

DESCRIPTION

Title of Invention

INTEGRATED DICING/DIE-BONDING FILM, METHOD FOR
MANUFACTURING SAME, AND METHOD FOR
5 MANUFACTURING SEMICONDUCTOR DEVICE

Technical Field

[0001] The present disclosure relates to a dicing die-bonding integrated film, a method for producing the same, and a method for producing a semiconductor device.

Background Art

[0002] A semiconductor device is produced by performing the following steps. First, a dicing step is carried out in a state in which an adhesive film for dicing is stuck to a wafer. Subsequently, an expansion step, a pickup step, a mounting step, a die-bonding step, and the like are carried
15 out.

[0003] In a production process for a semiconductor device, a film called dicing die-bonding integrated film is used. This film has a structure in which a base material layer, an adhesive layer, and a bonding adhesive layer are laminated in this order, and the film is used, for example, as
20 follows. First, the surface on the bonding adhesive layer side is stuck to a wafer, and the wafer is diced in a state in which the wafer is fixed by a dicing ring. As a result, the wafer is singularized into a plurality of chips. Subsequently, the adhesive force of the adhesive layer with respect to the bonding adhesive layer is weakened by irradiating the
25 adhesive layer with active energy rays, and then chips are picked up, together with adhesive pieces formed by singularizing the bonding

adhesive layer, from the adhesive layer. Subsequently, a semiconductor device is produced by performing a step of mounting a chip on a substrate or the like, with the bonding adhesive piece interposed therebetween. Incidentally, a laminated body composed of a chip obtainable by performing a dicing step; and a bonding adhesive piece attached to this chip, is referred to as DAF (Die Attach Film).

[0004] As described above, an adhesive layer (dicing film) in which the adhesive force is weakened by irradiation with active energy rays, is referred to as an active energy ray-curable type. In contrast, an adhesive layer in which the adhesive force remains constant without being irradiated with active energy rays in a production process for a semiconductor device, is referred to as a pressure-sensitive type. A dicing die-bonding integrated film including a pressure-sensitive type adhesive layer has merits in that a user (mainly a semiconductor device manufacturer) does not need to perform a step of irradiating with active energy rays, and that facilities for this purpose are unnecessary. In Patent Literature 1, the adhesive layer can be said to be an active energy ray-curable type, from the viewpoint that the adhesive layer contains a component that is cured by active energy rays. On the other hand, there is disclosed a dicing die-bonding integrated film which can also be said to be a pressure-sensitive type from the viewpoint that only a predetermined portion of the adhesive layer has been irradiated in advance with active energy rays so that the user does not need to irradiate active energy rays in the production process for a semiconductor device.

Citation List

Patent Literature

[0005] Patent Literature 1: Japanese Patent No. 4443962

Summary of Invention

Technical Problem

[0006] Generally, it is required for the adhesive layer of a dicing die-bonding integrated film that the adhesive force between the adhesive layer and the bonding adhesive layer is low. When the adhesive force is too low, there is a risk that pickup errors may occur in a pickup step for chips, and the product yield may be lowered. However, the inventors of the present invention found that when a chip to be produced by dicing becomes small (for example, the area in a plan view is 0.1 to 9 mm²), the pickup properties of the chip are not necessarily dominant on the adhesive force between the adhesive layer and the bonding adhesive layer, and peeling from the adhesive layer at the edges of the chip (hereinafter, referred to as "edge peeling") is a dominant factor on the pickup properties. That is, it is speculated that the pickup properties of a small chip are mainly dominated by the edge peel strength of a bonding adhesive piece-attached chip, and once edge peeling occurs by pushing up with a pin, the interface peeling between the adhesive layer and the bonding adhesive layer progresses smoothly.

[0007] Regarding an influence factor for the edge peel strength, for example, curing shrinkage of the adhesive layer may be mentioned. Usually, after a dicing step, burrs (cutting debris) generated as a mixture of the bonding adhesive layer, the adhesive layer, the wafer, and the like are generated on the dicing lines. When the adhesive layer is of the active energy ray-curable type, there is a risk that the adhesive layer may be cured together with the burrs (cutting debris) when irradiated with

active energy rays, causing the edge peel strength to increase to a large extent. When the adhesive layer has been cured in advance before the dicing step, there is no such influence because it is not necessary to carry out a step of irradiating with active energy rays. However, there is a risk that the edge peel strength may be increased due to an anchor effect caused by curing shrinkage of the adhesive layer at the bonding adhesive layer interface. The inventors of the present invention conducted a thorough investigation on the curing shrinkage of the adhesive layer, and they found that the magnitude of the curing shrinkage tends to be greater as the difference in the adhesive force of the adhesive layer measured before and after irradiation of the bonding adhesive layer with active energy rays is larger. Thus, the present inventors considered that the edge peel strength can be reduced by adjusting the difference between the adhesive force of the adhesive layer before irradiation with active energy rays and the adhesive force of the adhesive layer after irradiation with active energy rays (in other words, the difference between the adhesive force of the adhesive layer at a portion not irradiated with active energy rays and the adhesive force of the adhesive layer at a portion irradiated with active energy rays), and worked on the development of a dicing die-bonding integrated film having excellent pickup properties.

[0008] A main object of the present disclosure is to provide a dicing die-bonding integrated film including an adhesive layer having excellent pickup properties, the dicing die-bonding integrated film being applicable to a production process for a semiconductor device including a step of singularizing a wafer into a plurality of small chips (area 0.1 to 9 mm²), and a production method for the dicing die-bonding integrated film.

Solution to Problem

[0009] An aspect of the present disclosure relates to a dicing die-bonding integrated film. This film includes a base material layer; an adhesive layer formed from an active energy ray-curable adhesive, the adhesive layer having a first surface facing the base material layer and a second surface on the opposite side of the first surface; and a bonding adhesive layer provided so as to cover a central part of the second surface. The adhesive layer has a first region including at least a region corresponding to a sticking position for a wafer in the bonding adhesive layer and a second region located so as to surround the first region, and the first region is a region in a state of having an adhesive force decreased as compared with the second region by irradiation with active energy rays. With regard to the adhesive layer, when the adhesive force of the first region of the adhesive layer with respect to the bonding adhesive layer as measured under the conditions of a peeling angle of 30° and a peeling speed of 60 mm/min at a temperature of 23°C , is designated as f_1 (N/25 mm), and the adhesive force of the second region of the adhesive layer with respect to the bonding adhesive layer as measured under the conditions of a peeling angle of 30° and a peeling speed of 60 mm/min at a temperature of 23°C , is designated as f_2 (N/25 mm), the difference between f_2 and f_1 ($f_2 - f_1$) is 6.5 to 9.0 N/25 mm. This film is applied to a production process for a semiconductor device including a step of singularizing a wafer into a plurality of chips each having an area of 0.1 to 9 mm².

[0010] According to the dicing die-bonding integrated film, since the edge peel strength can be reduced by suppressing curing shrinkage of the

adhesive layer, the dicing die-bonding integrated film can be applied to a production process for a semiconductor device including a step of singularizing a wafer into a plurality of small chips (area 0.1 to 9 mm²), and excellent pickup properties from the adhesive layer can be achieved.

[0011] The difference between f2 and f1 (f2 - f1) may be 7.0 to 9.0 N/25 mm.

[0012] f1 (adhesive force of the first region with respect to the bonding adhesive layer as measured under the conditions of a peeling angle of 30° and a peeling speed of 60 mm/min at a temperature of 23°C) may be 1.1 to 4.5 N/25 mm or 1.1 to 3.0 N/25 mm, from the viewpoint that superior pickup properties from the adhesive layer can be achieved.

