

[DESCRIPTION]

[TITLE OF INVENTION]

FILM ADHESIVE, SEMICONDUCTOR PROCESSING SHEET, AND METHOD FOR
5 MANUFACTURING SEMICONDUCTOR APPARATUS

[Technical Field]

[0001]

The present invention relates to a film adhesive, a semiconductor processing
10 sheet, and a method for manufacturing a semiconductor device.

Priority is claimed on Japanese Patent Application No. 2016-069604, filed
March 30, 2016, the content of which is incorporated herein by reference.

[Background Art]

15 [0002]

A dicing sheet is used when dividing a semiconductor wafer into individual
semiconductor chips by dicing. The dicing sheet is constituted by having, for example,
a pressure-sensitive adhesive layer on a base material, and is used by being attached to a
semiconductor wafer by the pressure-sensitive adhesive layer. After dicing, for example,
20 by decreasing the adhesive force of the pressure-sensitive adhesive layer through curing
by the irradiation of energy rays such as ultraviolet rays, the semiconductor chip is pulled
away from the cured pressure-sensitive adhesive layer and easily picked up.

[0003]

On the other hand, the picked-up semiconductor chip is, for example, die
25 bonded to a circuit surface of a substrate by a film adhesive, and after one or more

additional semiconductor chips are stacked on this semiconductor chip, if necessary, and wire bonded, the entire constitution is sealed with a resin.

Using a semiconductor package obtained in this manner, an intended semiconductor device is ultimately manufactured. Accordingly, in some cases, the semiconductor chip is configured so as to be picked up in a state of having a film adhesive on a surface to be die-bonded.

[0004]

When a film adhesive is used as described above, a dicing/die bonding sheet in which an uncut film adhesive is provided on the pressure-sensitive adhesive layer of the above-mentioned dicing sheet may be used in some cases. On the other hand, a plurality of semiconductor chips that have been divided into individual pieces in advance are sometimes provided on a film adhesive, and also in this case, a semiconductor processing sheet having the same configuration as that of the dicing/die bonding sheet is used. In the case of using such a semiconductor processing sheet, for example, a plurality of semiconductor chips that have been divided into individual pieces in advance are provided on the film adhesive, and the semiconductor processing sheet is expanded at a low temperature, thereby cutting the film adhesive in accordance with the outer shape of the semiconductor chip to produce a semiconductor chip provided with the cut film adhesive on a target surface in some cases.

[0005]

As a semiconductor processing sheet provided with such a film adhesive, those in which a shear adhesive force of a film adhesive (that is, a die bonding film) at 25°C when being adhered to a semiconductor wafer and a shear adhesive force thereof when being adhered to a dicing sheet (that is, a dicing film) are respectively set within specific ranges (see Patent Document 1); those in which an elongation at break of a film adhesive

(that is, a die bonding film) at 25°C before heat curing and a ratio of the tensile storage elastic modulus at 0°C to the tensile storage elastic modulus at 25°C are respectively set within specific ranges (see Patent Document 2); those in which when the thickness of the semiconductor wafer is defined as A (μm), the thickness of the film adhesive (that is, the die bonding film) is defined as B (μm) and the thickness of the base material is defined as C (μm), ratios C/A, C/B and A/B are respectively set so as to be within specific ranges (see Patent Document 3); and those in which an elongation at break and modulus of elasticity of a film adhesive at 25°C in a B stage state (that is, an adhesive sheet), and a ratio A/B when the thickness of a dicing sheet (that is, a dicing tape) is defined as A and the thickness of the film adhesive is defined as B are respectively set so as to be within specific ranges (see Patent Document 4), have been disclosed.

[Citation List]

[Patent Documents]

15 [0006]

[Patent Document 1] Japanese Unexamined Patent Application, First Publication No. 2011-171588

[Patent Document 2] Japanese Unexamined Patent Application, First Publication No. 2011-228399

20 [Patent Document 3] Japanese Unexamined Patent Application, First Publication No. 2012-222002

[Patent Document 4] Japanese Unexamined Patent Application, First Publication No. 2009-283925

25 [Summary of Invention]

[Technical Problem]

[0007]

For the semiconductor processing sheet provided with a film adhesive, further improvement in performance is desired particularly from the viewpoint of improving the cutting characteristics through expansion of the film adhesive.

[0008]

Accordingly, the present invention has an object of providing a novel semiconductor processing sheet provided with a film adhesive having excellent cutting characteristics by expansion.

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[Solution to Problem]

[0009]

In order to solve the above-mentioned problems, the present invention provides a film adhesive which is a curable film adhesive, wherein either an uncured single layer of the aforementioned film adhesive having a thickness of 60 μm , or a laminate formed by laminating two or more uncured layers of the aforementioned film adhesive so that the total thickness becomes 60 μm , has an elongation at break at 0°C of equal to or less than 60%, and an adhesive force of the aforementioned uncured film adhesive with respect to a semiconductor wafer is equal to or more than 300 mN / 25 mm.

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Further, the present invention provides a semiconductor processing sheet in which the aforementioned film adhesive is provided on a support sheet.

In the semiconductor processing sheet of the present invention, it is preferable that the aforementioned support sheet is obtained by providing a pressure-sensitive adhesive layer on a base material, and the aforementioned film adhesive is provided in direct contact with the aforementioned pressure-sensitive adhesive layer.

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[0010]

In addition, the present invention provides a method for manufacturing a semiconductor device which is a method for manufacturing a semiconductor device using the aforementioned film adhesive, and includes: a laminated structure forming step of forming a laminated structure in which the aforementioned film adhesive is provided on a support sheet, and a plurality of already divided semiconductor chips are provided on a surface of the aforementioned film adhesive on a side opposite to a side where the aforementioned support sheet is provided; a cutting step in which the film adhesive of the aforementioned laminated structure is expanded, while being cooled, in a direction along a surface of the aforementioned film adhesive to cut the film adhesive; and a separating step of separating the aforementioned semiconductor chip provided with the aforementioned cut film adhesive from the aforementioned support sheet.

In the method for manufacturing a semiconductor device according to the present invention, prior to the aforementioned laminated structure forming step, it may further include: a modified layer forming step of forming a modified layer inside the aforementioned semiconductor wafer by irradiating a laser beam in an infrared region so as to converge on a focal point set inside the semiconductor wafer; and a dividing step of grinding a surface for providing the aforementioned film adhesive in the aforementioned semiconductor wafer in which the aforementioned modified layer has been formed, and applying a force at the time of grinding to the aforementioned semiconductor wafer, thereby dividing the aforementioned semiconductor wafer at a portion of the aforementioned modified layer and obtaining a plurality of semiconductor chips. The plurality of semiconductor chips obtained in the aforementioned dividing step may be used in the aforementioned laminated structure forming step.

[Advantageous Effects of Invention]

[0011]

According to the present invention, there is provided a novel semiconductor processing sheet provided with a film adhesive having excellent cutting characteristics by expansion.

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[Brief Description of Drawings]

[0012]

FIG. 1 is a cross-sectional view schematically showing one embodiment of a semiconductor processing sheet of the present invention.

10 FIG. 2 is a cross-sectional view for schematically illustrating one embodiment of a method for manufacturing a semiconductor device in the case of using the film adhesive or the semiconductor processing sheet of the present invention.

FIG. 3 is a cross-sectional view for schematically illustrating one embodiment of a method for forming grooves in a semiconductor wafer to obtain semiconductor chips.

15 FIG. 4 is a cross-sectional view for schematically illustrating one embodiment of a method for forming a modified layer in a semiconductor wafer to obtain semiconductor chips.

[Description of Embodiments]

20 [0013]

<Film adhesive>

The film adhesive according to the present invention is a curable film adhesive, wherein either an uncured single layer of the aforementioned film adhesive having a thickness of 60 μm , or a laminate formed by laminating two or more uncured layers of
25 the aforementioned film adhesive so that the total thickness becomes 60 μm , has an

elongation at break at 0°C of equal to or less than 60%, and an adhesive force of the aforementioned uncured film adhesive with respect to a semiconductor wafer is equal to or more than 300 mN / 25 mm.

[0014]

5 As a result of the aforementioned elongation at break being equal to or less than 60%, the film adhesive of the present invention is easily cut at an intended place, if a semiconductor processing sheet is constituted as described later, and when this sheet (that is, the film adhesive) is expanded in the direction along the surface thereof, in other words, when the so-called expansion is performed, at a low temperature.

10 [0015]

 In addition, as a result of the aforementioned adhesive force being equal to or more than 300 mN/25 mm, the film adhesive of the present invention is cut at an intended place without being accompanied by abnormalities such as chipping of the film adhesive, when the expansion is performed at a low temperature as described above. It is presumed that this is because, since the film adhesive has a sufficient adhesive force with respect to the semiconductor wafer, when the film adhesive is expanded, the force at the time of expansion tends to concentrate on a region, within the film adhesive, in the vicinity of an end portion of the semiconductor chip. On the other hand, when the aforementioned adhesive force is less than 300 mN / 25 mm, since the film adhesive is brittle at a low temperature, in the expanded film adhesive, in a region other than the vicinity of the end portion of the semiconductor chip, chipping or the like occurs, and furthermore, since the force at the time of expansion is dispersed in the film adhesive as a result, cutting of the film adhesive at the intended place becomes unsatisfactory. It should be noted that the uncured film adhesive exhibits the same levels of adhesive force with respect to the semiconductor wafer and the semiconductor chip.

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[0016]

The aforementioned film adhesive exhibits curability. The aforementioned film adhesive preferably exhibits thermosetting properties, and preferably exhibits pressure-sensitive adhesive properties. A film adhesive exhibiting both thermosetting properties and pressure-sensitive adhesive properties can be pasted onto various adherends by lightly pressing it thereonto in an uncured state. Further, the film adhesive may be one that can be attached to various adherends by heating and softening. The film adhesive finally becomes a cured product having high impact resistance by curing, and this cured product can retain sufficient adhesion properties even under severe high temperature and high humidity conditions.

[0017]

The film adhesive may be composed of one layer (that is, a single layer), or it may be composed of a plurality of layers of two or more layers. In the case where the film adhesive is composed of a plurality of layers, these plurality of layers may be the same as or different from each other, and the combination of these plurality of layers is not particularly limited as long as the effects of the present invention are not impaired.

It should be noted that in the present specification, and this is not limited to the case of a film adhesive, the expression “the plurality of layers may be the same as or different from each other” means that “all the layers may be the same, all the layers may be different, or only a part of the layers may be the same”. Moreover, the expression “the plurality of layers are different from each other” means that “at least one of the constituent material and the thickness of each layer is different from another”.

[0018]

The thickness of the film adhesive is not particularly limited, but it is preferably from 1 μm to 50 μm , and more preferably from 3 μm to 40 μm . By ensuring that the

thickness of the film adhesive is equal to or more than the above-mentioned lower limit value, a higher adhesive force with respect to the adherend (that is, a semiconductor chip) can be obtained. In addition, by ensuring that the thickness of the film adhesive is equal to or less than the above upper limit value, the film adhesive can be cut more easily by
5 the expansion process described later.

Here, the “thickness of the film adhesive” means the thickness of the entire film adhesive, and for example, the thickness of the film adhesive composed of a plurality of layers means the total thickness of all the layers constituting the film adhesive. It should be noted that as a method of measuring the thickness of the film adhesive, for
10 example, a method of measuring the thickness at five arbitrary places using a contact type thickness meter and calculating the average of the measured values, and the like can be mentioned.

[0019]

The laminate to be subjected for the determined of the elongation at break is one
15 obtained by laminating two or more layers of an uncured film adhesive having a thickness of less than 60 μm so that the total thickness becomes 60 μm .

[0020]

The elongation at break (%) of the film adhesive or laminate at 0°C can be measured by the following method.

20 That is, the elongation at break is determined by using the film adhesive or laminate having a width of 6 mm, a length of 5 mm and a thickness of 60 μm as a test piece, pulling it while changing the load applied to this test piece from 1 N to 18 N at a rate of 1 N/min, and measuring the elongation of the test piece at the time of rupture.

It should be noted that in the present specification, the expression “the
25 elongation at break is X% (in the formula, X is a positive number)” means that in the

above measuring method, when a test piece (in other words, a film adhesive or a laminate) is pulled and the test piece is extended in its tensile direction by a length of X% of the original length (that is, the length when no pulling is performed), that is, when the total length of the test piece in the tensile direction becomes $[1 + X/100]$ times the length before the pulling, the test piece breaks.

[0021]

The elongation at break (%) of the film adhesive or laminate is equal to or less than 60%, preferably equal to or less than 57%, and more preferably equal to or less than 54%. When the elongation at break is equal to or less than the above upper limit value, the film adhesive is satisfactorily cut by expansion.

Further, the lower limit value of the elongation at break (%) of the film adhesive or laminate is not particularly limited, but it is preferably 5%, for example. When the elongation at break is equal to or more than the above lower limit value, the handling properties of the film adhesive are improved and also the effect of suppressing scattering of the film adhesive at the time of expansion is enhanced.

[0022]

The elongation at break (%) can be appropriately adjusted by, for example, adjusting the type and amount of the component contained in the film adhesive and the like.

For example, the elongation at break can be easily adjusted by adjusting the molecular weight and content of a polymer component (a) described later, the structure, softening point and content of the components constituting an epoxy-based thermosetting resin (b), and the content of a filler (c), and the like.

However, these adjustment methods are only examples.

[0023]

The adhesive force (N / 25 mm) of the uncured film adhesive with respect to the semiconductor wafer can be measured by the following method.

That is, a laminated sheet of a film adhesive and an adhesive tape having a width of 25 mm and an arbitrary length is produced. In this laminated sheet, the film adhesive is laminated on the adhesive surface of the adhesive tape. Subsequently, the laminated sheet is attached to a semiconductor wafer by the film adhesive heated to 40 to 70°C to produce a laminate in which the adhesive tape, the film adhesive and the semiconductor wafer are laminated in this order. This laminate after production is immediately left to stand in an environment of 15 to 27°C for 30 minutes, and then the so-called 180° peeling is performed in which the laminated sheet of the film adhesive and the adhesive tape are peeled from the semiconductor wafer at a peeling rate of 300 mm/min, so that the planes of the film adhesive and the semiconductor wafer that have been brought into contact with each other form an angle of 180°. The peel force at this time is measured, and the measured value is defined as the adhesive force (N / 25 mm) of the uncured film adhesive with respect to the semiconductor wafer. The length of the laminated sheet to be subjected to the measurement is not particularly limited as long as it is within a range where the peel force can be stably measured, but it is preferably from 100 mm to 300 mm.

[0024]

The adhesive force of the uncured film adhesive with respect to the semiconductor wafer is equal to or more than 300 mN / 25 mm and can be set to any one of, for example, 310 mN / 25 mm or more, 340 mN / 25 mm or more, 380 mN / 25 mm or more, and the like, but it is not limited thereto.

Further, the upper limit value of the adhesive force is not particularly limited, and can be selected from, for example, 10 N / 25 mm, 800 mN / 25 mm, 700 mN / 25

mm, 600 mN / 25 mm, 500 mN / 25 mm, and the like, but these are only examples.

[0025]

The adhesive force of the uncured film adhesive with respect to the semiconductor wafer can be appropriately adjusted by, for example, adjusting the type
5 and amount of the component contained in the film adhesive and the like.

For example, the adhesive force of the film adhesive can be easily adjusted by adjusting the molecular weight of the polymer component (a) described later, the ratio of each monomer component constituting the polymer component (a), the softening point of the component constituting the epoxy-based thermosetting resin (b), the content of each
10 component contained in the film adhesive, and the like.

