comprising:
a semiconductor chip;
a support member on which the semiconductor chip is mounted;
25 and
a cured product of the film-shaped adhesive according to claim 1

or 2, disposed between the semiconductor chip and the support member and bonding the semiconductor chip and the support member.

[Claim 13] The semiconductor device according to claim 12, further comprising a different semiconductor chip stacked on a surface of the semiconductor chip.

[Claim 14] A method of manufacturing a semiconductor device, the method comprising:

laminating the adhesive layer of the dicing/die-bonding integrated film according to claim 11 onto a semiconductor wafer;

producing a plurality of singulated semiconductor chips with an adhesive piece by dicing the semiconductor wafer on which the adhesive layer has been laminated; and

bonding a first semiconductor chip with an adhesive piece, which is one of the plurality of semiconductor chips with an adhesive piece and has a first semiconductor chip and a first adhesive piece, to a support member via the first adhesive piece.

[Claim 15] The method according to claim 14, further comprising bonding a second semiconductor chip with an adhesive piece, which is another one of the plurality of semiconductor chips with an adhesive piece and has a second semiconductor chip and a second adhesive piece, to a surface of the first semiconductor chip of the first semiconductor chip with an adhesive piece bonded to the support member, via the second adhesive piece.

[Claim 16] A method of manufacturing a semiconductor device, the method comprising:

providing a laminate comprising: the dicing/die-bonding

integrated film according to claim 11; and a plurality of semiconductor chips provided on the adhesive layer of the dicing/die-bonding integrated film, the plurality of semiconductor chips being formed by singulating a semiconductor wafer;

5 producing a plurality of semiconductor chips with an adhesive piece by irradiating the adhesive layer with a laser through gaps between the plurality of semiconductor chips to singulate the adhesive layer; and

 bonding a first semiconductor chip with an adhesive piece, which is one of the plurality of semiconductor chips with an adhesive piece and
10 has a first semiconductor chip and a first adhesive piece, to a support member via the first adhesive piece.

[Claim 17] The method according to claim 16, wherein

 the laminate is produced by a method including:

 forming grooves along dicing lines on a circuit formation surface
15 of the semiconductor wafer;

 producing the plurality of semiconductor chips by grinding a back surface of the semiconductor wafer on which the grooves have been formed, the back surface being opposite to the circuit formation surface, to a depth that reaches at least the grooves; and

20 laminating the adhesive layer of the dicing/die-bonding integrated film onto back surfaces of the plurality of semiconductor chips.

[Claim 18] The method according to claim 16, further comprising
 bonding a second semiconductor chip with an adhesive piece, which is another one of the plurality of semiconductor chips with an adhesive piece
25 and has a second semiconductor chip and a second adhesive piece, to a surface of the first semiconductor chip of the first semiconductor chip with

an adhesive piece bonded to the support member, via the second adhesive piece.

[Claim 19] A method of manufacturing a semiconductor device, comprising bonding a first semiconductor chip to a support member, or
5 bonding the first semiconductor chip to a second semiconductor chip by interposing the film-shaped adhesive according to claim 1 or 2 between the first semiconductor chip and the support member, or between the first semiconductor chip and the second semiconductor chip.