[0013] The adhesive force of the second region of the adhesive layer with respect to a stainless steel substrate may be 0.2 N/25 mm or more, from the viewpoint of suppressing ring peeling in the dicing step. Incidentally, this adhesive force means the peel strength measured under the conditions of a peeling angle of 90° and a peeling speed of 50 mm/min at a temperature of 23°C.

[0014] The active energy ray-curable adhesive may include a (meth)acrylic resin having a functional group capable of chain polymerization. When the adhesive includes such a (meth)acrylic resin, the functional group may be at least one selected from an acryloyl group and a methacryloyl group, and the content of the functional group in the (meth)acrylic resin may be 0.1 to 1.2 mmol/g.

[0015] The active energy ray-curable adhesive may further include a crosslinking agent. When such a crosslinking agent is further included, the content of the crosslinking agent with respect to the total mass of the

active energy ray-curable adhesive may be 0.1% to 15% by mass. The crosslinking agent may be a reaction product between a polyfunctional isocyanate having two or more isocyanate groups in one molecule and a polyhydric alcohol having three or more hydroxy groups in one molecule.

5 [0016] The amount of irradiation with active energy rays may be 10 to 1000 mJ/cm².

[0017] The bonding adhesive layer may be formed from a bonding adhesive composition that includes a reactive group-containing (meth)acrylic copolymer, a curing accelerator, and a filler.

10 [0018] An aspect of the present disclosure relates to a method for producing a dicing die-bonding integrated film. This production method includes, in the following order: a step of producing, on the surface of a base material layer, a laminated body including an adhesive layer formed from an active energy ray-curable adhesive and a bonding
15 adhesive layer formed on the surface of the adhesive layer; and a step of irradiating a region constituting a first region of the adhesive layer included in the laminated body with active energy rays.

[0019] An aspect of the present disclosure relates to a method for producing a semiconductor device. This production method includes: a
20 step of preparing the above-described dicing die-bonding integrated film; a step of sticking a wafer to the bonding adhesive layer of the dicing die-bonding integrated film and sticking a dicing ring to the second surface of the adhesive layer; a step of singularizing the wafer into a plurality of chips; a step of picking up a chip, together with a bonding adhesive piece
25 obtained by singularizing the bonding adhesive layer, from the adhesive layer; and a step of mounting the chip on a substrate or another chip, with

the bonding adhesive piece interposed therebetween.

[0020] That is, this production method includes a step of preparing a dicing die-bonding integrated film that includes a base material layer, an adhesive layer formed from an active energy ray-curable adhesive, the adhesive layer having a first surface facing the base material layer and a second surface on the opposite side of the first surface, and a bonding adhesive layer provided so as to cover a central part of the second surface of the adhesive layer; a step of sticking a wafer to the bonding adhesive layer of the dicing die-bonding integrated film and sticking a dicing ring to the second surface of the adhesive layer; a step of singularizing the wafer into a plurality of chips; a step of picking up a chip, together with a bonding adhesive piece obtained by singularizing the bonding adhesive layer, from the adhesive layer; and a step of mounting the chip on a substrate or another chip, with the bonding adhesive piece interposed therebetween. The adhesive layer has a first region corresponding to a region in the bonding adhesive layer, to which the wafer is stuck, and a second region corresponding to a region to which a dicing ring is stuck, and the first region is a region in a state of having an adhesive force decreased as compared with the second region, by irradiation with active energy rays. With regard to the adhesive layer, when the adhesive force of the first region of the adhesive layer with respect to the bonding adhesive layer as measured under the conditions of a peeling angle of 30° and a peeling speed of 60 mm/min at a temperature of 23°C is designated as f1 (N/25 mm), and the adhesive force of the second region of the adhesive layer with respect to the bonding adhesive layer as measured under the conditions of a peeling angle of 30° and a peeling speed of 60

mm/min at a temperature of 23°C is designated as f2 (N/25 mm), the difference between f2 and f1 (f2 - f1) is 6.5 to 9.0 N/25 mm.

Advantageous Effects of Invention

[0021] According to the present disclosure, there are provided a dicing die-bonding integrated film including an adhesive layer having excellent pickup properties, the dicing die-bonding integrated film being applicable to a production process for a semiconductor device including a step of singularizing a wafer into a plurality of small chips (area 0.1 to 9 mm²), and a method for producing the same. Furthermore, according to the present disclosure, a method for producing a semiconductor device using such a dicing die-bonding integrated film is provided.

Brief Description of Drawings

[0022] FIG. 1(a) is a plan view illustrating an embodiment of a dicing die-bonding integrated film, and FIG. 1(b) is a schematic cross-sectional view taken along the line B-B shown in FIG. 1(a).

FIG. 2 is a schematic diagram illustrating a state in which a dicing ring is stuck to the periphery of an adhesive layer of a dicing die-bonding integrated film, and a wafer is stuck to the surface of a bonding adhesive layer.

FIG. 3 is a cross-sectional view schematically illustrating a situation in which the 30° peel strength of the adhesive layer with respect to the bonding adhesive layer is measured.

FIG. 4 is a schematic cross-sectional view of an embodiment of a semiconductor device.

FIG. 5(a), FIG. 5(b), FIG. 5(c), and FIG. 5(d) are cross-sectional views schematically illustrating a process for producing a DAF

(laminated body of a chip and a bonding adhesive piece).

FIG. 6 is a cross-sectional view schematically illustrating a process for producing the semiconductor device shown in FIG. 4.

FIG. 7 is a cross-sectional view schematically illustrating a process for producing the semiconductor device shown in FIG. 4.

FIG. 8 is a cross-sectional view schematically illustrating a process for producing the semiconductor device shown in FIG. 4.

FIG. 9(a), FIG. 9(b), and FIG. 9(c) are cross-sectional views schematically illustrating a step of measuring the edge peel strength.

FIG. 10 is a graph showing an example of the relationship between the displacement (mm) caused by push-up and the push-up force (N).

FIG. 11 is a plan view schematically illustrating a state in which the position corresponding to a central part of a chip to be measured is marked.

Description of Embodiments

[0023] Hereinafter, embodiments of the present disclosure will be described in detail with reference to the drawings. In the following description, identical or equivalent parts will be assigned with the same reference numeral, and any overlapping description will not be repeated. Incidentally, the present invention is not intended to be limited to the following embodiments. According to the present specification, the expression (meth)acryl means acryl or methacryl, and the same also applies to other similar expressions such as (meth)acrylate.

[0024] <Dicing die-bonding integrated film>

FIG. 1(a) is a plan view illustrating a dicing die-bonding

integrated film according to the present embodiment, and FIG. 1(b) is a schematic cross-sectional view taken along the line B-B shown in FIG. 1. A dicing die-bonding integrated film 10 (hereinafter, optionally simply referred to as "film 10") can be used in a production process for a semiconductor device including a step of singularizing a wafer W into a plurality of chips each having an area of 0.1 to 9 mm² (and a subsequent step of picking up) (see FIG. 5(c) and FIG. 5(d)).

[0025] The film 10 includes a base material layer 1; an adhesive layer 3 having a first surface F1 facing the base material layer 1 and a second surface F2 on the opposite side of the first surface F1; and a bonding adhesive layer 5 provided so as to cover a central part of the second surface F2 of the adhesive layer 3, in this order. In the present embodiment, a situation in which one laminated body of an adhesive layer 3 and a bonding adhesive layer 5 is formed on a square-shaped base material layer 1 is mentioned as an example; however, a situation in which the base material layer 1 has a predetermined length (for example, 100 m or more), and laminated bodies of an adhesive layer 3 and a bonding adhesive layer 5 are disposed at a predetermined interval so as to line up in the longitudinal direction of the base material layer 1, may also be adopted.