However, these adjustment methods are only examples.

[0026]

The film adhesive according to the present invention exhibits favorable cutting characteristics even at a relatively slow expansion rate. For example, the film adhesive
15 of the present invention is particularly suitable when used at a relatively slow expansion rate, such as an expansion rate of 0.5 to 100 mm/sec, as described later. When the expansion rate is relatively slow as described above, the semiconductor chip is less likely to be damaged at the time of cutting the film adhesive, and the effects of the present invention can be obtained more remarkably.

20 [0027]

Preferable examples of the film adhesive include those containing a polymer component (a) and an epoxy-based thermosetting resin (b).

[0028]

[Adhesive composition]

25 The film adhesive can be formed from an adhesive composition containing the

constituent material thereof. For example, the film adhesive can be formed at an intended portion by coating an adhesive composition on the surface on which the film adhesive is to be formed and drying it if necessary. A more specific method of forming the film adhesive will be described in detail later, together with a method of forming
5 other layers. The ratio of the contents of the components that are not vaporized at normal temperature to each other in the adhesive composition is usually the same as the ratio of the contents of the aforementioned components of the film adhesive to each other. It should be noted that in the present specification, the term “normal temperature” means a temperature obtained without particular cooling or heating, in other words, ordinary
10 temperature, and for example, a temperature of 15 to 25°C or the like can be mentioned.

[0029]

Coating of the adhesive composition may be carried out by a known method, and for example, a method using various coaters such as an air knife coater, a blade coater, a bar coater, a gravure coater, a comma coater, a roll coater, a roll knife coater, a
15 curtain coater, a die coater, a knife coater, a screen coater, a Meyer bar coater and a kiss coater can be mentioned.

[0030]

Although the drying condition of the adhesive composition is not particularly limited, in the case where the adhesive composition contains a solvent to be described
20 later, it is preferable to dry the adhesive composition by heating, and in this case, for example, it is preferable to dry under conditions of 70 to 130°C for 10 seconds to 5 minutes.

[0031]

Preferable examples of the adhesive composition include those containing a
25 polymer component (a) and an epoxy-based thermosetting resin (b). Each component

will be described below.

[0032]

(Polymer component (a))

The polymer component (a) is a component that can be regarded as being
5 formed by a polymerization reaction of a polymerizable compound, and it is a polymer
compound for imparting film-forming properties, flexibility and the like to the film
adhesive, and at the same time, improving adhesive properties (that is, sticking
properties) to an adhesion target such as a semiconductor chip. Further, the polymer
component (a) is also a component that does not correspond to an epoxy resin (b1) and a
10 thermal curing agent (b2) which will be described later.

[0033]

The polymer composition (a) contained in the adhesive composition and the film
adhesive may be composed of only one type or may be composed of two or more types,
and when it is composed of two or more types, the combination and ratio thereof can be
15 arbitrarily selected.

[0034]

Examples of the polymer component (a) include an acrylic resin, a polyester, a
urethane-based resin, an acrylic urethane resin, a silicone-based resin, a rubber-based
resin, a phenoxy resin and a thermosetting polyimide, and an acrylic resin is preferable.

20 [0035]

As the acrylic resin in the polymer component (a), a known acrylic polymer can
be mentioned.

The weight average molecular weight (M_w) of the acrylic resin is preferably
from 10,000 to 2,000,000, and more preferably from 100,000 to 1,500,000. When the
25 weight average molecular weight of the acrylic resin is within such a range, it becomes

easy to adjust the elongation at break of the film adhesive or the laminate and the adhesive force of the film adhesive to the above-mentioned ranges.

On the other hand, when the weight average molecular weight of the acrylic resin is equal to or more than the above-mentioned lower limit value, the shape stability
5 (that is, stability over time during storage) of the film adhesive is improved. Further, when the weight average molecular weight of the acrylic resin is equal to or less than the above upper limit value, the film adhesive easily follows the uneven surface of an adherend, and the generation of voids or the like between the adherend and the film adhesive is further suppressed.

10 It should be noted that in the present specification, the “number average molecular weight” and “weight average molecular weight” are polystyrene equivalent values measured by a gel permeation chromatography (GPC) method, unless otherwise specified.

[0036]

15 The glass transition temperature (T_g) of the acrylic resin is preferably from -60 to 70°C, and more preferably from -30 to 50°C. When the T_g of the acrylic resin is equal to or more than the above lower limit value, the adhesive force between the film adhesive and the support sheet described later is suppressed, and the separation of the semiconductor chip provided with the film adhesive from the support sheet becomes
20 easier during pickup. In addition, when the T_g of the acrylic resin is equal to or less than the above upper limit value, the adhesive force between the film adhesive and the semiconductor chip is improved. It should be noted that in the present specification, the “glass transition temperature” is obtained by measuring the DSC curve of a sample using a differential scanning calorimeter and is represented by the temperature of the inflection
25 point of the obtained DSC curve.

[0037]

As the acrylic resin, for example, a (meth)acrylic acid ester copolymer having a structural unit derived from a (meth)acrylic acid ester monomer can be mentioned.

Here, examples of the (meth)acrylic acid ester constituting the acrylic resin include

- 5 (meth)acrylic acid alkyl esters in which the alkyl group constituting the alkyl ester has a chain-like structure with 1 to 18 carbon atoms, such as methyl (meth)acrylate, ethyl (meth)acrylate, n-propyl (meth)acrylate, isopropyl (meth)acrylate, n-butyl (meth)acrylate, isobutyl (meth)acrylate, sec-butyl (meth)acrylate, tert-butyl (meth)acrylate, pentyl (meth)acrylate, hexyl (meth)acrylate, heptyl (meth)acrylate, 2-ethylhexyl (meth)acrylate, 10 isooctyl (meth)acrylate, n-octyl (meth)acrylate, n-nonyl (meth)acrylate, isononyl (meth)acrylate, decyl (meth)acrylate, undecyl (meth)acrylate, dodecyl (meth)acrylate (also referred to as lauryl (meth)acrylate), tridecyl (meth)acrylate, tetradecyl (meth)acrylate (also referred to as myristyl (meth)acrylate), pentadecyl (meth)acrylate, hexadecyl (meth)acrylate (also referred to as palmityl (meth)acrylate), heptadecyl 15 (meth)acrylate and octadecyl (meth)acrylate (also referred to as stearyl (meth)acrylate);
(meth)acrylic acid cycloalkyl esters such as isobornyl (meth)acrylate and dicyclopentanyl (meth)acrylate;
(meth)acrylic acid aralkyl esters such as benzyl (meth)acrylate;
(meth)acrylic acid cycloalkenyl esters such as dicyclopentenyl (meth)acrylate 20 esters;
(meth)acrylic acid cycloalkenyloxyalkyl esters such as dicyclopentenylloxyethyl (meth)acrylate esters;
(meth)acrylic acid imides;
glycidyl group-containing (meth)acrylic acid esters such as glycidyl 25 (meth)acrylate;

hydroxyl group-containing (meth)acrylic acid esters such as hydroxymethyl (meth)acrylate, 2-hydroxyethyl (meth)acrylate, 2-hydroxypropyl (meth)acrylate, 3-hydroxypropyl (meth)acrylate, 2-hydroxybutyl (meth)acrylate, 3-hydroxybutyl (meth)acrylate and 4-hydroxybutyl (meth)acrylate;

5 and substituted amino group-containing (meth)acrylic acid esters such as N-methylaminoethyl (meth)acrylate, and the like. Here, the term “substituted amino group” means a group formed by substituting one or two hydrogen atoms of an amino group with a group other than a hydrogen atom.

[0038]

10 It should be noted that in the present specification, the term “(meth)acrylic acid” is a concept that includes both “acrylic acid” and “methacrylic acid”. The same also applies to the terms similar to (meth)acrylic acid, and for example, the term “(meth)acrylate” is a concept including both “acrylate” and “methacrylate”, and the term “(meth)acryloyl group” is a concept including both “acryloyl group” and “methacryloyl group”.

15

[0039]

The acrylic resin may also be one formed by copolymerization of, for example, in addition to the above (meth)acrylic acid esters, one or more types of monomers selected from (meth)acrylic acid, itaconic acid, vinyl acetate, acrylonitrile, styrene, N-methylolacrylamide and the like.

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[0040]

The monomer constituting the acrylic resin may be composed of only one type or may be composed of two or more types, and when it is composed of two or more types, the combination and ratio thereof can be arbitrarily selected.

25

[0041]

In addition to the above-mentioned hydroxyl group, the acrylic resin may have a functional group capable of bonding with another compound such as a vinyl group, a (meth)acryloyl group, an amino group, a carboxy group and an isocyanate group. These functional groups including the hydroxyl group of the acrylic resin may be bonded to another compound via a crosslinking agent (f) described later, or may be bonded directly to another compound without interposing the crosslinking agent (f). The reliability of the package obtained by using the film adhesive tends to improve due to the bonding of the acrylic resin with another compound through the above functional groups.

[0042]

10 In the present invention, as the polymer component (a), a thermoplastic resin other than an acrylic resin (hereinafter, sometimes abbreviated simply as “thermoplastic resin”) may be used alone without using an acrylic resin, or may be used in combination with an acrylic resin. By including the thermoplastic resin, at the time of pickup, it becomes easier to separate the semiconductor chip provided with the film adhesive from the support sheet, or it becomes easier for the film adhesive to follow the uneven surface of an adherend, and the generation of voids or the like between the adherend and the film adhesive is further suppressed in some cases.

[0043]

The weight average molecular weight of the thermoplastic resin is preferably from 1,000 to 100,000, and more preferably from 3,000 to 80,000.

[0044]

The glass transition temperature (T_g) of the thermoplastic resin is preferably from -30 to 150°C, and more preferably from -20 to 120°C.

[0045]

25 Examples of the thermoplastic resin include polyesters, polyurethanes, phenoxy

resins, polybutenes, polybutadienes and polystyrenes.

[0046]

The thermoplastic resin contained in the adhesive composition and the film adhesive may be composed of only one type or may be composed of two or more types, and when it is composed of two or more types, the combination and ratio thereof can be arbitrarily selected.

[0047]

In the adhesive composition, the ratio of the content of the polymer component (a) with respect to the total content of all components other than the solvent (that is, the content of the polymer component (a) of the film adhesive) is preferably from 20 to 75% by mass, and more preferably from 30 to 65% by mass, regardless of the type of the component (a).

[0048]

(Epoxy-based thermosetting resin (b))

The epoxy-based thermosetting resin (b) is composed of an epoxy resin (b1) and a thermal curing agent (b2).

The epoxy-based thermosetting resin (b) contained in the adhesive composition and the film adhesive may be composed of only one type or may be composed of two or more types, and when it is composed of two or more types, the combination and ratio thereof can be arbitrarily selected.

[0049]

- Epoxy resin (b1)

Examples of the epoxy resin (b1) include known epoxy compounds, and for example, bifunctional or higher epoxy compounds, such as a polyfunctional epoxy resin, a biphenyl compound, a bisphenol A diglycidyl ether and a hydrogenated product thereof,

an orthocresol novolac epoxy resin, a dicyclopentadiene type epoxy resin, a biphenyl type epoxy resin, a bisphenol A type epoxy resin, a bisphenol F type epoxy resin and a phenylene skeleton type epoxy resin, and the like can be mentioned.

[0050]

5 As the epoxy resin (b1), an epoxy resin having an unsaturated hydrocarbon group may be used. The epoxy resin having an unsaturated hydrocarbon group has higher compatibility with an acrylic resin than the epoxy resin having no unsaturated hydrocarbon group. Therefore, by including the epoxy resin having an unsaturated hydrocarbon group, the reliability of the package obtained by using the film adhesive is
10 improved.

[0051]

As the epoxy resin having an unsaturated hydrocarbon group, for example, a compound in which a part of an epoxy group of a polyfunctional epoxy resin has been converted into a group having an unsaturated hydrocarbon group can be mentioned.
15 Such a compound can be obtained, for example, by an addition reaction of (meth)acrylic acid or a derivative thereof to an epoxy group. It should be noted that in the present specification, the term “derivative” means, unless otherwise specified, those in which one or more groups of the original compound are substituted with other groups (that is, substituents). Here, the term “group” is intended to encompass not only an atomic
20 group formed by the bonding of a plurality of atoms but also one atom.

[0052]

Further, examples of the epoxy resin having an unsaturated hydrocarbon group include a compound in which a group having an unsaturated hydrocarbon group is directly bonded to an aromatic ring or the like constituting the epoxy resin.

25 The unsaturated hydrocarbon group is an unsaturated group exhibiting

polymerizability, and specific examples thereof include an ethenyl group (that is, a vinyl group), a 2-propenyl group (that is, an allyl group), a (meth)acryloyl group and a (meth)acrylamide group, and an acryloyl group is preferable.

[0053]

5 The number average molecular weight of the epoxy resin (b1) is not particularly limited, but from the viewpoints of the curability of the film adhesive and the strength and heat resistance of the film adhesive after curing, it is preferably from 300 to 30,000, more preferably from 400 to 10,000, and particularly preferably from 500 to 3,000.

 The epoxy equivalent of the epoxy resin (b1) is preferably from 100 to 1,000
10 g/eq, and more preferably from 150 to 800 g/eq.

[0054]

 The epoxy resin (b1) contained in the adhesive composition and the film
adhesive may be composed of only one type or may be composed of two or more types,
and when it is composed of two or more types, the combination and ratio thereof can be
15 arbitrarily selected.

[0055]

- Thermal curing agent (b2)

 The thermal curing agent (b2) functions as a curing agent for the epoxy resin
(b1).

20 As the thermal curing agent (b2), for example, a compound having two or more functional groups capable of reacting with epoxy groups in one molecule can be mentioned. Examples of the functional group include a phenolic hydroxyl group, an alcoholic hydroxyl group, an amino group, a carboxy group and a group in which an acid group is made anhydrous, and a phenolic hydroxyl group, an amino group or a group in
25 which an acid group is made anhydrous is preferred, and a phenolic hydroxyl group or an

amino group is more preferred.

[0056]

Among the thermal curing agents (b2), examples of phenolic curing agents having a phenolic hydroxyl group include polyfunctional phenol resins, biphenols,
5 novolac type phenol resins, dicyclopentadiene type phenol resins, aralkyl type phenol resins and the like.

Among the thermal curing agents (b2), examples of amine-based curing agents having an amino group include dicyandiamide (DICY) and the like.

[0057]

10 The thermal curing agent (b2) may have an unsaturated hydrocarbon group.

Examples of the thermal curing agent (b2) having an unsaturated hydrocarbon group include a compound in which a part of the hydroxyl groups of the phenol resin is substituted with a group having an unsaturated hydrocarbon group, a compound in which a group having an unsaturated hydrocarbon group is directly bonded to an aromatic ring
15 of the phenol resin, and the like.

The unsaturated hydrocarbon group in the thermal curing agent (b2) is the same as the unsaturated hydrocarbon group in the above-mentioned epoxy resin having an unsaturated hydrocarbon group.

[0058]

20 When a phenolic curing agent is used as the thermal curing agent (b2), from the viewpoint of facilitating adjustment of the adhesive force of the film adhesive to the above-mentioned range, the thermal curing agent (b2) preferably has a high softening point or glass transition temperature.

[0059]

25 Among the thermal curing agents (b2), for example, the number average

molecular weight of the resin component such as polyfunctional phenol resins, novolac type phenol resins, dicyclopentadiene type phenol resins and aralkyl type phenol resins is preferably from 300 to 30,000, more preferably from 400 to 10,000, and particularly preferably from 500 to 3,000.

- 5 The molecular weight of the non-resin component such as biphenols, dicyandiamides and the like among the thermal curing agents (b2) is not particularly limited, but it is preferably from 60 to 500, for example.

[0060]

- The thermal curing agent (b2) contained in the adhesive composition and the
10 film adhesive may be composed of only one type or may be composed of two or more types, and when it is composed of two or more types, the combination and ratio thereof can be arbitrarily selected.

[0061]

- In the adhesive composition and the film adhesive, the content of the thermal
15 curing agent (b2) is preferably from 0.1 to 500 parts by mass, and more preferably from 1 to 200 parts by mass, with respect to 100 parts by mass of the content of the epoxy resin (b1). When the content of the thermal curing agent (b2) is equal to or more than the above lower limit value, curing of the film adhesive is more likely to proceed. Further, when the content of the thermal curing agent (b2) is equal to or less than the above upper
20 limit value, the moisture absorption rate of the film adhesive is reduced and the reliability of the package obtained by using the film adhesive is further improved.

[0062]

- In the adhesive composition and the film adhesive, the content of the epoxy-based thermosetting resin (b) (that is, the total content of the epoxy resin (b1) and the
25 thermal curing agent (b2)) is preferably from 5 to 100 parts by mass, more preferably

from 7 to 90 parts by mass, and particularly preferably from 9 to 80 parts by mass, when the content of the polymer component (a) is 100 parts by mass, and may be any one of, for example, 9 to 70 parts by mass, 9 to 60 parts by mass, 9 to 50 parts by mass, and 9 to 40 parts by mass, and the like. When the content of the epoxy-based thermosetting resin (b) is in such a range, it becomes easy to adjust the elongation at break of the film adhesive or the laminate and the adhesive force of the film adhesive to the above-mentioned ranges.

[0063]

In addition to the polymer component (a) and the epoxy-based thermosetting resin (b), the film adhesive may further contain other components that do not correspond to these, if necessary, in order to improve various physical properties thereof.

Preferable examples of other components contained in the film adhesive include a curing accelerator (c), a filler (d), a coupling agent (e), a crosslinking agent (f), an energy ray-curable resin (g), a photopolymerization initiator (h), a general purpose additive (i), and the like.

[0064]

(Curing accelerator (c))

The curing accelerator (c) is a component for adjusting the curing rate of the adhesive composition.

Preferable examples of the curing accelerator (c) include tertiary amines such as triethylenediamine, benzyldimethylamine, triethanolamine, dimethylaminoethanol and tris(dimethylaminomethyl) phenol; imidazoles (that is, imidazoles in which one or more hydrogen atoms are substituted with a group other than hydrogen atoms) such as 2-methylimidazole, 2-phenylimidazole, 2-phenyl-4-methylimidazole, 2-phenyl-4,5-dihydroxymethylimidazole and 2-phenyl-4-methyl-5-hydroxymethylimidazole; organic

phosphines (that is, phosphines in which one or more hydrogen atoms are substituted with an organic group) such as tributylphosphine, diphenylphosphine and triphenylphosphine; and tetraphenylborates such as tetraphenylphosphonium tetraphenylborate and triphenylphosphine tetraphenylborate.

5 [0065]

The curing accelerator (c) contained in the adhesive composition and the film adhesive may be composed of only one type or may be composed of two or more types, and when it is composed of two or more types, the combination and ratio thereof can be arbitrarily selected.

10 [0066]

In the case of using the curing accelerator (c), the content of the curing accelerator (c) in the adhesive composition and the film adhesive is preferably from 0.01 to 10 parts by mass, and more preferably from 0.1 to 5 parts by mass, with respect to 100 parts by mass of the content of the epoxy-based thermosetting resin (b). When the content of the curing accelerator (c) is equal to or more than the above lower limit value, the effect of using the curing accelerator (c) can be obtained more remarkably. Further, when the content of the curing accelerator (c) is equal to or less than the above upper limit value, for example, the effect of suppressing the high-polarity curing accelerator (c) from moving to and segregating in the adhesion interface side with an adhered in the film adhesive under high temperature and high humidity conditions is enhanced, and the reliability of the package obtained by using the semiconductor processing sheet is further improved.

[0067]

(Filler (d))

25 By containing the filler (d), it becomes easy to adjust the coefficient of thermal

expansion of the film adhesive, and by optimizing this coefficient of thermal expansion for an object to which the film adhesive is attached, the reliability of the package obtained by using the film adhesive is further improved. In addition, by including the filler (d) in the adhesive composition, it is also possible to reduce the moisture absorption rate of the film adhesive after curing and to improve the heat dissipation properties.

[0068]

The filler (d) may be either an organic filler or an inorganic filler, but it is preferably an inorganic filler.

Examples of preferred inorganic fillers include powders of silica, alumina, talc, calcium carbonate, titanium white, red iron oxide, silicon carbide, boron nitride and the like; beads formed by spheroidizing these inorganic fillers; surface modified products of these inorganic fillers: single crystal fibers of these inorganic fillers; glass fibers and the like.

Among them, the inorganic filler is preferably silica or alumina.

[0069]

The filler (d) contained in the adhesive composition and the film adhesive may be composed of only one type or may be composed of two or more types, and when it is composed of two or more types, the combination and ratio thereof can be arbitrarily selected.

[0070]

In the case of using the filler (d), the proportion of the content of the filler (d) with respect to the total content of all components except the solvent in the adhesive composition (that is, the content of the filler (d) of the film adhesive) is preferably from 5 to 80% by mass, and more preferably from 7 to 60% by mass. By ensuring that the content of the filler (d) is in such a range, the adjustment of the coefficient of thermal

expansion described above becomes easier.

[0071]

(Coupling agent (e))

By including the coupling agent (e) in the film adhesive, the adhesive properties
 5 and adhesion to an adherend are improved. In addition, since the film adhesive contains
 the coupling agent (e), the cured product thereof improves the water resistance without
 deteriorating the heat resistance. The coupling agent (e) has a functional group capable
 of reacting with an inorganic compound or an organic compound.

[0072]

10 The coupling agent (e) is preferably a compound having a functional group
 capable of reacting with a functional group included in the polymer component (a), the
 epoxy-based thermosetting resin (b) and the like, and is more preferably a silane coupling
 agent.

Preferable examples of the silane coupling agent include 3-
 15 glycidyloxypropyltrimethoxysilane, 3-glycidyloxypropylmethyldiethoxysilane, 3-
 glycidyloxypropyltriethoxysilane, 3-glycidyloxymethyldiethoxysilane, 2-(3,4-
 epoxycyclohexyl) ethyltrimethoxysilane, 3-methacryloyloxypropyltrimethoxysilane, 3-
 aminopropyltrimethoxysilane, 3-(2-aminoethylamino) propyltrimethoxysilane, 3-(2-
 aminoethylamino) propylmethyldiethoxysilane, 3-(phenylamino) propyltrimethoxysilane,
 20 3-anilinopropyltrimethoxysilane, 3-ureidopropyltriethoxysilane, 3-
 mercaptopropyltrimethoxysilane, 3-mercaptopropylmethyldimethoxysilane, bis(3-
 triethoxysilylpropyl) tetrasulfane, methyltrimethoxysilane, methyltriethoxysilane,
 vinyltrimethoxysilane, vinyltriacetoxysilane, imidazolesilane and the like.

[0073]

25 The coupling agent (e) contained in the adhesive composition and the film

adhesive may be composed of only one type or may be composed of two or more types, and when it is composed of two or more types, the combination and ratio thereof can be arbitrarily selected.

[0074]

5 In the case of using the coupling agent (e), the content of the coupling agent (e) in the adhesive composition and the film adhesive is preferably from 0.03 to 20 parts by mass, more preferably from 0.05 to 10 parts by mass, and particularly preferably from 0.1 to 5 parts by mass, with respect to 100 parts by mass of the total content of the polymer component (a) and the epoxy-based thermosetting resin (b).

10 When the content of the coupling agent (e) is equal to or more than the above lower limit value, the effects of using the coupling agent (e), such as an improvement in dispersibility of the filler (d) in the resin and an improvement in adhesive properties of the film adhesive to an adherend can be obtained more remarkably. Further, by ensuring that the content of the coupling agent (e) is equal to or less than the above upper
15 limit value, the generation of outgas is further suppressed.

[0075]

(Crosslinking agent (f))

 In the case of using, as the polymer component (a), those having a functional group such as a vinyl group, a (meth)acryloyl group, an amino group, a hydroxyl group, a
20 carboxy group and an isocyanate group which is capable of bonding with other compounds, such as the acrylic resin described above, the adhesive composition and the film adhesive may contain a crosslinking agent (f) for bonding and crosslinking the functional group with other compounds. By performing the crosslinking process using the crosslinking agent (f), the initial adhesive force and cohesive force of the film
25 adhesive can be controlled.

[0076]

Examples of the crosslinking agent (f) include an organic polyvalent isocyanate compound, an organic polyvalent imine compound, a metal chelate-based crosslinking agent (that is, a crosslinking agent having a metal chelate structure), an aziridine-based
5 crosslinking agent (that is, a crosslinking agent having an aziridinyl group) and the like.

[0077]

Examples of the organic polyvalent isocyanate compound include an aromatic polyvalent isocyanate compound, an aliphatic polyvalent isocyanate compound, and an alicyclic polyvalent isocyanate compound (hereinafter these compounds are collectively
10 abbreviated as “aromatic polyvalent isocyanate compound and the like” in some cases); a trimer, an isocyanurate form and an adduct form of the aforementioned aromatic polyvalent isocyanate compound and the like; an isocyanate-terminated urethane prepolymer obtained by reacting the aforementioned aromatic polyvalent isocyanate compound and the like with a polyol compound, and the like. The aforementioned
15 “adduct form” means a reaction product of the aforementioned aromatic polyvalent isocyanate compound, aliphatic polyvalent isocyanate compound or alicyclic polyisocyanate compound with an active hydrogen-containing compound having a low molecular weight, such as ethylene glycol, propylene glycol, neopentyl glycol, trimethylolpropane or castor oil, and examples thereof include a xylylene diisocyanate
20 adduct of trimethylolpropane as described later. Further, the term “isocyanate-terminated urethane prepolymer” is as described above.

[0078]

More specific examples of the organic polyvalent isocyanate compound include 2,4-tolylene diisocyanate; 2,6-tolylene diisocyanate; 1,3-xylylene diisocyanate; 1,4-
25 xylene diisocyanate; diphenylmethane-4,4'-diisocyanate; diphenylmethane-2,4'-

diisocyanate; 3-methyldiphenylmethane diisocyanate; hexamethylene diisocyanate; isophorone diisocyanate; dicyclohexylmethane-4,4'-diisocyanate; dicyclohexylmethane-2,4'-diisocyanate; a compound obtained by adding any one or two or more of tolylene diisocyanate, hexamethylene diisocyanate and xylylene diisocyanate to all or a part of the
 5 hydroxyl groups of a polyol such as trimethylolpropane; and lysine diisocyanate.

[0079]

Examples of the organic polyvalent imine compound include N,N'-diphenylmethane-4,4'-bis(1-aziridinecarboxamide), trimethylolpropane-tri- β -aziridinyl propionate, tetramethylolmethane-tri- β -aziridinyl propionate and N,N'-toluene-2,4-bis(1-
 10 aziridinecarboxamide)triethylene melamine.

[0080]

When an organic polyvalent isocyanate compound is used as the crosslinking agent (f), it is preferable to use a hydroxyl group-containing polymer as the polymer component (a). In the case where the crosslinking agent (f) has an isocyanate group and
 15 the polymer component (a) has a hydroxyl group, a crosslinked structure can be easily introduced into the film adhesive by the reaction of the crosslinking agent (f) and the polymer component (a).

[0081]

The crosslinking agent (f) contained in the adhesive composition and the film
 20 adhesive may be composed of only one type or may be composed of two or more types, and when it is composed of two or more types, the combination and ratio thereof can be arbitrarily selected.

[0082]

In the case of using the crosslinking agent (f), the content of the crosslinking
 25 agent (f) in the adhesive composition is preferably from 0.01 to 20 parts by mass, more

preferably from 0.1 to 10 parts by mass, and particularly preferably from 0.3 to 5 parts by mass, with respect to 100 parts by mass of the content of the polymer component (a).

When the content of the crosslinking agent (f) is equal to or more than the above lower limit value, the effect of using the crosslinking agent (f) can be obtained more remarkably.

- 5 Further, by ensuring that the content of the crosslinking agent (f) is equal to or less than the above upper limit value, the excessive use of the crosslinking agent (f) is suppressed.

[0083]

(Energy ray-curable resin (g))

- By containing the energy ray-curable resin (g), the film adhesive can change its
10 characteristics through irradiation of energy rays.

[0084]

The energy ray-curable resin (g) is obtained by polymerizing (curing) an energy ray-curable compound.

- Examples of the energy ray-curable compound include a compound having at
15 least one polymerizable double bond in the molecule, and an acrylate-based compound having a (meth)acryloyl group is preferable.

[0085]

- Examples of the acrylate-based compound include chain-like aliphatic skeleton-
containing (meth)acrylates such as trimethylolpropane tri(meth)acrylate,
20 tetramethylolmethane tetra(meth)acrylate, pentaerythritol tri(meth)acrylate,
pentaerythritol tetra(meth)acrylate, dipentaerythritol monohydroxypenta(meth)acrylate,
dipentaerythritol hexa(meth)acrylate, 1,4-butylene glycol di(meth)acrylate and 1,6-
hexanediol di(meth)acrylate; cyclic aliphatic skeleton-containing (meth)acrylates such as
dicyclopentanyl di(meth)acrylate; polyalkylene glycol (meth)acrylates such as
25 polyethylene glycol di(meth)acrylate; oligoester (meth)acrylates; urethane (meth)acrylate

oligomers; epoxy-modified (meth)acrylates; polyether (meth)acrylates other than the aforementioned polyalkylene glycol (meth)acrylates; and itaconic acid oligomers.

[0086]

The weight average molecular weight of the energy ray-curable resin (g) is
5 preferably from 100 to 30,000, and more preferably from 300 to 10,000.

[0087]

The energy ray-curable resin (g) contained in the adhesive composition may be composed of only one type or may be composed of two or more types, and when it is composed of two or more types, the combination and ratio thereof can be arbitrarily
10 selected.

[0088]

In the case of using the energy ray-curable resin (g), the ratio of the content of the energy ray-curable resin (g) with respect to the total content of all components other than the solvent in the adhesive composition is preferably from 1 to 95% by mass, more
15 preferably from 5 to 90% by mass, and particularly preferably from 10 to 85% by mass.

[0089]

(Photopolymerization initiator (h))

In the case where the energy ray-curable resin (g) is contained, the adhesive composition may contain a photopolymerization initiator (h) in order to efficiently carry
20 out the polymerization reaction of the energy ray-curable resin (g).