[0026] (Adhesive layer)

The adhesive layer 3 has a first region 3a including at least a region R_w corresponding to a sticking position for a wafer W in the bonding adhesive layer 5; and a second region 3b located so as to surround the first region 3a. The broken lines in FIG. 1(a) and FIG. 1(b) indicate the boundary between the first region 3a and the second region

3b. The first region 3a and the second region 3b are formed from the same composition (active energy ray-curable adhesive) before irradiation with active energy rays. The first region 3a is a region in a state in which the adhesive force has been decreased as compared with the second region 3b, by irradiation with active energy rays. The second region 3b is a region in which a dicing ring DR can be stuck (see FIG. 2). The second region 3b is a region that has not been irradiated with active energy rays, and has high adhesive force with respect to the dicing ring DR. The active energy rays may be at least one selected from ultraviolet radiation, an electron beam, and visible light, and may be ultraviolet radiation. The amount of irradiation with active energy rays may be, for example, 10 to 1000 mJ/cm², 100 to 700 mJ/cm², or 200 to 500 mJ/cm². [0027] When the adhesive force of the first region 3a of the adhesive layer 3 with respect to the bonding adhesive layer 5 is designated as f1 (N/25 mm), and the adhesive force of the second region 3b of the adhesive layer 3 with respect to the bonding adhesive layer 5 is designated as f2 (N/25 mm), the difference between f2 and f1 (f2 - f1) is 6.5 to 9.0 N/25 mm, and may be 7.0 to 9.0 N/25 mm. Here, f1 and f2 are the 30° peel strength measured under the conditions of a peeling angle of 30° and a peeling speed of 60 mm/min at a temperature of 23°C. FIG. 3 is a cross-sectional view schematically illustrating a situation in which the 30° peel strength of the adhesive layer 3 is measured in a state in which the bonding adhesive layer 5 of a measurement sample (25 mm in width × 100 mm in length) is immobilized on a support plate 80. FIG. 3 may be a situation of measuring f1. The second region 3b of the adhesive layer 3 is a region in a state similar to the adhesive layer before

irradiation with active energy rays and can also be a region that is not irradiated with active energy rays. Therefore, f_2 may be measured by substituting the adhesive layer 3 in FIG. 3 with an adhesive layer 3 that does not have the first region 3a. Since the state of the adhesive layer 3 that does not have the first region 3a is a state before the adhesive layer is irradiated with active energy rays, f_2 can be determined by using a laminated body disposed on the surface of a base material layer 1, the laminated body including an adhesive layer formed from an active energy ray-curable adhesive and a bonding adhesive layer 5 formed on the surface of the adhesive layer, to measure the adhesive force of the adhesive layer (adhesive layer 3 that does not have the first region 3a) with respect to the bonding adhesive layer 5 before irradiation with active energy rays. By setting the ($f_2 - f_1$) to such a range, the edge peel strength can be reduced by suppressing the curing shrinkage of the adhesive layer, and therefore, the dicing die-bonding integrated film can be applied to a production process for a semiconductor device including a step of singularizing a wafer into a plurality of small chips (area 0.1 to 9 mm²), and excellent pickup properties from the adhesive layer 3 can be achieved. The ($f_2 - f_1$) may be 6.6 N/25 mm or more, 6.8 N/25 mm or more, 7.0 N/25 mm or more, or 7.2 N/25 mm or more, and may be 8.8 N/25 mm or less, 8.6 N/25 mm or less, 8.4 N/25 mm or less, or 8.2 N/25 mm or less.

[0028] As described above, the film 10 can be suitably used also for a production process for a semiconductor device including a step of singularizing a wafer into a plurality of small chips each having an area of 0.1 to 9 mm² (and a subsequent step of picking up). The present

inventors focused on the fact that the pickup behavior of a small chip having a size of $3\text{ mm} \times 3\text{ mm}$ or less (area 9 mm^2 or less) and the pickup behavior of, for example, a large chip having a size of about $8\text{ mm} \times 6\text{ mm}$ are different and conducted an investigation, and as a result, the difference ($f_2 - f_1$) between the adhesive force of the second region 3b of the adhesive layer 3 with respect to the bonding adhesive layer 5 and the adhesive force of the first region 3a of the adhesive layer 3 with respect to the bonding adhesive layer 5 was specified as 6.5 to 9.0 N/25 mm. The present inventors found in the past that in the case of small chips, edge peeling is a dominant factor for the pickup properties, and that the main cause of an increase in the edge peel strength is curing shrinkage, and the inventors further found that by setting the ($f_2 - f_1$) to 6.5 to 9.0 N/25 mm, curing shrinkage can be suppressed, and excellent pickup properties from the adhesive layer 3 can be achieved. As a result, it is possible to produce a semiconductor device with a sufficiently high product yield by using the film 10.

[0029] The adhesive force (f_1) of the first region 3a of the adhesive layer 3 with respect to the bonding adhesive layer 5 may be, for example, 1.1 to 4.5 N/25 mm or 1.1 to 3.0 N/25 mm. f_1 may be 1.2 N/25 mm or more, 1.5 N/25 mm or more, or 2.0 N/25 mm or more, and may be 4.0 N/25 mm or less, 3.7 N/25 mm or less, 3.5 N/25 mm or less, 3.2 N/25 mm or less, or 3.0 N/25 mm or less.

[0030] The first region 3a having adhesive force in the above-described range with respect to the bonding adhesive layer 5 is formed by irradiation with active energy rays and can be said to be an active energy ray-irradiated region. The present inventors also found that lowering

the adhesive force of the adhesive layer by irradiation with active energy rays affect the peeling of the edge portion of a DAF. That is, when the adhesive force of the first region 3a is excessively decreased by irradiation with active energy rays, the 30° peel strength of the first region 3a with respect to the bonding adhesive layer 5 is lowered, and when the object to be picked up is a small chip, there is a tendency that the edge portion of the DAF is not easily peeled off, so that the chip is excessively deformed and cracks or pickup failure is likely to occur. Regarding the lower limit of the adhesive force (for example, 1.1 N/25 mm) of the first region 3a with respect to the bonding adhesive layer 5, it can be said that the adhesive force before irradiation with active energy rays is not excessively reduced, and as a result, peeling of the edge portion of the DAF easily occurs even in a small chip. On the other hand, when the adhesive force of the first region 3a with respect to the bonding adhesive layer 5 is excessively high, the pickup properties tend to be lowered. Regarding the upper limit of the adhesive force (for example, 4.5 N/25 mm) of the first region 3a with respect to the bonding adhesive layer 5, it can be said that the adhesive force before irradiation with active energy rays has been decreased to the extent that excellent pickup properties are exhibited.

[0031] The adhesive force (f_2) of the second region 3b of the adhesive layer 3 with respect to the bonding adhesive layer 5 may be, for example, 8.0 to 11.5 N/25 mm. f_2 may be 8.5 N/25 mm or more, 9.0 N/25 mm or more, or 9.5 N/25 mm or more, and may be 11.0 N/25 mm or less, 10.8 N/25 mm or less, or 10.5 N/25 mm or less.

[0032] According to the present embodiment, for example, by adjusting

the content of the functional group capable of chain polymerization (content of a functional group-introducing compound) in the (meth)acrylic resin, the content of the crosslinking agent in the adhesive layer, and the amount of irradiation with active energy rays, or by adding, for example, a resin other than the (meth)acrylic resin (an acrylic monomer or oligomer, a urethane monomer or oligomer, or the like) or an adhesiveness imparting agent (a tackifier or the like), f1, f2, and (f2 - f1) can be adjusted.

[0033] The adhesive force of the second region 3b of the adhesive layer 3 with respect to a stainless steel substrate may be 0.2 N/25 mm or more. This adhesive force is the 90° peel strength measured under the conditions of a peeling angle of 90° and a peeling speed of 50 mm/min at a temperature of 23°C. When this adhesive force is 0.2 N/25 mm or more, the ring peeling at the time of dicing can be sufficiently suppressed.