[0090]

Examples of the photopolymerization initiator (h) in the adhesive composition include benzoin compounds such as benzoin, benzoin methyl ether, benzoin ethyl ether, benzoin isopropyl ether, benzoin isobutyl ether, benzoin benzoic acid, benzoin methyl
25 benzoate and benzoin dimethyl ketal; acetophenone compounds such as acetophenone, 2-

hydroxy-2-methyl-1-phenyl-propan-1-one and 2,2-dimethoxy-1,2-diphenylethan-1-one; acylphosphine oxide compounds such as bis(2,4,6-trimethylbenzoyl) phenylphosphine oxide and 2,4,6-trimethylbenzoyl diphenylphosphine oxide; sulfide compounds such as benzyl phenyl sulfide and tetramethyl thiuram monosulfide; α -ketol compounds such as

5 1-hydroxycyclohexyl phenyl ketone; azo compounds such as azobisisobutyronitrile; titanocene compounds such as titanocene; thioxanthone compounds such as thioxanthone; peroxide compounds; diketone compounds such as diacetyl; benzyl; dibenzyl; benzophenone; 2,4-diethylthioxanthone; 1,2-diphenylmethane; 2-hydroxy-2-methyl-1-[4-(1-methylvinyl)phenyl] propanone; and quinone compounds such as 1-

10 chloroanthraquinone and 2-chloroanthraquinone.

Further, examples of the photopolymerization initiator (h) also include photosensitizers such as amines.

[0091]

The photopolymerization initiator (h) contained in the adhesive composition

15 may be composed of only one type or may be composed of two or more types, and when it is composed of two or more types, the combination and ratio thereof can be arbitrarily selected.

[0092]

In the case of using the photopolymerization initiator (h), the content of the

20 photopolymerization initiator (h) in the adhesive composition is preferably from 0.1 to 20 parts by mass, more preferably from 1 to 10 parts by mass, and particularly preferably from 2 to 5 parts by mass, with respect to 100 parts by mass of the content of the energy ray-curable resin (g).

[0093]

25 (General purpose additive (i))

The general purpose additive (I) may be a known additive, and can be arbitrarily selected depending on the purpose and is not particularly limited, but preferred examples thereof include a plasticizer, an antistatic agent, an antioxidant, a colorant (that is, a dye or a pigment), a gettering agent and the like.

5 [0094]

The general purpose additive (i) contained in the adhesive composition and the film adhesive may be composed of only one type or may be composed of two or more types, and when it is composed of two or more types, the combination and ratio thereof can be arbitrarily selected.

10 The contents of the adhesive composition and the film adhesive are not particularly limited and may be appropriately selected according to the purpose.

[0095]

In the adhesive composition and the film adhesive, the content of the polymer component (a) is preferably equal to or more than 30 parts by mass, and more preferably
15 equal to or more than 38 parts by mass, with respect to 100 parts by mass of the total content of the polymer component (a), the epoxy-based thermosetting resin (b) and the filler (d) (that is, the total content of the polymer component (a), the epoxy resin (b1), the thermal curing agent (b2) and the filler (d)) from the viewpoint of improving the film-forming properties, such as an improvement in surface conditions of the film adhesive.
20 Further, from the above point of view, the upper limit value of the content of the polymer component (a) is not particularly limited, but it is preferably 65 parts by mass.

[0096]

On the other hand, in the adhesive composition and the film adhesive, from the viewpoint of improving the reliability of the film adhesive, the content of the polymer
25 component (a) is preferably equal to or more than 45 parts by mass, with respect to 100

parts by mass of the total content of the polymer component (a), the epoxy-based thermosetting resin (b) and the filler (d) (that is, the total content of the polymer component (a), the epoxy resin (b1), the thermal curing agent (b2) and the filler (d)).

Further, from the above point of view, the upper limit value of the content of the polymer

5 component (a) is not particularly limited, but it is preferably 65 parts by mass.

[0097]

(Solvent)

It is preferable that the adhesive composition further contain a solvent. The adhesive composition containing a solvent exhibits favorable handling properties.

10 Although the solvent is not particularly limited, preferred examples thereof include hydrocarbons such as toluene and xylene; alcohols such as methanol, ethanol, 2-propanol, isobutyl alcohol (2-methylpropan-1-ol) and 1-butanol; esters such as ethyl acetate; ketones such as acetone and methyl ethyl ketone; ethers such as tetrahydrofuran; and amides such as dimethylformamide and N-methylpyrrolidone (that is, compounds
15 having an amide bond).

The solvent contained in the adhesive composition may be composed of only one type or may be composed of two or more types, and when it is composed of two or more types, the combination and ratio thereof can be arbitrarily selected.

[0098]

20 The solvent contained in the adhesive composition is preferably methyl ethyl ketone or the like from the viewpoint of more uniformly mixing the components contained in the adhesive composition.

[0099]

[Method for producing adhesive composition]

25 The adhesive composition can be obtained by blending the components for

constituting the adhesive composition.

The addition order at the time of blending each component is not particularly limited, and two or more types of components may be added at the same time.

In the case of using a solvent, it may be used by mixing the solvent with any one
5 of the blended components other than the solvent and diluting the blended component in advance, or it may be used by mixing the solvent with these blended components without previously diluting any one of the blended components other than the solvent.

[0100]

The method of mixing the respective components at the time of blending is not
10 particularly limited, and may be selected appropriately from known methods, such as a method of mixing by rotating a stirrer, a stirring blade or the like; a method of mixing by using a mixer; and a method of mixing by applying ultrasonic waves.

The temperature and time at the time of adding and mixing each component are not particularly limited, as long as each blended component does not deteriorate, and may
15 be adjusted appropriately, although the temperature is preferably from 15 to 30°C.

[0101]

- Semiconductor processing sheet

The semiconductor processing sheet of the present invention is one in which the above-described film adhesive of the present invention is provided on a support sheet.

20 In the semiconductor processing sheet of the present invention, a plurality of already divided semiconductor chips are provided in advance on the film adhesive, and the film adhesive together with the support sheet is subjected to the so-called expansion process at a low temperature to be expanded in a direction along the surface of the film adhesive, so that it is suitable for use in the step of cutting the film adhesive in
25 accordance with the outer shape of the semiconductor chip. A semiconductor chip

provided with a film adhesive after cutting (sometimes referred to as “semiconductor chip with a film adhesive” in the present specification) on the surface (that is, the back surface) opposite to the surface on which a circuit is formed (hereinafter may be abbreviated as “circuit forming surface” in some cases), is used for manufacturing a semiconductor device after being picked up.

[0102]

By using the semiconductor processing sheet of the present invention, at the time of cutting the film adhesive by the expansion process, the film adhesive is cut at an intended place, and at the cut place, the occurrence of abnormalities such as chipping of the film adhesive is suppressed, so that excellent cutting characteristics are exhibited. Therefore, it is possible to easily pick up a semiconductor chip with a film adhesive with no process abnormality.

[0103]

The above-mentioned cutting of the film adhesive by expansion is suitable for application when, for example, a semiconductor chip with a film adhesive having a thin semiconductor chip is manufactured.

The plurality of already divided semiconductor chips can be produced, for example, by forming grooves from a circuit forming surface (that is, the front surface) of the semiconductor wafer on the side opposite to the surface to which the film adhesive is attached (that is, the back surface), and grinding the back surface until reaching the grooves. An operation of cutting the semiconductor wafer so as to leave a bottom portion of the groove without dividing the semiconductor wafer as described above is called “half-cut”. However, in the present invention, the term “half-cut” means not only an operation of cutting a semiconductor wafer so that the depth of the groove becomes a certain value such as, for example, half the thickness of the semiconductor wafer, but

also an operation in general of cutting a semiconductor wafer so as to leave the bottom portion of the groove as described above.

[0104]

As a method of forming the groove, for example, a method of forming a groove
5 by cutting a semiconductor wafer using a blade (that is, blade dicing), a method of forming a groove by cutting a semiconductor wafer through laser irradiation (that is, laser dicing), a method of forming a groove by cutting a semiconductor wafer by spraying water containing a polishing agent (that is, water dicing) and the like can be mentioned. However, in the case of manufacturing a semiconductor chip by scraping off a part of a
10 semiconductor wafer as described in these examples, the loss of semiconductor wafer occurs by the amount of a part of the semiconductor wafer being scraped off (that is, by the amount of grooves being formed in the semiconductor wafer), and the number of semiconductor chips obtained from one semiconductor wafer is reduced. In addition, since the film adhesive after cutting ultimately becomes larger than the semiconductor
15 chip, at the time of cutting the film adhesive or at the time of picking up a semiconductor chip with a film adhesive to be described later, the cut film adhesive may be wound around the side surface of the semiconductor chip or the like in some cases.

[0105]

On the other hand, the plurality of already divided semiconductor chips can also
20 be produced by forming a modified layer inside the semiconductor wafer through irradiation of a laser beam in the infrared region so as to converge on a focal point set inside the semiconductor wafer, and then grinding the back surface of the semiconductor wafer while further applying a force at the time of grinding to the semiconductor wafer during grinding of the back surface, thereby dividing the semiconductor wafer at a
25 portion where the modified layer has been formed. In this method, since there is no step

of scraping off a part of the semiconductor wafer, it is advantageous from the viewpoint that reduction in the number of manufactured semiconductor chips, winding of the cut film adhesive around the side surface of the semiconductor chip, and the like, as described above, are suppressed.

5 [0106]

<< Support sheet >>

Examples of the support sheet include those having a base material. Such a support sheet may be, for example, made of a base material (that is, having only a base material), or may have a base material and a layer other than the base material. As the
10 support sheet having the other layer, for example, one having a pressure-sensitive adhesive layer on a base material can be mentioned.

In the semiconductor processing sheet of the present invention, the film adhesive is provided on the support sheet. Therefore, for example, in the case where the support sheet is provided with a pressure-sensitive adhesive layer on the base material,
15 the film adhesive is provided on the pressure-sensitive adhesive layer, and in the case where the support sheet is made of the base material, the film adhesive is provided in direct contact with the base material.

[0107]

The support sheet may be composed of one layer (that is, a single layer), or it
20 may be composed of a plurality of layers of two or more layers. In the case where the support sheet is composed of a plurality of layers, these plurality of layers may be the same as or different from each other, and the combination of these plurality of layers is not particularly limited as long as the effects of the present invention are not impaired.

[0108]

25 As the support sheet, one provided with a pressure-sensitive adhesive layer on a

base material is preferable, and one having a pressure-sensitive adhesive layer in direct contact with the base material is more preferable.

That is, the semiconductor processing sheet of the present invention is preferably a sheet in which a pressure-sensitive adhesive layer is provided on a base material and the film adhesive is provided on the pressure-sensitive adhesive layer, more preferably a sheet in which a pressure-sensitive adhesive layer is provided in direct contact with a base material and the film adhesive is provided on the pressure-sensitive adhesive layer, and particularly preferably a sheet in which a pressure-sensitive adhesive layer is provided in direct contact with a base material and the film adhesive is provided in direct contact with the pressure-sensitive adhesive layer.

[0109]

<Base material>

The material constituting the base material is preferably various resins, and specific examples thereof include polyethylenes (low density polyethylenes (sometimes abbreviated as LDPE), linear low density polyethylenes (sometimes abbreviated as LLDPE), high density polyethylenes (sometimes abbreviated as HDPE) or the like), polypropylenes, polybutenes, polybutadienes, polymethylpentenes, styrene/ethylenebutylene/styrene block copolymers, polyvinyl chlorides, vinyl chloride copolymers, polyethylene terephthalates, polybutylene terephthalates, polyurethanes, polyurethane acrylates, polyimides, ethylene vinyl acetate copolymers, ionomer resins, ethylene/(meth)acrylic acid copolymers, ethylene/(meth)acrylate copolymers, polystyrenes, polycarbonates, fluororesins, and hydrogenated products, modified products, crosslinked products or copolymers of any of these resins.

[0110]

The resin constituting the base material may be composed of only one type or

may be composed of two or more types, and when it is composed of two or more types, the combination and ratio thereof can be arbitrarily selected.

[0111]

The base material may be composed of one layer (that is, a single layer), or it
5 may be composed of a plurality of layers of two or more layers. In the case where the base material is composed of a plurality of layers, these plurality of layers may be the same as or different from each other, and the combination of these plurality of layers is not particularly limited as long as the effects of the present invention are not impaired.

The surface of the base material composed of a single layer may be subjected to
10 a release treatment by a known method.

[0112]

The thickness of the base material can be appropriately selected according to the purpose, but it is preferably from 50 μm to 300 μm , and more preferably from 70 μm to 150 μm .

15 Here, the “thickness of the base material” means the thickness of the entire base material, and for example, the thickness of the base material composed of a plurality of layers means the total thickness of all the layers constituting the base material. It should be noted that as a method of measuring the thickness of the base material, for example, a method of measuring the thickness at five arbitrary places using a contact type thickness
20 meter and calculating the average of the measured values, and the like can be mentioned.

[0113]

In order to improve the adhesion to other layers provided thereon, such as a pressure-sensitive adhesive layer to be described later, the surface of the base material may be subjected to a roughening treatment by a sandblasting treatment, a solvent
25 treatment or the like, or an oxidation treatment such as a corona discharge treatment, an

electron beam irradiation treatment, a plasma treatment, an ozone/ultraviolet irradiation treatment, a flame treatment, a chromic acid treatment, a hot air treatment or the like.

Further, the surface of the base material may be subjected to a primer treatment.

In addition, when an antistatic coating layer and the semiconductor processing
5 sheet are superposed and stored, the base material may have a layer for preventing adhesion of the base material to another sheet and adhesion of the base material to the suction table, or the like.

[0114]

<Pressure-sensitive adhesive layer>

10 The pressure-sensitive adhesive layer is in the form of a sheet or a film and contains a pressure-sensitive adhesive.

The pressure-sensitive adhesive layer may be a known one.

As the pressure-sensitive adhesive, for example, an adhesive resin such as an acrylic resin, a urethane-based resin, a rubber-based resin, a silicone-based resin, an
15 epoxy-based resin, a polyvinyl ether, a polycarbonate and the like can be mentioned, and an acrylic resin is preferable.

[0115]

It should be noted that in the present invention, the term “adhesive resin” is a concept that includes both a resin exhibiting tackiness and a resin exhibiting adhesive
20 properties, and for example, includes not only a resin exhibiting tackiness by itself, but also a resin exhibiting tackiness when used in combination with other components such as an additive, a resin exhibiting adhesive properties by the presence of a trigger such as heat or water, and the like.

[0116]

25 The pressure-sensitive adhesive layer may be either energy ray-curable or non-

energy ray-curable, but it is preferably non-energy ray curable.

In the present invention, the term “energy ray” means an electromagnetic wave or a charged particle beam having an energy quantum, and examples thereof include ultraviolet rays and electron beams.

5 For example, ultraviolet rays can be irradiated by using a high pressure mercury lamp, a fusion H lamp, a xenon lamp, a light emitting diode or the like as an ultraviolet light source. An electron beam generated by an electron beam accelerator or the like can be irradiated.

10 In the present invention, the term “energy ray-curable” means a property of being cured by irradiation with an energy ray, and the term “non-energy ray-curable” means a property of not being cured even when irradiated with an energy ray.

[0117]

15 Preferred examples of the pressure-sensitive adhesive layer in the present invention include a pressure-sensitive adhesive layer having a thickness of 200 μm and a storage elastic modulus at 0°C of 1,000 MPa or less, and in which the adhesive force of the pressure-sensitive adhesive layer with respect to the mirror surface of the semiconductor wafer is equal to or less than 200 mN / 25 mm.

However, the preferred pressure-sensitive adhesive layer is not limited thereto.

[0118]

20 The pressure-sensitive adhesive layer to be determined for the storage elastic modulus may be a pressure-sensitive adhesive layer composed of a single layer having a thickness of 200 μm , or may be a laminate obtained by laminating two or more layers of a pressure-sensitive adhesive layer having a thickness of less than 200 μm so that the total thickness becomes 200 μm .

25 It should be noted that in this specification, the pressure-sensitive adhesive layer

for which the storage elastic modulus is to be determined may be simply described as “pressure-sensitive adhesive layer” regardless of whether it is a pressure-sensitive adhesive layer composed of a single layer or the laminate.

Further, in the present specification, unless otherwise specified, the above-mentioned “storage elastic modulus of the pressure-sensitive adhesive layer” and “storage elastic modulus of the laminate” mean, when the pressure-sensitive adhesive layer is curable, “the storage elastic modulus of the pressure-sensitive adhesive layer before being cured” and “the storage elastic modulus of the laminate before the pressure-sensitive adhesive layer is cured”, respectively.

10 [0119]

The storage elastic modulus of the pressure-sensitive adhesive layer or laminate at 0°C is preferably equal to or less than 1,000 MPa, and more preferably equal to or less than 996 MPa. By ensuring that the storage elastic modulus is equal to or less than the above upper limit value, floating and scattering of the semiconductor chip with the film adhesive from the pressure-sensitive adhesive layer are suppressed at the time of cutting the film adhesive by expansion, as described later.

The lower limit value of the storage elastic modulus of the pressure-sensitive adhesive layer or laminate at 0°C is not particularly limited, and may be set to, for example, any one of 100 MPa, 300 MPa and 500 MPa, but these are only examples.

20 [0120]

The above storage elastic modulus (MPa) can be obtained by measuring the storage elastic modulus (MPa) at the time when the temperature of the pressure-sensitive adhesive layer or laminate to be measured is increased, for example, within a certain temperature range such as from -50°C to 50°C under conditions of a rate of temperature increase of 10°C/min and a frequency of 11 Hz.

[0121]

The storage elastic modulus can be appropriately adjusted by, for example, adjusting the type and amount of components contained in the pressure-sensitive adhesive layer, and the like.

5 For example, by adjusting the ratio of the monomers constituting the adhesive resin, the added amount of the crosslinking agent, the content of the filler, and the like, it is possible to easily adjust the storage elastic modulus of the pressure-sensitive adhesive layer and the storage elastic modulus of the laminate.

However, these adjustment methods are only examples.

10 [0122]

The adhesive force of the pressure-sensitive adhesive layer with respect to the semiconductor wafer is preferably equal to or less than 200 mN / 25 mm, and more preferably equal to or less than 196 mN / 25 mm. By ensuring that the adhesive force is equal to or less than the above upper limit value, the semiconductor chip with the film
15 adhesive can be easily picked up without curing the pressure-sensitive adhesive layer by energy ray irradiation or the like, as described later.

The lower limit value of the adhesive force of the pressure-sensitive adhesive layer with respect to the semiconductor wafer is not particularly limited, and can be set to, for example, any one of 10 mN / 25 mm, 30 mN / 25 mm, and 50 mN / 25 mm, but these
20 are only examples.

[0123]

It should be noted that in the present specification, unless otherwise stated, the “adhesive force of the pressure-sensitive adhesive layer with respect to the semiconductor wafer” means the “adhesive force of the uncured pressure-sensitive
25 adhesive layer with respect to the semiconductor wafer” when the pressure-sensitive

adhesive layer is curable. In addition, the measurement of the adhesive force is a measurement of the adhesive force in the standard state prescribed in JIS Z 0237 2008, unless otherwise specified.

[0124]

5 In the present invention, the adhesive force (mN / 25 mm) can be measured by the following method. That is, the support sheet having a width of 25 mm and an arbitrary length and in which a pressure-sensitive adhesive layer is provided on a base material is prepared. Subsequently, this support sheet is attached to the semiconductor wafer through the pressure-sensitive adhesive layer under normal temperature. Then,
10 while the temperature remains unchanged, the so-called 180° peeling is performed in which the support sheet is peeled from the semiconductor wafer at a peeling rate of 300 mm/min, so that the planes of the pressure-sensitive adhesive layer and the semiconductor wafer that have been brought into contact with each other form an angle of 180°. The peel force at this time is measured, and the measured value is defined as
15 the adhesive force (mN / 25 mm). The length of the support sheet to be subjected to the measurement is not particularly limited as long as it is within a range in which the peel force can be stably measured.

[0125]

Even if the types of semiconductor wafers such as silicon wafers are different or
20 even if the types are the same but the production lots are different, when the same pressure-sensitive adhesive layer is attached to the same portion, variations in the adhesive force with the pressure-sensitive adhesive layer are small. Therefore, the adhesive force of the pressure-sensitive adhesive layer can be specified with high accuracy by selecting the semiconductor wafer as a measurement target. In the present
25 invention, by selecting a pressure-sensitive adhesive layer exhibiting an adhesive force

with respect to the mirror surface of the semiconductor wafer of 200 mN / 25 mm or less, when the semiconductor chip with the film adhesive is separated and picked up from the pressure-sensitive adhesive layer, the adhesive force of the pressure-sensitive adhesive layer with respect to the film adhesive can be adjusted, so that the occurrence of process
5 abnormalities can be suppressed to facilitate the pickup process. Such effects of the present invention are exhibited in the film adhesives in general that are used in the field.

[0126]

The adhesive force of the pressure-sensitive adhesive layer with respect to the semiconductor wafer can be appropriately adjusted by, for example, adjusting the type
10 and amount of components contained in the pressure-sensitive adhesive layer, and the like.

For example, by adjusting the combination of the monomers constituting the adhesive resin, the ratio of the monomers, the added amount of the crosslinking agent, the content of the filler, and the like, the adhesive force of the pressure-sensitive adhesive
15 layer can be easily adjusted.

However, these adjustment methods are only examples.

[0127]

The pressure-sensitive adhesive layer may be composed of one layer (that is, a single layer), or it may be composed of two or more layers (that is, a plurality of layers).
20 In the case where the pressure-sensitive adhesive layer is composed of a plurality of layers, these plurality of layers may be the same as or different from each other, and the combination of these plurality of layers is not particularly limited as long as the effects of the present invention are not impaired.

[0128]

25 The thickness of the pressure-sensitive adhesive layer can be appropriately

selected depending on the purpose, but it is preferably from 1 μm to 100 μm , more preferably from 1 μm to 60 μm , and particularly preferably from 1 μm to 30 μm .

Here, the “thickness of the pressure-sensitive adhesive layer” means the thickness of the entire pressure-sensitive adhesive layer, and for example, the thickness
5 of the pressure-sensitive adhesive layer composed of a plurality of layers means the total thickness of all the layers constituting the pressure-sensitive adhesive layer. It should be noted that as a method of measuring the thickness of the pressure-sensitive adhesive layer, for example, a method of measuring the thickness at five arbitrary places using a contact type thickness meter and calculating the average of the measured values, and the
10 like can be mentioned.

[0129]

The pressure-sensitive adhesive layer can be formed from a pressure-sensitive adhesive composition containing a pressure-sensitive adhesive. For example, a pressure-sensitive adhesive layer can be formed at an intended portion by applying a
15 pressure-sensitive adhesive composition onto the surface on which the pressure-sensitive adhesive layer is to be formed and drying it if necessary. A more specific method of forming the pressure-sensitive adhesive layer will be described in detail later, together with a method of forming other layers. The ratio of the contents of the components that are not vaporized at normal temperature to each other in the pressure-sensitive adhesive
20 composition is usually the same as the ratio of the contents of the aforementioned components of the pressure-sensitive adhesive layer to each other.

[0130]

The coating of the pressure-sensitive adhesive composition may be carried out by a known method, and it can be carried out by the same method as the above-
25 mentioned coating of the adhesive composition.

[0131]

Although the drying condition of the pressure-sensitive adhesive composition is not particularly limited, in the case where the pressure-sensitive adhesive composition contains a solvent to be described later, it is preferable to dry the pressure-sensitive adhesive composition by heating, and in this case, for example, it is preferable to dry
5 under conditions of 70 to 130°C for 10 seconds to 5 minutes.

[0132]

[Pressure-sensitive adhesive composition]

The pressure-sensitive adhesive composition is preferably non-energy ray-
10 curable.

As the non-energy ray-curable pressure-sensitive adhesive composition, for example, those containing an adhesive resin (hereinafter referred to as “adhesive resin (i)”) such as the acrylic resin, a urethane-based resin, a rubber-based resin, a silicone-based resin, an epoxy-based resin, a polyvinyl ether or a polycarbonate can be mentioned.

15 [0133]

(Adhesive resin (i))

The adhesive resin (i) is preferably the aforementioned acrylic resin.

As the acrylic resin in the adhesive resin (i), for example, an acrylic polymer having at least a structural unit derived from an (meth)acrylic acid alkyl ester can be
20 mentioned.

The structural unit included in the acrylic resin may be composed of only one type or may be composed of two or more types, and when it is composed of two or more types, the combination and ratio thereof can be arbitrarily selected.

[0134]

25 Examples of the (meth)acrylic acid alkyl ester include those in which the alkyl

group constituting the alkyl ester has 1 to 20 carbon atoms, and the alkyl group is preferably linear or branched.

More specific examples of the (meth)acrylic acid alkyl ester include methyl (meth)acrylate, ethyl (meth)acrylate, n-propyl (meth)acrylate, isopropyl (meth)acrylate, 5 n-butyl (meth)acrylate, isobutyl (meth)acrylate, sec-butyl (meth)acrylate, tert-butyl (meth)acrylate, pentyl (meth)acrylate, hexyl (meth)acrylate, heptyl (meth)acrylate, 2-ethylhexyl (meth)acrylate, isooctyl (meth)acrylate, n-octyl (meth)acrylate, n-nonyl (meth)acrylate, isononyl (meth)acrylate, decyl (meth)acrylate, undecyl (meth)acrylate, dodecyl (meth)acrylate (also referred to as lauryl (meth)acrylate), tridecyl (meth)acrylate, 10 tetradecyl (meth)acrylate (also referred to as myristyl (meth)acrylate), pentadecyl (meth)acrylate, hexadecyl (meth)acrylate (also referred to as palmityl (meth)acrylate), heptadecyl (meth)acrylate, octadecyl (meth)acrylate (also referred to as stearyl (meth)acrylate), nonadecyl (meth)acrylate and eicosyl (meth)acrylate.

[0135]

15 From the viewpoint of improving the adhesive force of the pressure-sensitive adhesive layer, it is preferable that the acrylic polymer has a structural unit derived from a (meth)acrylic acid alkyl ester in which the alkyl group has 4 or more carbon atoms. Further, from the viewpoint of further improving the adhesive force of the pressure-sensitive adhesive layer, the number of carbon atoms of the alkyl group is preferably 20 from 4 to 12, and more preferably from 4 to 8. In addition, the (meth)acrylic acid alkyl ester in which the alkyl group has 4 or more carbon atoms is preferably an acrylic acid alkyl ester.

[0136]

In addition to the structural unit derived from a (meth)acrylic acid alkyl ester, it 25 is preferable that the acrylic polymer further has a structural unit derived from a

functional group-containing monomer.

As the functional group-containing monomer, for example, those in which the functional group reacts with a crosslinking agent to be described later to thereby become a starting point of crosslinking, and those in which the functional group reacts with an
 5 unsaturated group in an unsaturated group-containing compound to thereby enable introduction of an unsaturated group into the side chain of the acrylic polymer can be mentioned.

[0137]

Examples of the functional group in the functional group-containing monomer
 10 include a hydroxyl group, a carboxy group, an amino group and an epoxy group.

That is, examples of the functional group-containing monomer include a hydroxyl group-containing monomer, a carboxy group-containing monomer, an amino group-containing monomer and an epoxy group-containing monomer.

[0138]

15 Examples of the hydroxyl group-containing monomer include hydroxyalkyl (meth)acrylates such as hydroxymethyl (meth)acrylate, 2-hydroxyethyl (meth)acrylate, 2-hydroxypropyl (meth)acrylate, 3-hydroxypropyl (meth)acrylate, 2-hydroxybutyl (meth)acrylate, 3-hydroxybutyl (meth)acrylate and 4-hydroxybutyl (meth)acrylate; non-
 (meth)acrylic unsaturated alcohols (that is, unsaturated alcohols having no
 20 (meth)acryloyl skeleton) such as vinyl alcohol and allyl alcohol, and the like.

[0139]

Examples of the carboxy group-containing monomer include ethylenically unsaturated monocarboxylic acids (that is, monocarboxylic acids having an ethylenically unsaturated bond) such as (meth)acrylic acid and crotonic acid; ethylenically unsaturated
 25 dicarboxylic acids (that is, dicarboxylic acids having an ethylenically unsaturated bond)

such as fumaric acid, itaconic acid, maleic acid and citraconic acid; anhydrides of the ethylenically unsaturated dicarboxylic acids; (meth)acrylic acid carboxyalkyl esters such as 2-carboxyethyl methacrylate, and the like.

[0140]

- 5 The functional group-containing monomer is preferably a hydroxyl group-containing monomer or a carboxy group-containing monomer, and more preferably a hydroxyl group-containing monomer.

[0141]

- The functional group-containing monomer constituting the acrylic polymer may
10 be composed of only one type or may be composed of two or more types, and when it is composed of two or more types, the combination and ratio thereof can be arbitrarily selected.

[0142]

- In the acrylic polymer, the content of the structural unit derived from the
15 functional group-containing monomer is preferably from 1 to 35% by mass, more preferably from 3 to 32% by mass, and particularly preferably from 5 to 30% by mass with respect to the total amount of the structural units.

[0143]

- In addition to the structural unit derived from the (meth)acrylic acid alkyl ester
20 and the structural unit derived from the functional group-containing monomer, the acrylic polymer may further include a structural unit derived from another monomer.

 The other monomer is not particularly limited as long as it is copolymerizable with a (meth)acrylic acid alkyl ester or the like.

- Examples of the other monomer include styrene, α -methylstyrene, vinyltoluene,
25 vinyl formate, vinyl acetate, acrylonitrile and acrylamide.

[0144]

The other monomer constituting the acrylic polymer may be composed of only one type or may be composed of two or more types, and when it is composed of two or more types, the combination and ratio thereof can be arbitrarily selected.

5 [0145]

Like the acrylic polymer, the aforementioned adhesive resin (i) other than the acrylic polymer also preferably has a structural unit derived from a functional group-containing monomer.

[0146]

10 The adhesive resin (i) contained in the pressure-sensitive adhesive composition may be composed of only one type or may be composed of two or more types, and when it is composed of two or more types, the combination and ratio thereof can be arbitrarily selected.

[0147]

15 In the pressure-sensitive adhesive composition, the ratio of the content of the adhesive resin (i) (that is, the content of the adhesive resin (i) of the pressure-sensitive adhesive layer) with respect to the total content of the components except the solvent is preferably from 45 to 90% by mass, more preferably from 55 to 87% by mass, and particularly preferably from 65 to 84% by mass. By ensuring that the ratio of the
20 content of the adhesive resin (i) is within such a range, the tackiness of the pressure-sensitive adhesive layer is further improved.

[0148]

(Crosslinking agent (ii))

The pressure-sensitive adhesive composition preferably contains a crosslinking
25 agent (ii).

For example, the crosslinking agent (ii) reacts with the functional group to crosslink the adhesive resins (i) with each other.