The adhesive force of the second region 3b of the adhesive layer 3 with respect to a stainless steel substrate may be 0.25 N/25 mm or more or 0.3 N/25 mm or more, and may be 2.0 N/25 mm or less, 1.0 N/25 mm or less, 0.8 N/25 mm or less, or 0.6 N/25 mm or less.

[0034] The adhesive layer before irradiation with active energy rays is formed from, for example, an active energy ray-curable adhesive including a (meth)acrylic resin, a photopolymerization initiator, and a crosslinking agent. The second region 3b that is not irradiated with active energy rays can have the same composition as that of the adhesive layer before irradiation with active energy rays. In the following description, the components contained in the active energy ray-curable adhesive will be described in detail.

[0035] [(Meth)acrylic resin]

The active energy ray-curable adhesive may include a (meth)acrylic resin having a functional group capable of chain polymerization. When such a (meth)acrylic resin is included, the functional group may be at least one selected from an acryloyl group and a methacryloyl group. The content of the functional group in the (meth)acrylic resin may be 0.1 to 1.2 mmol/g. The content of the functional group in the (meth)acrylic resin may be 0.2 mmol/g or more or 0.3 mmol/g or more, and may be 1.0 mmol/g or less, 0.8 mmol/g or less, 0.7 mmol/g or less, 0.6 mmol/g or less, or 0.5 mmol/g or less. When the content of the functional group is 0.1 mmol/g or more, there is a tendency that a region in which the adhesive force has been appropriately decreased by irradiation with active energy rays (first region 3a) is easily formed, and on the other hand, when the content of the functional group is 1.2 mmol/g or less, there is a tendency that excellent pickup properties are easily achieved.

[0036] The (meth)acrylic resin can be obtained by synthesizing the resin by a known method. Examples of the synthesis method include a solution polymerization method, a suspension polymerization method, an emulsion polymerization method, a bulk polymerization method, a precipitation polymerization method, a gas phase polymerization method, a plasma polymerization method, and a supercritical polymerization method. Furthermore, examples of the type of the polymerization reaction include radical polymerization, cationic polymerization, anionic polymerization, living radical polymerization, living cationic polymerization, living anionic polymerization, coordination

polymerization, and immortal polymerization, as well as techniques such as ATRP (atom transfer radical polymerization) and RAFT (reversible addition-fragmentation chain-transfer polymerization). Among these, synthesizing the resin by radical polymerization using a solution polymerization method has advantages such as high economic efficiency, high reaction rate, and easy polymerization control, as well as an advantage that a resin solution obtained by polymerization can be used and blended in as it is.

[0037] Here, a synthesis method for a (meth)acrylic resin will be described in detail by taking a method for obtaining a (meth)acrylic resin by radical polymerization using a solution polymerization method as an example.

[0038] The monomer used when synthesizing the (meth)acrylic resin is not particularly limited as long as it has one (meth)acryloyl group in one molecule. Specific examples thereof include aliphatic (meth)acrylates such as methyl (meth)acrylate, ethyl (meth)acrylate, butyl (meth)acrylate, isobutyl (meth)acrylate, tert-butyl (meth)acrylate, butoxyethyl (meth)acrylate, isoamyl (meth)acrylate, hexyl (meth)acrylate, 2-ethylhexyl (meth)acrylate, heptyl (meth)acrylate, octyl heptyl (meth)acrylate, nonyl (meth)acrylate, decyl (meth)acrylate, undecyl (meth)acrylate, lauryl (meth)acrylate, tridecyl (meth)acrylate, tetradecyl (meth)acrylate, pentadecyl (meth)acrylate, hexadecyl (meth)acrylate, stearyl (meth)acrylate, behenyl (meth)acrylate, methoxy polyethylene glycol (meth)acrylate, ethoxy polyethylene glycol (meth)acrylate, methoxy polypropylene glycol (meth)acrylate, ethoxy polypropylene glycol (meth)acrylate, and mono(2-(meth)acryloyloxyethyl) succinate;

alicyclic (meth)acrylates such as cyclopentyl (meth)acrylate, cyclohexyl
 (meth)acrylate, cyclopentyl (meth)acrylate, dicyclopentany
 (meth)acrylate, dicyclopentenyl (meth)acrylate, isobornyl
 (meth)acrylate, mono(2-(meth)acryloyloxyethyl) tetrahydrophthalate,
 5 and mono(2-(meth)acryloyloxyethyl) hexahydrophthalate; aromatic
 (meth)acrylates such as benzyl (meth)acrylate, phenyl (meth)acrylate, o-
 biphenyl (meth)acrylate, 1-naphthyl (meth)acrylate, 2-naphthyl
 (meth)acrylate, phenoxyethyl (meth)acrylate, p-cumyl phenoxyethyl
 (meth)acrylate, o-phenyl phenoxyethyl (meth)acrylate, 1-naphthoxyethyl
 10 (meth)acrylate, 2-naphthoxyethyl (meth)acrylate, phenoxy polyethylene
 glycol (meth)acrylate, nonylphenoxy polyethylene glycol (meth)acrylate,
 phenoxy polypropylene glycol (meth)acrylate, 2-hydroxy-3-
 phenoxypropyl (meth)acrylate, 2-hydroxy-3-(o-phenylphenoxy)propyl
 (meth)acrylate, 2-hydroxy-3-(1-naphthoxy)propyl (meth)acrylate, and 2-
 15 hydroxy-3-(2-naphthoxy)propyl (meth)acrylate; heterocyclic
 (meth)acrylates such as 2-tetrahydrofurfuryl (meth)acrylate, N-
 (meth)acryloyloxyethyl hexahydrophthalimide, and 2-
 (meth)acryloyloxyethyl N-carbazole; compounds having an ethylenically
 unsaturated group and an epoxy group, such as caprolactone modification
 20 products of these, ω -carboxypolycaprolactone mono(meth)acrylate,
 glycidyl (meth)acrylate, α -ethyl glycidyl (meth)acrylate, α -propyl
 glycidyl (meth)acrylate, α -butyl glycidyl (meth)acrylate, 2-methyl
 glycidyl (meth)acrylate, 2-ethyl glycidyl (meth)acrylate, 2-propyl
 glycidyl (meth)acrylate, 3,4-epoxybutyl (meth)acrylate, 3,4-epoxyheptyl
 25 (meth)acrylate, α -ethyl-6,7-epoxyheptyl (meth)acrylate, 3,4-
 epoxycyclohexyl methyl (meth)acrylate, o-vinylbenzyl glycidyl ether, m-

vinylbenzyl glycidyl ether, and p-vinylbenzyl glycidyl ether; compounds having an ethylenically unsaturated group and an oxetanyl group, such as (2-ethyl-2-oxetanyl)methyl (meth)acrylate, (2-methyl-2-oxetanyl)methyl (meth)acrylate, 2-(2-ethyl-2-oxetanyl)ethyl (meth)acrylate, 2-(2-methyl-2-oxetanyl)ethyl (meth)acrylate, 3-(2-ethyl-2-oxetanyl)propyl (meth)acrylate, and 3-(2-methyl-2-oxetanyl)propyl (meth)acrylate; compounds having an ethylenically unsaturated group and an isocyanate group, such as 2-(meth)acryloyloxyethyl isocyanate; and compounds having an ethylenically unsaturated group and a hydroxyl group, such as 2-hydroxyethyl (meth)acrylate, 2-hydroxypropyl (meth)acrylate, 4-hydroxybutyl (meth)acrylate, 3-chloro-2-hydroxypropyl (meth)acrylate, and 2-hydroxybutyl (meth)acrylate. Intended (meth)acrylic resins can be obtained by appropriately combining these.

[0039] The (meth)acrylic resin may have at least one functional group selected from a hydroxyl group, a glycidyl group (epoxy group), an amino group, and the like as a reaction point with a functional group-introducing compound that will be described below or a crosslinking agent. Examples of a monomer for synthesizing a (meth)acrylic resin having a hydroxyl group include compounds having an ethylenically unsaturated group and a hydroxyl group, such as 2-hydroxyethyl (meth)acrylate, 2-hydroxypropyl (meth)acrylate, 4-hydroxybutyl (meth)acrylate, 3-chloro-2-hydroxypropyl (meth)acrylate, and 2-hydroxybutyl (meth)acrylate. These may be used singly or in combination of two or more kinds thereof.

[0040] Examples of a monomer for synthesizing a (meth)acrylic resin having a glycidyl group include compounds having an ethylenically

unsaturated group and an epoxy group, such as glycidyl (meth)acrylate, α -ethyl glycidyl (meth)acrylate, α -propyl glycidyl (meth)acrylate, α -butyl glycidyl (meth)acrylate, 2-methyl glycidyl (meth)acrylate, 2-ethyl glycidyl (meth)acrylate, 2-propyl glycidyl (meth)acrylate, 3,4-epoxybutyl (meth)acrylate, 3,4-epoxyheptyl (meth)acrylate, α -ethyl-6,7-epoxyheptyl (meth)acrylate, 3,4-epoxycyclohexyl methyl (meth)acrylate, o-vinylbenzyl glycidyl ether, m-vinylbenzyl glycidyl ether, and p-vinylbenzyl glycidyl ether. These may be used singly or in combination of two or more kinds thereof.

[0041] A (meth)acrylic resin synthesized from these monomers includes a functional group capable of chain polymerization. The functional group capable of chain polymerization is, for example, at least one selected from an acryloyl group and a methacryloyl group. The functional group capable of chain polymerization can be introduced into, for example, a (meth)acrylic resin having at least one functional group selected from a hydroxyl group, a glycidyl group (epoxy group), an amino group, and the like as synthesized as described above, by reacting this (meth)acrylic resin with the following compound (functional group-introducing compound). Specific examples of the functional group-introducing compound include 2-methacryloyloxyethyl isocyanate, meta-isopropenyl- α,α -dimethylbenzyl isocyanate, methacryloyl isocyanate, allyl isocyanate, 1,1-(bisacryloyloxymethyl)ethyl isocyanate; an acryloyl monoisocyanate compound obtainable by a reaction between a diisocyanate compound or a polyisocyanate compound and hydroxyethyl (meth)acrylate or 4-hydroxybutylethyl (meth)acrylate; and an acryloyl monoisocyanate compound obtainable by a reaction between

a diisocyanate compound or a polyisocyanate compound, a polyol compound, and hydroxyethyl (meth)acrylate. These may be used singly or in combination of two or more kinds thereof. Among these, the functional group-introducing compound may be 2-methacryloyloxyethyl isocyanate.

[0042] [Photopolymerization initiator]

The photopolymerization initiator is not particularly limited as long as it generates an active species capable of chain polymerization when irradiated with active energy rays. The active energy rays may be at least one selected from ultraviolet radiation, electron beam, and visible light and may be ultraviolet radiation. Examples of the photopolymerization initiator include a photoradical polymerization initiator. Here, the active species capable of chain polymerization means a species that initiates a polymerization reaction by reacting with a functional group capable of chain polymerization.

[0043] Examples of the photoradical polymerization initiator include benzoin ketals such as 2,2-dimethoxy-1,2-diphenylethan-1-one; α -hydroxyketones such as 1-hydroxycyclohexyl phenyl ketone, 2-hydroxy-2-methyl-1-phenylpropan-1-one, and 1-[4-(2-hydroxyethoxy)phenyl]-2-hydroxy-2-methyl-1-propan-1-one; α -aminoketones such as 2-benzyl-2-dimethylamino-1-(4-morpholinophenyl)-butan-1-one and 1,2-methyl-1-[4-(methylthio)phenyl]-2-morpholinopropan-1-one; oxime esters such as 1-[4-(phenylthiol)phenyl]-1,2-octadione-2-(benzoyl)oxime; phosphine oxides such as bis(2,4,6-trimethylbenzoyl)phenylphosphine oxide, bis(2,6-dimethoxybenzoyl)-2,4,4-trimethylpentylphosphine oxide, and 2,4,6-trimethylbenzoyldiphenylphosphine oxide; 2,4,5-triarylimidazole

dimers such as a 2-(o-chlorophenyl)-4,5-diphenylimidazole dimer, a 2-(o-chlorophenyl)-4,5-di(methoxyphenyl)imidazole dimer, a 2-(o-fluorophenyl)-4,5-diphenylimidazole dimer, a 2-(o-methoxyphenyl)-4,5-diphenylimidazole dimer, and a 2-(p-methoxyphenyl)-4,5-diphenylimidazole dimer; benzophenone compounds such as benzophenone, N,N,N',N'-tetramethyl-4,4'-diaminobenzophenone, N,N,N',N'-tetraethyl-4,4'-diaminobenzophenone, and 4-methoxy-4'-dimethylaminobenzophenone; quinone compounds such as 2-ethylanthraquinone, phenanthrenequinone, 2-tert-butylanthraquinone, octamethylanthraquinone, 1,2-benzanthraquinone, 2,3-benzanthraquinone, 2-phenylanthraquinone, 2,3-diphenylanthraquinone, 1-chloroanthraquinone, 2-methylanthraquinone, 1,4-naphthoquinone, 9,10-phenanthraquinone, 2-methyl-1,4-naphthoquinone, and 2,3-dimethylanthraquinone; benzoin ethers such as benzoin methyl ether, benzoin ethyl ether, and benzoin phenyl ether; benzoin compounds such as benzoin, methylbenzoin, and ethylbenzoin; benzyl compounds such as benzyl dimethyl ketal; acridine compounds such as 9-phenylacridine and 1,7-bis(9,9'-acridinyl)heptane; N-phenylglycine, and coumarin.

[0044] The content of the photopolymerization initiator in the active energy ray-curable adhesive may be 0.1 to 30 parts by mass, 0.3 to 10 parts by mass, or 0.5 to 5 parts by mass, with respect to 100 parts by mass of the content of the (meth)acrylic resin. When the content of the photopolymerization initiator is 0.1 parts by mass or more, the adhesive layer is sufficiently cured after being irradiated with active energy rays, and there is a tendency that pickup failure does not easily occur. When the content of the photopolymerization initiator is 30 parts by mass or

less, there is a tendency that contamination of the bonding adhesive layer (transfer of the photopolymerization initiator to the bonding adhesive layer) can be prevented.

[0045] [Crosslinking agent]

5 The crosslinking agent is used for the purpose of, for example, controlling the elastic modulus and/or adhesiveness of the adhesive layer. The crosslinking agent may be a compound having, in one molecule, two or more units of a functional group capable of reacting with at least one functional group selected from a hydroxyl group, a glycidyl group, an
10 amino group, and the like carried by the (meth)acrylic resin. Examples of the bond formed by a reaction between the crosslinking agent and the (meth)acrylic resin include an ester bond, an ether bond, an amide bond, an imide bond, a urethane bond, and a urea bond.

[0046] According to the present embodiment, the crosslinking agent may
15 be, for example, a polyfunctional isocyanate having two or more isocyanate groups in one molecule. When such a polyfunctional isocyanate is used, the compound easily reacts with a hydroxyl group, a glycidyl group, an amino group, and the like carried by the (meth)acrylic resin and can form a strong crosslinked structure.

20 [0047] Examples of the polyfunctional isocyanate having two or more isocyanate groups in one molecule include isocyanate compounds such as 2,4-tolylene diisocyanate, 2,6-tolylene diisocyanate, 1,3-xylylene diisocyanate, 1,4-xylene diisocyanate, diphenylmethane-4,4'-diisocyanate, diphenylmethane-2,4'-diisocyanate, 3-
25 methyldiphenylmethane diisocyanate, hexamethylene diisocyanate, isophorone diisocyanate, dicyclohexylmethane-4,4'-diisocyanate,

dicyclohexylmethane-2,4'-diisocyanate, and lysine isocyanate.