As the crosslinking agent (ii), for example, an isocyanate-based crosslinking agent (that is, a crosslinking agent having an isocyanate group) such as tolylene diisocyanate, hexamethylene diisocyanate, xylylene diisocyanate and adduct forms of these diisocyanates; an epoxy-based crosslinking agent (that is, a crosslinking agent having a glycidyl group) such as ethylene glycol glycidyl ethers; an aziridine-based crosslinking agent (that is, a crosslinking agent having an aziridinyl group) such as hexa[1-(2-methyl)-aziridinyl]triphosphatriazine; a metal chelate-based crosslinking agent (that is, a crosslinking agent having a metal chelate structure) such as aluminum chelates; an isocyanurate-based crosslinking agent (that is, a crosslinking agent having an isocyanuric acid skeleton), and the like can be mentioned.

It is preferable that the crosslinking agent (ii) is an isocyanate-based crosslinking agent from the viewpoints of improving the cohesive force of the pressure-sensitive adhesive to improve the adhesive force of the pressure-sensitive adhesive layer, easy availability, and the like.

[0149]

The crosslinking agent (ii) contained in the pressure-sensitive adhesive composition may be composed of only one type or may be composed of two or more types, and when it is composed of two or more types, the combination and ratio thereof can be arbitrarily selected.

[0150]

When the pressure-sensitive adhesive composition contains the crosslinking agent (ii), the content of the crosslinking agent (ii) in the pressure-sensitive adhesive composition is preferably from 5 to 50 parts by mass, more preferably from 10 to 45

parts by mass, and particularly preferably from 15 to 40 parts by mass, with respect to 100 parts by mass of the content of the adhesive resin (i). When the content of the crosslinking agent (ii) is equal to or more than the above lower limit value, the effect of using the crosslinking agent (ii) can be obtained more remarkably. Further, by ensuring
5 that the content of the crosslinking agent (ii) is equal to or less than the above upper limit value, it becomes easier to control the adhesive force of the pressure-sensitive adhesive layer with respect to the film adhesive.

[0151]

(Other additives)

10 The pressure-sensitive adhesive composition may contain other additives that do not correspond to any of the above-mentioned components within a range that does not impair the effects of the present invention.

Examples of the other additives include known additives such as an antistatic agent, an antioxidant, a softener (that is, a plasticizer), a filling material (that is, a filler),
15 a rust inhibitor, a colorant (that is, a pigment or a dye), a sensitizer, a tackifier, a reaction retarder and a crosslinking accelerator (that is, a catalyst).

It should be noted that the term “reaction retarder” means, for example, one that suppresses the unintended crosslinking reaction in the pressure-sensitive adhesive composition during storage by the action of the catalyst incorporated in the pressure-
20 sensitive adhesive composition. As the reaction retarder, for example, those that form a chelate complex by chelating to the catalyst can be mentioned, and more specifically, those having two or more carbonyl groups ($-C(=O)-$) in one molecule can be mentioned.

[0152]

The other additive contained in the pressure-sensitive adhesive composition may
25 be composed of only one type or may be composed of two or more types, and when it is

composed of two or more types, the combination and ratio thereof can be arbitrarily selected.

[0153]

In the pressure-sensitive adhesive composition, the content of other additives is
5 not particularly limited, and may be appropriately selected depending on the types thereof.

[0154]

(Solvent)

The pressure-sensitive adhesive composition may contain a solvent. Since the
10 pressure-sensitive adhesive composition contains a solvent, the coatability to the surface to be coated is improved.

[0155]

The solvent is preferably an organic solvent, and examples of the organic solvent include ketones such as methyl ethyl ketone and acetone; carboxylic acid esters
15 such as ethyl acetate; ethers such as tetrahydrofuran and dioxane; aliphatic hydrocarbons such as cyclohexane and n-hexane; aromatic hydrocarbons such as toluene and xylene; and alcohols such as 1-propanol and 2-propanol.

[0156]

As the solvent, for example, the one used at the time of production of the
20 adhesive resin (i) may be used as it is in the pressure-sensitive adhesive composition without being removed from the adhesive resin (i), or a solvent of the same or different type from that used at the time of production of the adhesive resin (i) may be added separately at the time of production of the pressure-sensitive adhesive composition.

[0157]

25 The solvent contained in the pressure-sensitive adhesive composition may be

composed of only one type or may be composed of two or more types, and when it is composed of two or more types, the combination and ratio thereof can be arbitrarily selected.

[0158]

5 In the pressure-sensitive adhesive composition, the content of the solvent is not particularly limited and may be appropriately adjusted.

[0159]

[Method for producing pressure-sensitive adhesive composition]

The pressure-sensitive adhesive composition can be obtained by blending each
10 component for constituting the pressure-sensitive adhesive composition, and can be produced by the same method as in the case of the above-described adhesive composition, for example, except that the blended components are different.

[0160]

FIG. 1 is a cross-sectional view schematically showing one embodiment of the
15 semiconductor processing sheet of the present invention. It should be noted that the drawings used in the following description are showing the main part in an enlarged manner in some cases for the sake of convenience in order to make the features of the present invention easy to understand, and the dimensional ratios and the like of the respective constituents are not necessarily the same as the actual ratios.

20 [0161]

In a semiconductor processing sheet 1 shown here, a pressure-sensitive adhesive layer 12 is provided on a base material 11, and a film adhesive 13 is provided on the pressure-sensitive adhesive layer 12.

In the semiconductor processing sheet 1, the pressure-sensitive adhesive layer
25 12 is laminated on one surface 11a of the base material 11, and the film adhesive 13 is

laminated on one surface of the pressure-sensitive adhesive layer 12, that is, a surface 12a of the pressure-sensitive adhesive layer 12 on the side opposite to the side where the base material 11 is provided. The film adhesive 13 is the film adhesive of the present invention mentioned above.

5 That is, in the semiconductor processing sheet 1, one in which the pressure-sensitive adhesive layer 12 is provided on the base material 11 is used as a support sheet 10, and the film adhesive 13 is provided in direct contact with the pressure-sensitive adhesive layer 12.

[0162]

10 It should be noted that the semiconductor processing sheet of the present invention is not limited to the one shown in FIG. 1, but may be one shown in FIG. 1 in which a part of the configuration is modified, deleted or added within a range that does not impair the effects of the present invention.

[0163]

15 << Method for producing semiconductor processing sheet >>

The semiconductor processing sheet can be produced by sequentially laminating the above-described layers so as to establish the corresponding positional relationships. The method of forming each layer is as described above.

For example, in the case of laminating a pressure-sensitive adhesive layer or a
20 film adhesive on a base material, it may be configured so that a pressure-sensitive adhesive composition or an adhesive composition is applied onto a release film and, if necessary, dried to thereby form the pressure-sensitive adhesive layer or film adhesive on the release film in advance, and the exposed surface of the already formed pressure-sensitive adhesive layer or film adhesive which is on the side opposite to the side in
25 contact with the release film is laminated onto the surface of the base material. At this

time, it is preferable that the pressure-sensitive adhesive composition or the adhesive composition is applied to the release-treated surface of the release film. After the formation of the laminated structure, the release film may be removed as necessary.

[0164]

5 For example, in the case of producing a semiconductor processing sheet in which a pressure-sensitive adhesive layer is laminated on a base material and a film adhesive is laminated on the pressure-sensitive adhesive layer (that is, a semiconductor processing sheet in which the support sheet is a laminate of a base material and a pressure-sensitive adhesive layer), it is possible to obtain the semiconductor processing
10 sheet in the following manner. That is, the pressure-sensitive adhesive layer is laminated on the base material in advance by the above-described method, and the adhesive composition is separately applied onto a release film, followed by drying as needed, to thereby form the film adhesive on the release film in advance, and then the exposed surface of the film adhesive is laminated to the exposed surface of the pressure-
15 sensitive adhesive layer already laminated on the base material to laminate the film adhesive on the pressure-sensitive adhesive layer. Also in the case of forming a film adhesive on a release film, it is preferable to apply the adhesive composition to the release-treated surface of the release film, and after the formation of the laminated structure, the release film may be removed as necessary.

20 [0165]

As described above, since any layer other than the base material constituting the semiconductor processing sheet can be laminated by a method of forming the layer in advance on the release film and then laminating it on the surface of the target layer, if necessary, a layer for employing such a process may be appropriately selected to produce
25 the semiconductor processing sheet.

[0166]

It should be noted that in general, after providing all the necessary layers such as an adhesive layer for a jig for fixing the semiconductor processing sheet to a jig, such as a ring frame for dicing, the semiconductor processing sheet is stored in a state where the release film is laminated on the surface of the outermost layer on the side opposite to the support sheet.

[0167]

<< Method for manufacturing semiconductor device >>

A method for manufacturing a semiconductor device according to the present invention is a method for manufacturing a semiconductor device using the film adhesive of the present invention as described above, and includes: a laminated structure forming step of forming a laminated structure in which the aforementioned film adhesive is provided on a support sheet, and a plurality of already divided semiconductor chips are provided on a surface of the aforementioned film adhesive on a side opposite to a side where the aforementioned support sheet is provided; a cutting step in which the film adhesive of the aforementioned laminated structure is expanded, while being cooled, in a direction parallel to the surface thereof to cut the film adhesive; and a separating step of picking up (that is, separating) the aforementioned semiconductor chip provided with the aforementioned cut film adhesive (abbreviated as a “semiconductor chip with a film adhesive” in some cases in the present specification) from the aforementioned support sheet.

The one in which the film adhesive is provided on the support sheet is the semiconductor processing sheet of the present invention described above, and as described later, the method for manufacturing a semiconductor device according to the present invention uses the film adhesive or the semiconductor processing sheet of the

present invention.

[0168]

By using the film adhesive or the semiconductor processing sheet of the present invention, in the cutting step, it is possible to easily cut the film adhesive at an intended
5 place without being accompanied by abnormalities such as chipping of the film adhesive at the time of cutting the film adhesive through the expansion of the film adhesive.

Further, in the case of using the semiconductor processing sheet having the non-energy ray-curable pressure-sensitive adhesive layer described above, in the above-described separating step, even if the pressure-sensitive adhesive layer is not cured
10 through energy ray irradiation, the semiconductor chip with the film adhesive can be easily separated and picked up from the pressure-sensitive adhesive layer. In this case, the manufacturing process of the semiconductor device can be simplified.

[0169]

Hereinafter, the manufacturing method will be described with reference to FIG.
15 2. FIG. 2 is a cross-sectional view for schematically illustrating one embodiment of a method for manufacturing a semiconductor device in the case of using the film adhesive or the semiconductor processing sheet of the present invention. Here, a manufacturing method in the case of using the film adhesive 13 or the semiconductor processing sheet 1 shown in FIG. 1 will be described. It should be noted that in FIG. 2 and in the
20 subsequent figures, the same components as those shown in FIG. 1 are denoted by the same reference numerals as in FIG. 1, and a detailed description thereof will be omitted. Further, in FIG. 2, only the configurations related to the semiconductor processing sheet and the semiconductor chip are shown in cross section.

[0170]

25 <Laminated structure forming step>

In a laminated structure 101 shown in FIG. 2(a), a pressure-sensitive adhesive layer 12 is provided on a base material 11, a film adhesive agent 13 is provided on a surface 12a of the pressure-sensitive adhesive layer 12, and a plurality of already divided semiconductor chips 8 are provided on a surface 13a of the film adhesive 13 on the side
5 opposite to the side on which the pressure-sensitive adhesive layer 12 is provided.

It should be noted that in FIG. 2, gap portions between the plurality of semiconductor chips 8 (that is, those originating from the grooves) are highlighted.

[0171]

In the laminated structure forming step, for example, one sheet of film adhesive
10 13 is attached to back surfaces 8b of a plurality of already divided semiconductor chips 8, and then the pressure-sensitive adhesive layer 12 of the support sheet 10 is attached to a surface (that is, the back surface) 13b of this film adhesive 13 on the side opposite to the side on which the semiconductor chips 8 are provided, whereby the laminated structure 101 can be formed. Further, by using the semiconductor processing sheet 1 of the
15 present invention, the laminated structure 101 can also be formed by attaching the surface 13a of the film adhesive 13 on the side opposite to the side on which the pressure-sensitive adhesive layer 12 is provided to the back surfaces 8b of the plurality of already divided semiconductor chips 8.

[0172]

20 As described above, the plurality of already divided semiconductor chips 8 can be produced by forming grooves from a circuit forming surface (that is, the front surface) of the semiconductor wafer on the side opposite to the surface to which the film adhesive 13 is attached (that is, the back surface), and grinding the back surface until reaching the grooves. Further, the grooves can be formed by a method such as blade dicing, laser
25 dicing and water dicing.

[0173]

FIG. 3 is a cross-sectional view for schematically illustrating one embodiment of a method for forming grooves in such a semiconductor wafer to obtain semiconductor chips.

5 In this method, as shown in FIG. 3(a), grooves 80' are formed in a semiconductor wafer 8' from one surface 8a' which is a circuit forming surface thereof by a method such as blade dicing, laser dicing and water dicing.

 Subsequently, as shown in FIG. 3(b), a surface (that is, the back surface) 8b' of the semiconductor wafer 8' on the opposite side of the aforementioned surface (that is, 10 the circuit forming surface) 8a' is ground. Grinding of the back surface 8b' can be carried out by a known method by using, for example, a grinder 62. It is preferable that grinding of the back surface 8b' is performed by attaching a back grinding tape 63 to the surface 8a' of the semiconductor wafer 8', as shown here.

 Then, by grinding the back surface 8b' until it reaches the grooves 80', a 15 plurality of semiconductor chips 8 are obtained from the semiconductor wafer 8' as shown in FIG. 3 (c). The back surface 8b' of the semiconductor wafer 8' will become the back surface 8b of the semiconductor chip 8, that is, the surface for providing the film adhesive 13.

[0174]

20 However, in the aforementioned manufacturing method of a semiconductor device, as described above, it is preferable to adopt a method of forming a modified layer inside the semiconductor wafer, and dividing the semiconductor wafer at the portion where the modified layer is formed, instead of a method of scraping off a part of these semiconductor wafers.

25 [0175]

That is, in the method for manufacturing a semiconductor device according to the present invention, prior to the aforementioned laminated structure forming step, it is preferable to further include: a modified layer forming step of forming a modified layer inside the aforementioned semiconductor wafer by irradiating a laser beam in an infrared region so as to converge on a focal point set inside the semiconductor wafer; and a dividing step of grinding a surface for providing the aforementioned film adhesive in the aforementioned semiconductor wafer in which the aforementioned modified layer has been formed, and applying a force at the time of grinding to the aforementioned semiconductor wafer, thereby dividing the aforementioned semiconductor wafer at a portion of the aforementioned modified layer and obtaining a plurality of semiconductor chips, and is preferable to use the plurality of semiconductor chips obtained in the aforementioned dividing step in the aforementioned laminated structure forming step.

FIG. 4 is a cross-sectional view for schematically illustrating one embodiment of a method for forming a modified layer in such a semiconductor wafer to obtain semiconductor chips.

[0176]

<Modified layer forming step>

In this method, in the modified layer forming step, as shown in FIG. 4(a), a laser beam in the infrared region is irradiated so as to converge on a focal point set inside the semiconductor wafer 8' to form modified layers 81' inside the semiconductor wafer 8'.

In the modified layer forming step, in order to form the modified layers 81' while minimizing the damage to the surface of the semiconductor wafer 8' and to the region in the vicinity of the surface by the irradiation of laser beam, for example, it is preferable to irradiate a laser beam with a large numerical aperture (NA).

[0177]

<Dividing step>

Subsequently, in the dividing step, as shown in FIG. 4(b), a surface (that is, a back surface) 8b' of the semiconductor wafer 8' on the opposite side of the aforementioned surface (that is, the circuit forming surface) 8a' is ground. Grinding at this time can be carried out in the same manner as in the grinding of the back surface of the semiconductor wafer on which grooves have been formed, as described above with reference to FIG. 3. For example, grinding of the back surface 8b' at this time is preferably performed by attaching a back grinding tape 63 to the surface 8a' of the semiconductor wafer 8'.

10 [0178]

Then, by grinding the back surface 8b' of the semiconductor wafer 8' and further applying a force at the time of grinding to the semiconductor wafer 8' during grinding, the semiconductor wafer 8' is divided at the portion where the modified layers 81' are formed, thereby obtaining a plurality of semiconductor chips 8 from the semiconductor wafer 8' as shown in FIG. 4(c). Also in this case, as in the case described with reference to FIG. 3, the back surface 8b' of the semiconductor wafer 8' will become the back surface 8b of the semiconductor chip 8, that is, the surface for providing the film adhesive 13.

[0179]

20 In any of the above methods, when the back grinding tape 63 is used, the obtained plurality of semiconductor chips 8 are held in an aligned state on the back grinding tape 63.

[0180]

Although the thickness of the semiconductor chip 8 is not particularly limited, it is preferably from 5 μm to 60 μm , and more preferably from 10 μm to 55 μm . When

such a thin semiconductor chip is used, the effect in the case of using the semiconductor processing sheet of the present invention can be obtained more remarkably.

[0181]

<Cutting step>

5 In the cutting step in the above-described method for manufacturing a semiconductor device, after the laminated structure forming step, as shown in FIG. 2(b), while cooling the film adhesive 13 of the laminated structure 101, the film adhesive 13 is expanded in a direction parallel to a surface 13a of the film adhesive 13 to cut the film adhesive 13. The film adhesive 13 may be expanded together with the base material 11
10 and the pressure-sensitive adhesive layer 12 (that is, the support sheet 10). Here, although the cut film adhesive is denoted by the reference numeral 13', this type of film adhesive 13' after cutting is simply referred to as "film adhesive 13" in some cases. Further, the direction of the expansion of the film adhesive 13 is indicated by an arrow I.

[0182]

15 The cooling temperature of the film adhesive 13 in the cutting step is not particularly limited, but it is preferably from -15 to 10°C from the viewpoint that the film adhesive 13 can be cut more easily.

[0183]

20 In the cutting step, the expansion rate (that is, the expansion speed) of the film adhesive 13 is not particularly limited as long as it does not impair the effects of the present invention, but it is preferably from 0.5 to 100 mm/sec, more preferably from 0.5 to 60 mm/sec, and may be, for example, from 1 to 50 mm/sec or the like. By ensuring that the expansion rate is within such a range, the effects of the present invention can be obtained more remarkably. Furthermore, by ensuring that the expansion rate is equal to
25 or less than the above upper limit value, the semiconductor chips 8 are less likely to be

damaged at the time of expanding the film adhesive 13.

[0184]

In the cutting step, since the film adhesive 13 (that is, the semiconductor processing sheet 1) is used, the film adhesive 13 is cut at an intended place, and the occurrence of abnormalities such as chipping of the film adhesive 13' is suppressed at the cut place.

[0185]

In the cutting step, by using the above-mentioned pressure-sensitive adhesive layer having a storage elastic modulus of equal to or less than 1,000 MPa at 0°C, at the time of cutting the film adhesive 13, floating or scattering of the semiconductor chip 8 having the cut film adhesive 13' (that is, a semiconductor chip with a film adhesive) from the pressure-sensitive adhesive layer 12 is suppressed.

[0186]

<Separating step>

In the separating step, after the cutting step, as shown in FIG. 2(c), the semiconductor chip 8 provided with the cut film adhesive 13' is separated and picked up from the support sheet 10 (that is, the pressure-sensitive adhesive layer 12).

[0187]

In the separating step, the semiconductor chip 8 is lifted up by a lifting portion 61 of the manufacturing apparatus of the semiconductor device, so that the cut film adhesive 13' attached to the back surface 8b of the semiconductor chip 8 is separated from the pressure-sensitive adhesive layer 12. A method for lifting up the semiconductor chip 8 may be a known method, and for example, a method in which the surface of the semiconductor chip 8 is sucked and lifted up by a vacuum collet, or the like can be mentioned. Here, the lifting direction of the semiconductor chip 8 is

indicated by an arrow II.

[0188]

In the separating step, by using the above-mentioned pressure-sensitive adhesive layer having an adhesive force with respect to the semiconductor wafer of 200 mN / 25 mm or
5 less, even if the pressure-sensitive adhesive layer is not cured by energy ray irradiation or the like, the semiconductor chip with the film adhesive can be easily picked up.

[0189]

In the above manufacturing method of a semiconductor device, using the semiconductor chip 8 separated (that is, picked up) together with the cut film adhesive
10 13' (that is, the semiconductor chip with the film adhesive), followed by the same method as the conventional method, in other words, a semiconductor device can be manufactured through a process of die bonding the semiconductor chip to the circuit surface of the substrate with the film adhesive. For example, the semiconductor chip 8 is die bonded to the circuit surface of the substrate with the film adhesive 13', and one or
15 more semiconductor chips are further laminated on the semiconductor chip 8, if necessary, and after carrying out wire bonding, the entire constitution is sealed with a resin, thereby forming a semiconductor package (not shown). Then, by using this semiconductor package, a desired semiconductor device may be fabricated.

[0190]

20 The method for manufacturing a semiconductor device using the film adhesive or the semiconductor processing sheet of the present invention is not limited to the method described above with reference to FIG. 2, and some of the configurations in the above method may be changed, deleted or added within a range that does not impair the effects of the present invention.

[Examples]

[0191]

Hereinafter, the present invention will be described in more detail with reference to specific examples. However, the present invention is not limited in any way by the following examples.

[0192]

The components used for the production of the adhesive composition are shown below.

- Polymer component

(A)-1: Acrylic resin (weight average molecular weight: 800,000, glass transition temperature: 9°C) obtained by copolymerization of methyl acrylate (hereinafter abbreviated as “MA”) (95 parts by mass) and 2-hydroxyethyl acrylate (hereinafter abbreviated as “HEA”) (5 parts by mass).

- Epoxy resin

(b1)-1: cresol novolak type epoxy resin added with an acryloyl group (“CNA 147” manufactured by Nippon Kayaku Co., Ltd., epoxy equivalent: 518 g/eq, number average molecular weight: 2,100, content of unsaturated group is equal to that of epoxy group)

- Thermal curing agent

(b2)-1: Aralkyl phenol resin (“MILEX XLC-4L” manufactured by Mitsui Chemicals, Inc., number average molecular weight: 1,100)

- Filler

(d)-1: Spherical silica (“YA 050 C-MJE” manufactured by Admatechs Co., Ltd., average particle size: 50 nm, product treated with methacrylic silane)

- Coupling agent

(e)-1: Silane coupling agent, 3-glycidoxypopylmethyldiethoxysilane (“KBE-402” manufactured by Shin-Etsu Chemical Co., Ltd.)

- Crosslinking agent

(f)-1: Tolylene diisocyanate-based crosslinking agent (“BHS 8515”
5 manufactured by Toyo Ink Co., Ltd.)

[0193]

<Production of film adhesive and semiconductor processing sheet>

[Example 1]

(Production of adhesive composition)

10 The polymer component (a)-1, the epoxy resin (b1)-1, the thermal curing agent (b2)-1, the filler (d)-1, the coupling agent (e)-1 and the crosslinking agent (f)-1 were dissolved or dispersed in methyl ethyl ketone so that the contents (parts by mass) of these components became the values shown in Table 1, and the resultant was stirred at 23°C to obtain an adhesive composition.

15 [0194]

(Production of film adhesive)

The adhesive composition obtained as described above was applied to a release-treated surface of a release film in which one surface of a polyethylene terephthalate film (thickness: 38 μm) had been subjected to a release treatment through a silicone treatment,
20 and dried by heating at 120°C for 3 minutes, thereby forming a film adhesive having a thickness of 20 μm .

Subsequently, the release-treated surface of the release film was separately attached to the exposed surface of the film adhesive to obtain a film adhesive laminate in which the release film was attached to both surfaces of the film adhesive.

25 [0195]

(Production of pressure-sensitive adhesive composition)

A crosslinking agent (30.16 parts by mass) was added to an adhesive resin (100 parts by mass), and the resulting mixture was stirred at 23°C to obtain a non-energy ray-curable pressure-sensitive adhesive composition. It should be noted that all the numbers
5 of blended parts by mass shown here are values in terms of solid content.

The adhesive resin is an acrylic polymer (weight average molecular weight: 860,000, glass transition temperature: -61°C) obtained by copolymerizing 2-ethylhexyl acrylate (80 parts by mass) and 2-hydroxyethyl acrylate (20 parts by mass). Further, the crosslinking agent is a tolylene diisocyanate trimer adduct of trimethylolpropane
10 (“Coronate L” manufactured by Tosoh Corporation).

[0196]

(Production of pressure-sensitive adhesive sheet)

The pressure-sensitive adhesive composition obtained as described above was applied to a release-treated surface of a release film (“SP-PET 381031” manufactured by
15 Lintec Corporation, thickness: 38 µm) which was a polyethylene terephthalate film whose one side had been subjected to a release treatment through a silicone treatment, and heated and dried at 120°C for 2 minutes to form a pressure-sensitive adhesive layer having a thickness of 10 µm.

Subsequently, a low-density polyethylene (LDPE) film having a thickness of
20 110 µm was laminated on the exposed surface of the pressure-sensitive adhesive layer as a base material to obtain a pressure-sensitive adhesive sheet having a release film.

[0197]

(Production of semiconductor processing sheet)

The film adhesive laminate was stored for 1 week at normal temperature
25 immediately after production, and then one of the release films was removed to expose

one surface of the film adhesive. Further, the release film was removed from the pressure-sensitive adhesive sheet obtained above to expose one surface of the pressure-sensitive adhesive layer. Then, by laminating the exposed surface of the film adhesive and the exposed surface of the pressure-sensitive adhesive layer, a semiconductor processing sheet in which the base material, the pressure-sensitive adhesive layer, the film adhesive and the release film were laminated in this order was obtained.

[0198]

[Examples 2 to 7, Comparative Examples 1 to 7]

A film adhesive and a semiconductor processing sheet were produced in the same manner as in Example 1 except that the components contained in the adhesive composition were as shown in Table 1 or Table 2.

[0199]

It should be noted that the solid content concentrations of the adhesive compositions produced in the above Examples and Comparative Examples are from 18 to 24% by mass.

[0200]

<Evaluation of film adhesive and semiconductor processing sheet>

For the film adhesive and the semiconductor processing sheet obtained as described above, the following properties were evaluated.

[0201]

(Elongation at break of laminate)

Using a laminator, a plurality of layers of the film adhesive obtained above were laminated to each other to produce a laminate in which the film adhesives were laminated to have a total thickness of 60 μm . Furthermore, the laminate was cut to prepare a test piece having a width of 6 mm, a length of 5 mm and a thickness of 60 μm .

[0202]

Subsequently, the temperature of the obtained test piece was set to 0°C, and the test piece was pulled using a dynamic viscoelasticity measuring device (“DMA Q 800” manufactured by TA Instruments, Inc.) to determine the elongation at break (%) of the test piece, that is, the laminate in which the uncured film adhesives were laminated. When pulling the test piece, the load applied to the test piece was changed from 1 N/min to 18 N/min. The results are shown in Table 1 or Table 2.

[0203]

(Adhesive force of film adhesive with respect to semiconductor wafer)

10 An adhesive tape obtained by laminating an adhesive layer (thickness: 24 μm) with a strong adhesive force on one surface of a polyethylene terephthalate film (thickness: 50 μm) was prepared. One of the release films was removed from the film adhesive laminate obtained above to expose one surface of the film adhesive. Then, a laminated sheet was produced by laminating the adhesive layer of the adhesive tape onto 15 the exposed surface of the film adhesive using a laminator. Furthermore, this laminated sheet was cut to a size of 25 mm in width and 150 mm in length, and then the remaining release film was removed from the film adhesive to produce a test piece.

[0204]

This test piece was laminated onto the mirror surface of a silicon wafer via a 20 film adhesive heated to 50°C by using a laminator and allowed to stand for 30 minutes under the temperature condition of 23°C. Then, using the universal tensile tester (“Autograph” manufactured by Shimadzu Corporation), while keeping the same temperature, the so-called 180° peeling was performed in which the test piece was peeled from the silicon wafer at a peeling rate of 300 mm/min, so that the planes of the test piece 25 (that is, film adhesive) and the silicon wafer that were brought into contact with each

other form an angle of 180°. The peel force at this time was measured and the measured value was used as an adhesive force (mN / 25 mm) of the uncured film adhesive with respect to the semiconductor wafer. The results are shown in Table 1 or Table 2.

5 [0205]

(Cutting characteristic (1) of film adhesive)

Using a dicing apparatus ("DFD 6361" manufactured by DISCO Corporation), half-cut dicing was carried out to form grooves by making cuts from the surface to a depth of 80 μm with a dicing blade so as to draw a square having a size of 10 mm $\times$ 10 mm on a mirror surface of an 8-inch silicon wafer (thickness: 720 μm).

Subsequently, using a tape laminator ("RAD-3510" manufactured by Lintec Corporation), a back grinding tape ("ADWILL E-3125 KN" manufactured by Lintec Corporation) was attached under normal temperature through the adhesive layer thereof to the mirror surface of the silicon wafer on which the above-mentioned grooves had been formed.

Then, using a grinder ("DFG 8760" manufactured by DISCO Corporation), the surface of the silicon wafer opposite to the mirror surface on which the grooves described above had been formed was ground. At this time, grinding was performed so that the thickness of the silicon wafer became 50 μm , and at the same time, the silicon wafer was divided into individual silicon chips. The obtained silicon chips were fixed on the back grinding tape with a space of about 30 μm from each other.

Subsequently, to the ground surface of the obtained silicon chip, the semiconductor processing sheet obtained as described above was attached through the film adhesive thereof which was heated to 60°C using a tape mounter ("ADWILL RAD 2500" manufactured by Lintec Corporation) to obtain a laminate.

Then, the obtained laminate was attached and fixed to a ring frame for dicing through the exposed surface of the pressure-sensitive adhesive layer thereof, and the back grinding tape was peeled off from the silicon chip, thereby obtaining a test piece of a laminated structure in which a plurality of semiconductor chips that had been divided
 5 into individual pieces in advance were aligned on the uncut film adhesive of the semiconductor processing sheet.

[0206]

The test piece obtained as described above was set in an expansion unit of an expander (“ME-300B” manufactured by JCM Co., Ltd.), and the semiconductor
 10 processing sheet was expanded in an environment of 0°C under conditions of an expansion amount (that is, expanding amount) of 10 mm, and an expansion rate (that is, expansion speed) of 1 mm/sec, and an attempt was made to cut the film adhesive along the outer shape of the silicon chip.

Then, the film adhesive was observed using a digital microscope (“VH-Z100”
 15 manufactured by Keyence Corporation), and the cutting characteristic (1) of the film adhesive was evaluated according to the following criteria. The results are shown in Table 1 or Table 2.

A: The film adhesive could be cut at all the intended places.

B: The film adhesive could not be cut at some of the intended places.