[0048] The crosslinking agent may be a reaction product (isocyanate group-containing oligomer) between a polyfunctional isocyanate and a polyhydric alcohol having two or more hydroxy groups in one molecule.

5 Examples of the polyhydric alcohol having two or more hydroxy groups in one molecule include ethylene glycol, propylene glycol, butylene glycol, 1,6-hexanediol, 1,8-octanediol, 1,9-nonanediol, 1,10-decanediol, 1,11-undecanediol, 1,12-dodecanediol, glycerin, trimethylolpropane, pentaerythritol, dipentaerythritol, 1,4-cyclohexanediol, and 1,3-
10 cyclohexanediol.

[0049] Among these, the crosslinking agent may be a reaction product (isocyanate group-containing oligomer) between a polyfunctional isocyanate having two or more isocyanate groups in one molecule and a polyhydric alcohol having three or more hydroxy groups in one molecule.

15 By using such an isocyanate group-containing oligomer as the crosslinking agent, the adhesive layer 3 forms a compact crosslinked structure, and as a result, there is a tendency that the adhesive adhering to the bonding adhesive layer 5 in the pickup step can be sufficiently suppressed.

20 [0050] The content of the crosslinking agent in the active energy ray-curable adhesive can be appropriately set according to the cohesive force, the elongation percentage at break, the bonding adhesiveness to the bonding adhesive layer, and the like required of the adhesive layer. Specifically, the content of the crosslinking agent may be, for example, 3
25 to 30 parts by mass, 4 to 15 parts by mass, and 7 to 10 parts by mass, with respect to 100 parts by mass of the content of the (meth)acrylic resin.

By setting the content of the crosslinking agent to the above-described range, both the characteristics required from the adhesive layer in the dicing step and the characteristics required from the adhesive layer in the die-bonding step can be achieved in a well-balanced manner, and excellent pickup properties can also be achieved.

[0051] When the content of the crosslinking agent is 3 parts by mass or more with respect to 100 parts by mass of the content of the (meth)acrylic resin, formation of a crosslinked structure is less likely to be insufficient, and in the pickup step, there is a tendency that the interface adhesive force to the bonding adhesive layer is sufficiently decreased while failure is less likely to occur at the time of picking up. On the other hand, when the content of the crosslinking agent is 30 parts by mass or less with respect to 100 parts by mass of the content of the (meth)acrylic resin, the adhesive layer is less likely to become excessively hard, and there is a tendency that chips are not easily peeled off in the expansion step.

[0052] The content of the crosslinking agent with respect to the total mass of the active energy ray-curable adhesive may be, for example, 0.1% to 15% by mass, 3% to 15% by mass, or 5% to 15% by mass. When the content of the crosslinking agent is 0.1% by mass or more, a region in which the adhesive force has been appropriately decreased (first region 3a) by irradiation with active energy rays is likely to be formed, and when the content is 15% by mass or less, excellent pickup properties tend to be easily achieved.

[0053] The thickness of the adhesive layer 3 may be appropriately set according to the conditions (temperature, tensile force, and the like) of the expansion step, and for example, the thickness may be 1 to 200 μm ,

5 to 50 μm , or 10 to 20 μm . When the thickness of the adhesive layer 3 is 1 μm or more, adhesiveness is less likely to be insufficient, and when the thickness is 200 μm or less, the kerf width becomes wide at the time of expanding (stress is not relieved when the pin is pushed up), while there is a tendency that picking up is less likely to be insufficiently achieved.

[0054] The adhesive layer 3 is formed on the base material layer 1. Regarding the method for forming the adhesive layer 3, a known technique can be employed. For example, a laminated body of the base material layer 1 and the adhesive layer 3 may be formed by a two-layer extrusion method; a varnish of an active energy ray-curable adhesive (varnish for forming an adhesive layer) may be prepared, and this varnish may be applied on the surface of the base material layer 1; or the adhesive layer 3 may be formed on a release-treated film, and this may be transferred onto the base material layer 1.

[0055] The varnish of the active energy ray-curable adhesive (varnish for forming an adhesive layer) may be an organic solvent that can dissolve the (meth)acrylic resin, the photopolymerization initiator, and the crosslinking agent and is volatilized by heating. Specific examples of the organic solvent include aromatic hydrocarbons such as toluene, xylene, mesitylene, cumene, and p-cymene; cyclic ethers such as tetrahydrofuran and 1,4-dioxane; alcohols such as methanol, ethanol, isopropanol, butanol, ethylene glycol, and propylene glycol; ketones such as acetone, methyl ethyl ketone, methyl isobutyl ketone, cyclohexanone, and 4-hydroxy-4-methyl-2-pentanone; esters such as methyl acetate, ethyl acetate, butyl acetate, methyl lactate, ethyl lactate, and γ -

butyrolactone; carbonic acid esters such as ethylene carbonate and propylene carbonate; polyhydric alcohol alkyl ethers such as ethylene glycol monomethyl ether, ethylene glycol monoethyl ether, ethylene glycol monobutyl ether, ethylene glycol dimethyl ether, ethylene glycol diethyl ether, propylene glycol monomethyl ether, propylene glycol monoethyl ether, propylene glycol dimethyl ether, propylene glycol diethyl ether, diethylene glycol monomethyl ether, diethylene glycol monoethyl ether, diethylene glycol monobutyl ether, diethylene glycol dimethyl ether, and diethylene glycol diethyl ether; polyhydric alcohol alkyl ether acetates such as ethylene glycol monomethyl ether acetate, ethylene glycol monoethyl ether acetate, ethylene glycol monobutyl ether acetate, propylene glycol monomethyl ether acetate, propylene glycol monoethyl ether acetate, diethylene glycol monomethyl ether acetate, and diethylene glycol monoethyl ether acetate; and amides such as N,N-dimethylformamide, N,N-dimethylacetamide, and N-methyl-2-pyrrolidone. Regarding these organic solvents, one kind thereof may be used alone, or two or more kinds thereof may be used in combination.

[0056] Among these, from the viewpoints of solubility and the boiling point, the organic solvent may be at least one selected from the group consisting of toluene, methanol, ethanol, isopropanol, acetone, methyl ethyl ketone, methyl isobutyl ketone, cyclohexanone, methyl acetate, ethyl acetate, butyl acetate, ethylene glycol monomethyl ether, ethylene glycol monoethyl ether, propylene glycol monomethyl ether, propylene glycol monoethyl ether, diethylene glycol dimethyl ether, ethylene glycol monomethyl ether acetate, propylene glycol monomethyl ether acetate, and N,N-dimethylacetamide. The solid content concentration of the

varnish is usually 10% to 60% by mass.

[0057] (Base material layer)

Regarding the base material layer 1, a known polymer sheet or film can be used, and the base material layer 1 is not particularly limited as long as it can be subjected to the expansion step under low temperature conditions. Specific examples of the base material layer 1 include polyolefins such as crystalline polypropylene, amorphous polypropylene, high-density polyethylene, medium-density polyethylene, low-density polyethylene, ultralow-density polyethylene, low-density linear polyethylene, polybutene, and polymethylpentene; an ethylene-vinyl acetate copolymer, an ionomer resin, an ethylene-(meth)acrylic acid copolymer, an ethylene-(meth)acrylic acid ester (random, alternating) copolymer, an ethylene-butene copolymer, an ethylene-hexene copolymer, polyurethane; polyesters such as polyethylene terephthalate and polyethylene naphthalate; polycarbonate, polyimide, polyether ether ketone, polyimide, polyetherimide, polyamide, total aromatic polyamide, polyphenyl sulfide, aramid (paper), glass, glass cloth, a fluororesin, polyvinyl chloride, polyvinylidene chloride, a cellulose-based resin, a silicone resin, a mixture obtained by mixing a plasticizer with these, or a cured product that has been crosslinked by irradiation with an electron beam.