20 C: The film adhesive could not be cut at all the intended places.

[0207]

(Cutting characteristic (2) of film adhesive)

A back grinding tape (“E-3125 KL” manufactured by Lintec Corporation) was laminated on one surface of a 12-inch silicon wafer using a tape laminator for back
 25 grinding (“RAD-3510F/12” manufactured by Lintec Corporation).

Subsequently, stealth dicing was carried out in which a laser beam in the infrared region was irradiated from the exposed surface side of the silicon wafer where the back grinding tape was not laminated, so as to converge on a focal point set inside the silicon wafer to form a modified layer inside the silicon wafer. This stealth dicing
5 process was carried out by using “DFL 7361” manufactured by DISCO Corporation as an apparatus and adjusting so as to obtain a silicon chip having a size of 8 mm × 10 mm.

Subsequently, the exposed surface of the silicon wafer was ground using a grinder (“DGP 8761” manufactured by DISCO Corporation). At this time, grinding was performed so that the thickness of the silicon wafer became 40 μm, and at the same time,
10 the silicon wafer was divided into individual silicon chips. The obtained silicon chips were fixed on the back grinding tape.

Subsequently, to the ground surface of the obtained silicon chip, the semiconductor processing sheet obtained as described above was attached through the film adhesive thereof which was heated to 60°C using a tape mounter (“DFM 2800”
15 manufactured by DISCO Corporation) to obtain a laminate.

Then, the obtained laminate was attached and fixed to a ring frame for dicing through the exposed surface of the pressure-sensitive adhesive layer thereof, and the back grinding tape was peeled off from the silicon chip, thereby obtaining a test piece of a laminated structure in which a plurality of semiconductor chips that had been divided
20 into individual pieces in advance were aligned on the uncut film adhesive of the semiconductor processing sheet.

[0208]

The test piece obtained as described above was set in an expander (“DDS 2300” manufactured by DISCO Corporation), and the semiconductor processing sheet was
25 expanded in an environment of 0°C under conditions of a table lifting height of 15 mm

and a table lifting speed of 1 mm/sec, and an attempt was made to cut the film adhesive along the outer shape of the silicon chip.

Subsequently, the table was lowered to release the expansion, and the test piece after expansion was placed on another table different from that of the expander described above. Then, the test piece was lifted under conditions of a table lifting height of 8 mm and a table lifting speed of 1 mm/sec without being attached to the table, and the test piece was attached to the table at the stage when the table was fully elevated, and an attempt was made to expand the semiconductor processing sheet and expand the space between adjacent silicon chips (that is, the kerf width). Furthermore, the table was lowered while the test piece remained attached on the table to be held without changing the kerf width, and the sagging in the outer peripheral portion where the silicon chip of the test piece was not provided was resolved through the shrinkage due to heating at 250°C. As described above, attempts were made to obtain a test piece with an extended kerf width.

Then, the film adhesive was observed using a digital microscope ("VH-Z100" manufactured by Keyence Corporation), and the cutting characteristic (2) of the film adhesive was evaluated according to the same criteria as in the case of the cutting characteristic (1) of the film adhesive described above. The results are shown in Table 1 or Table 2.

[0209]

(Reliability of film adhesive)

- Production of silicon chips

Using a tape mounter ("Adwill RAD 2700" manufactured by Lintec Corporation), the semiconductor processing sheet obtained as described above was heated to 60°C and attached to a dry polish-finished 12-inch silicon wafer (thickness: 75

μm), and a ring frame was mounted.

Then, using a dicing apparatus (“DFD 6361” manufactured by DISCO Corporation), the silicon wafer was divided into individual silicon chips having a size of 8 mm × 8 mm. The dicing at this time was carried out under conditions of a blade speed of 50 mm/sec, a blade rotation speed of 40,000 rpm, and a cutting water amount of 1 L/min. Further, the amount of cut into the base material at the time of dicing was set to be 20 μm.

[0210]

- Production of semiconductor package

- 10 As a substrate, a substrate (“LN001E-001 PCB (Au) AUS 308” manufactured by Chino Giken Corporation) in which a circuit pattern was formed on a copper foil (thickness: 18 μm) of a copper foil-clad laminate (“OCL-HL 830” manufactured by Mitsubishi Gas Chemical Company, Inc.), and a solder resist (“PSR-4000 AUS308” manufactured by Taiyo Ink Mfg. Co., Ltd.) was included on the circuit pattern was used.
- 15 The silicon chip on the semiconductor processing sheet obtained as described above was peeled from the base material together with the film adhesive and pressure bonded onto the substrate under conditions of 120°C, 250 gf and 0.5 seconds to fix the silicon chip on the substrate through the film adhesive, thereby obtaining a laminate.

- Subsequently, the obtained laminate was placed in an oven heated to 175°C for
- 20 4 hours or 2 hours to apply a thermal history assuming wire bonding to the laminate.

- Then, using a sealing device (“G-CUBE MZ 549-1” manufactured by Apic Yamada Corporation) and using a molding resin (“KE-G 1250” manufactured by Kyocera Chemical Corporation), the laminate after being applied with the thermal history was sealed under the conditions of a sealing temperature of 175°C, a sealing pressure of
- 25 7 MPa and a sealing time of 2 minutes so that the sealing thickness was 400 μm.

Furthermore, the molding resin was cured at 175°C for 5 hours.

Subsequently, the sealed substrate was laminated to a dicing tape (“Adwill D-510T” manufactured by Lintec Corporation), and the sealed substrate was divided into individual pieces having a size of 15 mm × 15 mm using a dicing apparatus (“DFD 6361” manufactured by DISCO Corporation). The dicing at this time was carried out under conditions of a blade speed of 50 mm/sec, a blade rotation speed of 40,000 rpm, and a cutting water amount of 1 L/min.

As described above, a semiconductor package was obtained.

[0211]

- 10 - Evaluation of surface mounting of semiconductor package and package reliability (that is, reliability of film adhesive)

The semiconductor package obtained as described above was allowed to stand for 168 hours under conditions of a temperature of 85°C and a relative humidity of 60% to absorb moisture, and then the IR reflow process was carried out three times on this semiconductor package after moisture absorption using a reflow oven (“WL-15-20 DNX type” manufactured by Sagami-Rikou Co., Ltd.) under conditions of a maximum temperature of 260°C and a heating time of 1 minute.

Then, it was confirmed whether or not cracks were generated in the semiconductor package by using a scanning ultrasonic flaw detector (“Hye-Focus” manufactured by Hitachi Kenki FineTech Co., Ltd.), and the package reliability (that is, reliability of the film adhesive) was evaluated according to the following criteria. The results are shown in Table 1 or Table 2.

A: No cracks were generated at all in the semiconductor package after the IR reflow process when using the laminate applied with the thermal history under conditions of 175°C for 4 hours.

B: Although no cracks were generated at all in the semiconductor package after the IR reflow process when using the laminate applied with the thermal history under conditions of 175°C for 2 hours, cracks were generated in the semiconductor package after the IR reflow process when using the laminate applied with the thermal history
5 under conditions of 175°C for 4 hours.

C: Cracks were generated in the semiconductor package after the IR reflow process in both cases where the laminate applied with the thermal history under conditions of 175°C for 2 hours was used and where the laminate applied with the thermal history under conditions of 175°C for 4 hours.

10 [0212]

(Film-forming property of film adhesive)

At the time of producing the film adhesive described above, the film-forming property of the film adhesive was evaluated at the same time.

That is, when the adhesive composition was applied to the release film on the
15 surface of the obtained film adhesive, the appearance was visually observed, with respect to the surface formed from the portion of the adhesive composition which was in contact with the release film, and the film-forming property of the film adhesive was evaluated according to the following criteria. The results are shown in Table 1 or Table 2.

A: No abnormality was found on the surface, and the surface conditions were
20 favorable.

B: Although streaks or cissing occurred on the surface, the disturbance of the surface conditions was mild.

C: Aggregates were generated on the surface, and the surface conditions were not uniform.

25 [0213]

[Table 1]

			Examples						
			1	2	3	4	5	6	7
Components contained in adhesive composition (parts by mass)	Polymer component	(a)-1	57.5	55.4	53.4	50.4	47.5	42.6	40.5
	Epoxy-based thermosetting resin	(b1)-1 + (b2)-1	21.6	13.9	5.9	18.9	11.9	4.7	28.8
	Filler	(d)-1	20.2	30.0	40.0	30.0	40.0	52.1	30.0
	Coupling agent	(e)-1	0.43	0.38	0.32	0.38	0.32	0.26	0.43
	Crosslinking agent	(f)-1	0.37	0.36	0.34	0.32	0.31	0.27	0.37
Evaluation results	Elongation at break (%)		52	43	39	35	21	17	16
	Adhesive force (mN / 25 mm)		360	400	400	320	300	310	315
	Cutting characteristic (1)		A	A	A	A	A	A	A
	Cutting characteristic (2)		A	-	A	-	-	A	-
	Reliability		A	A	A	A	A	B	B
	Film-forming property		A	A	A	A	A	A	A

[0214]

[Table 2]

			Comparative Examples						
			1	2	3	4	5	6	7
Components contained in adhesive composition (parts by mass)	Polymer component	(a)-1	71.1	62.3	36.2	35.8	26.9	18.0	33.3
	Epoxy-based thermosetting resin	(b1)-1 + (b2)-1	7.9	6.9	13.6	4.0	3.0	0.2	35.9
	Filler	(d)-1	20.1	30.0	49.7	59.7	69.8	79.8	30.0
	Coupling agent	(e)-1	0.43	0.38	0.27	0.22	0.16	0.11	0.43
	Crosslinking agent	(f)-1	0.46	0.40	0.23	0.23	0.17	0.11	0.37
Evaluation results	Elongation at break (%)		97	61	14	5	Unmeasurable	Unmeasurable	12
	Adhesive force (mN / 25 mm)		750	550	210	140	Unmeasurable	Unmeasurable	260
	Cutting characteristic (1)		C	C	B	B	Unevaluable	Unevaluable	B
	Cutting characteristic (2)		-	-	B	B	-	-	B
	Reliability		A	A	C	C	Unevaluable	Unevaluable	B
	Film-forming property		A	A	B	B	C	C	B

[0215]

As is apparent from the above results, in Examples 1 to 7, the elongation at break of the laminate at 0°C was equal to or less than 52%, and the adhesive force of the film adhesive was equal to or more than 300 mN / 25 mm.

At the time of evaluation of the cutting characteristic (1), the film adhesives of Examples 1 to 7 were cut at intended places by expansion, while no abnormality such as chipping of the film adhesive was observed at the cut places, so that excellent cutting characteristics were exhibited. In addition, the film adhesives of Examples 1, 3 and 6 exhibited excellent cutting characteristics also in the evaluation of the cutting characteristic (2) (the film adhesives of Examples 2, 4 and 5 have yet to be evaluated for the cutting characteristic (2)).

Furthermore, the film adhesives of Examples 1 to 6 were all satisfactory in reliability and film-forming property, and there were no problems in the basic

characteristics as film adhesives.

[0216]

On the other hand, in Comparative Examples 1 and 2, the elongation at break of the laminate at 0°C was equal to or more than 61%, and at the time of evaluation of the cutting characteristic (1), the film adhesives were inferior in cutting characteristics since it was not possible to cut the film adhesives into intended shapes.

Further, in Comparative Examples 3, 4 and 7, the adhesive force of the film adhesive was equal to or less than 260 mN / 25 mm, and at the time of evaluating the cutting characteristic (1), since it was not possible to cut the film adhesive at some of the intended places, and even when it was cut at an intended place, abnormality such as chipping of the film adhesive was observed at the cut place, the film adhesive was inferior in cutting characteristics. In addition, the film adhesives of Comparative Examples 3, 4 and 7 were inferior in cutting characteristics even at the time of evaluation of the cutting characteristic (2) (the film adhesives of Comparative Examples 1, 2, 5, and 6 have yet to be evaluated for the cutting characteristic (2)).

Further, in Comparative Examples 5 and 6, neither the elongation at break of the laminate at 0°C nor the adhesive force of the film adhesive could be measured, and both the cutting characteristic (1) and the cutting characteristic (2) could not be evaluated.

Furthermore, the film adhesives of Comparative Examples 3 and 4 were inferior in reliability, and the film adhesives of Comparative Examples 5 and 6 were poor in film-forming properties, and there were problems with these in the basic characteristics as film adhesives.

[0217]

It should be noted that although the cutting characteristic (2) was not evaluated here for some of the film adhesives, it is conceivable that the cutting characteristics (2) of

these film adhesives will show the same evaluation results as those for the cutting characteristics (1). This is because, if there is no abnormality in the semiconductor chip used for evaluation, the method for producing a semiconductor chip (that is, the method for dividing a semiconductor wafer) does not affect the above evaluation process. The evaluation results of Examples 1, 3, and 6, and Comparative Examples 3, 4, and 7 which evaluate both the cutting characteristic (1) and the cutting characteristic (2) are believed to support this notion.

[Industrial Applicability]

10 [0218]

The present invention is industrially extremely important because it can be suitably used for manufacturing a semiconductor device.

[Reference Signs List]

15 [0219]

1: Semiconductor processing sheet; 10: Support sheet; 11: Base material; 12: Pressure-sensitive adhesive layer; 12a: Surface of pressure-sensitive adhesive layer; 13: Film adhesive; 13': Cut film adhesive; 101: Laminated structure; 8: Semiconductor chip; 8': Semiconductor wafer; 81': Modified layer of semiconductor wafer; 8b': Back surface of semiconductor wafer

[CLAIMS]

[Claim 1]

A film adhesive which is a curable film adhesive, wherein

5 either an uncured single layer of said film adhesive having a thickness of $60\ \mu$ m, or a laminate formed by laminating two or more uncured layers of said film adhesive so that a total thickness becomes $60\ \mu$ m, has an elongation at break at 0° C of equal to or less than 60%, and

 an adhesive force of said uncured film adhesive with respect to a semiconductor

10 wafer is equal to or more than 300 mN / 25 mm.

[Claim 2]

A semiconductor processing sheet, wherein the film adhesive according to Claim 1 is provided on a support sheet.

15

[Claim 3]

The semiconductor processing sheet according to Claim 2, wherein

 said support sheet is obtained by providing a pressure-sensitive adhesive layer on a base material, and

20 said film adhesive is provided in direct contact with said pressure-sensitive adhesive layer.

[Claim 4]

A method for manufacturing a semiconductor device which is a method for

25 manufacturing a semiconductor device using the film adhesive according to Claim 1, the

method comprising:

- a laminated structure forming step of forming a laminated structure in which said film adhesive is provided on a support sheet, and a plurality of already divided semiconductor chips are provided on a surface of said film adhesive on a side opposite to
- 5 a side where said support sheet is provided;
- a cutting step in which the film adhesive of said laminated structure is expanded, while being cooled, in a direction along a surface of said film adhesive to cut the film adhesive; and
- a separating step of separating said semiconductor chip provided with said cut
- 10 film adhesive from said support sheet.

[Claim 5]

- The method for manufacturing a semiconductor device according to Claim 4, further comprising, prior to said laminated structure forming step:
- 15 a modified layer forming step of forming a modified layer inside said semiconductor wafer by irradiating a laser beam in an infrared region so as to converge on a focal point set inside the semiconductor wafer; and
- a dividing step of grinding a surface for providing said film adhesive in said semiconductor wafer in which said modified layer has been formed, and applying a force
- 20 at the time of grinding to said semiconductor wafer, thereby dividing said semiconductor wafer at a portion of said modified layer and obtaining a plurality of semiconductor chips,
- wherein the plurality of semiconductor chips obtained in said dividing step are used in said laminated structure forming step.