[0058] The base material layer 1 may be a base material layer having a surface that includes at least one resin selected from the group consisting of polyethylene, polypropylene, a polyethylene-polypropylene random copolymer, and a polyethylene-polypropylene block copolymer as a main component, this surface being in contact with the adhesive layer 3.

These resins can be satisfactory base materials even from the viewpoints of the characteristics such as Young's modulus, stress relaxation properties, and melting point, as well as the price, waste material recycling after use, and the like. The base material layer 1 may be a single layer and may also have a multilayer structure in which layers formed from different materials are laminated, as necessary. From the viewpoint of controlling the bonding adhesiveness to the adhesive layer 3, the surface of the base material layer 1 may be subjected to a surface roughening treatment such as a mattifying treatment or a corona treatment.

[0059] (Bonding adhesive layer)

To the bonding adhesive layer 5, a bonding adhesive composition that constitutes a known die-bonding film can be applied. Specifically, the bonding adhesive composition constituting the bonding adhesive layer 5 may include a reactive group-containing (meth)acrylic copolymer, a curing accelerator, and a filler. According to a bonding adhesive layer 5 including these components, there is a tendency of having features such as that the bonding adhesiveness between the chip and the substrate and between a chip and another chip is excellent, electrode embedding properties, wire embedding properties, and the like can also be imparted, adhesion can be achieved at a low temperature in the die-bonding step, excellent curing can be attained in a short period of time, and excellent reliability is exhibited after molding with an encapsulating agent.

[0060] The reactive group-containing (meth)acrylic copolymer may be, for example, an epoxy group-containing (meth)acrylic copolymer. The epoxy group-containing (meth)acrylic copolymer may be a copolymer

obtainable by using glycidyl (meth)acrylate as a raw material in an amount of 0.5% to 6% by mass with respect to the obtainable copolymer. When the content of glycidyl (meth)acrylate is 0.5% by mass or more, high adhesive force is easily obtained, and when the content is 6% by mass or less, there is a tendency that gelation can be suppressed. The monomer constituting the remaining portion of the reactive group-containing (meth)acrylic copolymer may be, for example, an alkyl (meth)acrylate having an alkyl group with 1 to 8 carbon atoms, such as methyl (meth)acrylate, styrene, acrylonitrile, or the like. Among these, the monomer constituting the remaining portion of the reactive group-containing (meth)acrylic copolymer may be ethyl (meth)acrylate and/or butyl (meth)acrylate. The mixing ratio can be adjusted in consideration of the T_g of the reactive group-containing (meth)acrylic copolymer. When T_g is -10°C or higher, there is a tendency that the tackiness of the bonding adhesive layer 5 in a B stage state can be suppressed from being excessively high, and there is a tendency that excellent handleability is obtained. Incidentally, the glass transition point (T_g) of the epoxy group-containing (meth)acrylic copolymer may be, for example, 30°C or lower. The polymerization method is not particularly limited; however, examples include pearl polymerization and solution polymerization. Examples of a commercially available epoxy group-containing (meth)acrylic copolymer include HTR-860P-3 (trade name, manufactured by Nagase ChemteX Corp.).

[0061] The weight average molecular weight of the epoxy group-containing (meth)acrylic copolymer may be 100000 from the viewpoints of adhesiveness and heat resistance, and may be 300000 to 3000000, or

500000 to 2000000. When the weight average molecular weight is 3000000 or less, deterioration of the fillability between the chip and the substrate supporting this chip can be suppressed. The weight average molecular weight is a polystyrene-equivalent value obtained by gel permeation chromatography method (GPC) using a calibration curve based on polystyrene standards.

[0062] The curing accelerator may be, for example, a tertiary amine, an imidazole, or a quaternary ammonium salt. Specific examples of the curing accelerator include 2-methylimidazole, 2-ethyl-4-methylimidazole, 1-cyanoethyl-2-phenylimidazole, and 1-cyanoethyl-2-phenylimidazolium trimellitate. These may be used singly, or two or more kinds thereof may be used in combination.

[0063] The filler may be an inorganic filler. Specific examples of the inorganic filler include aluminum hydroxide, magnesium hydroxide, calcium carbonate, magnesium carbonate, calcium silicate, magnesium silicate, calcium oxide, magnesium oxide, aluminum oxide, aluminum nitride, aluminum borate whiskers, boron nitride, crystalline silica, and amorphous silica. These may be used singly, or two or more kinds thereof may be used in combination.

[0064] The bonding adhesive composition may further include an epoxy resin and an epoxy resin curing agent. Examples of the epoxy resin include a bisphenol A type epoxy resin, a bisphenol F type epoxy resin, a bisphenol S type epoxy resin, an alicyclic epoxy resin, an aliphatic chain-like epoxy resin, a phenol novolac type epoxy resin, a cresol novolac type epoxy resin, a bisphenol A novolac type epoxy resin, diglycidyl etherified product of biphenol, diglycidyl etherified product of naphthalenediol,

diglycidyl etherified product of a phenol, diglycidyl etherified product of an alcohol; bifunctional epoxy resins such as alkyl-substituted products, halides, and hydrogenation products of the above-described compounds; and novolac type epoxy resins. Furthermore, other epoxy resins that are generally known, such as a polyfunctional epoxy resin and a heterocyclic ring-containing epoxy resin, may also be applied. These can be used singly or in combination of two or more kinds thereof. Incidentally, components other than epoxy resins may also be included as impurities, to the extent that does not impair the characteristics.

[0065] Regarding the epoxy resin curing agent, for example, a phenol resin obtainable by reacting a phenol compound and a xylylene compound, which is a divalent linking group, without catalyst or in the presence of an acid catalyst may be mentioned. Examples of the phenol compound that is used for the production of a phenol resin include phenol, o-cresol, m-cresol, p-cresol, o-ethylphenol, p-ethylphenol, o-n-propylphenol, m-n-propylphenol, p-n-propylphenol, o-isopropylphenol, m-isopropylphenol, p-isopropylphenol, o-n-butylphenol, m-n-butylphenol, p-n-butylphenol, o-isobutylphenol, m-isobutylphenol, p-isobutylphenol, octylphenol, nonylphenol, 2,4-xylenol, 2,6-xylenol, 3,5-xylenol, 2,4,6-trimethylphenol, resorcin, catechol, hydroquinone, 4-methoxyphenol, o-phenylphenol, m-phenylphenol, p-phenylphenol, p-cyclohexylphenol, o-allylphenol, p-allylphenol, o-benzylphenol, p-benzylphenol, o-chlorophenol, p-chlorophenol, o-bromophenol, p-bromophenol, o-iodophenol, p-iodophenol, o-fluorophenol, m-fluorophenol, and p-fluorophenol. These phenol compounds may be used singly, or two or more kinds thereof may be used as mixtures.

Regarding the xylylene compound, which is a divalent linking group used for the production of the phenol resin, xylylene dihalide, xylylene diglycol, and derivatives thereof as shown below can be used. That is, specific examples of the xylylene compound include α,α' -dichloro-p-xylene, α,α' -dichloro-m-xylene, α,α' -dichloro-o-xylene, α,α' -dibromo-p-xylene, α,α' -dibromo-m-xylene, α,α' -dibromo-o-xylene, α,α' -diiodo-p-xylene, α,α' -diiodo-m-xylene, α,α' -diiodo-o-xylene, α,α' -dihydroxy-p-xylene, α,α' -dihydroxy-m-xylene, α,α' -dihydroxy-o-xylene, α,α' -dimethoxy-p-xylene, α,α' -dimethoxy-m-xylene, α,α' -dimethoxy-o-xylene, α,α' -diethoxy-p-xylene, α,α' -diethoxy-m-xylene, α,α' -diethoxy-o-xylene, α,α' -di-n-propoxy-p-xylene, α,α' -di-n-propoxy-m-xylene, α,α' -di-n-propoxy-o-xylene, α,α' -diisopropoxy-p-xylene, α,α' -diisopropoxy-m-xylene, α,α' -diisopropoxy-o-xylene, α,α' -di-n-butoxy-p-xylene, α,α' -di-n-butoxy-m-xylene, α,α' -di-n-butoxy-o-xylene, α,α' -diisobutoxy-p-xylene, α,α' -diisobutoxy-m-xylene, α,α' -diisobutoxy-o-xylene, α,α' -di-tert-butoxy-p-xylene, α,α' -di-tert-butoxy-m-xylene, and α,α' -di-tert-butoxy-o-xylene. These may be used singly or in combination of two or more kinds thereof.

[0066] When a phenol compound and a xylylene compound are caused to react, a phenol resin is obtained by causing the compounds to react using acidic catalysts, such as mineral acids such as hydrochloric acid, sulfuric acid, phosphoric acid, and polyphosphoric acid; organic carboxylic acids such as dimethylsulfuric acid, diethylsulfuric acid, p-toluenesulfonic acid, methanesulfonic acid, and ethanesulfonic acid; super strong acids such as trifluoromethanesulfonic acid; strongly acidic ion exchange resins such as an alkanesulfonic acid type ion exchange

resin; super strong acid ion exchange resins such as a perfluoroalkanesulfonic acid type ion exchange resin (trade name: NAFION, Nafion, manufactured by Du Pont, Inc., "NAFION" is a registered trademark); natural and synthetic zeolites; and activated white clay (acidic white clay), until the xylylene compound as a raw material substantially disappears at 50°C to 250°C and the reaction composition becomes constant. The reaction time can be appropriately set according to the raw materials and can be set to, for example, about 1 hour to 15 hours, and the reaction time can be determined while tracking the reaction composition by GPC (gel permeation chromatography) or the like.

[0067] The thickness of the bonding adhesive layer 5 may be, for example, 1 to 300 μm , 5 to 150 μm , or 10 to 100 μm . When the thickness of the bonding adhesive layer 5 is 1 μm or more, the bonding adhesiveness tends to be superior, and when the thickness is 300 μm or less, the dividability at the time of expansion and the pickup properties tend to be superior.

[0068] <Method for producing dicing die-bonding integrated film>

A method for producing the film 10 includes, in the following order, a step of producing, on the surface of a base material layer 1, a laminated body including an adhesive layer formed from an active energy ray-curable adhesive whose adhesive force is decreased by irradiation with active energy rays, and a bonding adhesive layer 5 formed on the surface of the adhesive layer; and a step of irradiating a region that constitutes the first region 3a of the adhesive layer included in the laminated body with active energy rays. The amount of irradiation with active energy rays for the region that constitutes the first region 3a may

be, for example, 10 to 1000 mJ/cm², 100 to 700 mJ/cm², or 200 to 500 mJ/cm². This production method is a method of first producing a laminated body of an adhesive layer and a bonding adhesive layer 5 and then irradiating a particular region of the adhesive layer with active energy rays.

[0069] <Semiconductor device and method for producing the same>

FIG. 4 is a cross-sectional view schematically illustrating a semiconductor device according to the present embodiment. The semiconductor device 100 shown in this diagram includes a substrate 70; four chips S1, S2, S3, and S4 laminated on the surface of the substrate 70; wires W1, W2, W3, and W4 electrically connecting electrodes (not shown in the diagram) and the four chips S1, S2, S3, and S4 on the surface of the substrate 70; and an encapsulation layer 50 encapsulating these.

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

[0071] The four chips S1, S2, S3, and S4 are laminated with a cured product 5C of a bonding adhesive piece 5P interposed therebetween.

The shape of the chips S1, S2, S3, and S4 in a plan view is, for example, a square shape or a rectangular shape. The area of the chips S1, S2, S3, and S4 is 0.1 to 9 mm² and may be 0.1 to 4 mm² or 0.1 to 2 mm². The length of one side of the chips S1, S2, S3, and S4 may be, for example, 0.1 to 3 mm, 0.1 to 2 mm, or 0.1 to 1 mm. The thickness of the chips S1, S2, S3, and S4 may be, for example, 10 to 170 μm or 25 to 100 μm. Incidentally, the lengths of one side of the four chips S1, S2, S3, and S4

may be the same or may be different from each other, and the same also applies to the thickness.

[0072] A method for producing the semiconductor device 100 includes a step of preparing the above-mentioned film 10; a step of sticking a wafer W to the bonding adhesive layer 5 of the film 10 and sticking a dicing ring DR to the second surface F2 of the adhesive layer 3; a step of singularizing the wafer W into a plurality of chips S (dicing step); a step of picking up a DAF 8 (laminated body of a chip S1 and a bonding adhesive piece 5P, see FIG. 5(d)) from the first region 3a of the adhesive layer 3; and a step of mounting the chip S1 on the substrate 70, with the bonding adhesive piece 5P interposed therebetween.

[0073] An example of the method for producing the DAF 8 will be described with reference to FIG. 5(a), FIG. 5(b), FIG. 5(c), and FIG. 5(d). First, the above-mentioned film 10 is prepared. As shown in FIG. 5(a) and FIG. 5(b), the film 10 is stuck such that the bonding adhesive layer 5 comes into contact with one surface of the wafer W. Furthermore, a dicing ring DR is stuck to the second surface F2 of the adhesive layer 3.

[0074] The wafer W, the bonding adhesive layer 5, and the adhesive layer 3 are diced. As a result, as shown in FIG. 5(c), the wafer W is singularized to obtain chips S. The bonding adhesive layer 5 is also singularized to obtain adhesive pieces 5P. Regarding the dicing method, a method of using a dicing blade or a laser may be mentioned. Incidentally, prior to the dicing of the wafer W, the wafer W may be made into a thin film by grinding.

[0075] After dicing, while the chips S are separated apart from each other by expanding the base material layer 1 at normal temperature or under

cooling conditions as shown in FIG. 5(d) without irradiating the adhesive layer 3 with active energy rays, the bonding adhesive pieces 5P are peeled off from the adhesive layer 3 by pushing up with a pin 42, and the DAF8 is suctioned and picked up using a suction collet 44.

5 [0076] The method for producing the semiconductor device 100 will be specifically described with reference to FIG. 6, FIG. 7, and FIG. 8. First, as shown in FIG. 6, a first-stage chip S1 (chip S) is pressure-bonded at a predetermined position of the substrate 70, with the bonding adhesive piece 5P interposed therebetween. Next, the bonding adhesive piece 5P
10 is cured by heating. As a result, the bonding adhesive piece 5P is cured to form a cured product 5C. The curing treatment of the bonding adhesive piece 5P may be carried out in a pressurized atmosphere, from the viewpoint of reducing voids.

[0077] A second-stage chip S2 is mounted on the surface of the chip S1
15 in the same manner as in the mounting of the chip S1 on the substrate 70. Furthermore, by mounting third-stage and fourth-stage chips S3 and S4, a structural body 60 shown in FIG. 7 is produced. The chips S1, S2, S3, and S4 and the substrate 70 are electrically connected using wires W1, W2, W3, and W4 (see FIG. 8), and then the semiconductor elements and
20 the wires are encapsulated by an encapsulation layer 50 to complete the semiconductor device 100 shown in FIG. 4.

[0078] Thus, embodiments of the present disclosure have been described in detail; however, the present invention is not intended to be limited to the above-described embodiments. For example, in the above-
25 described embodiment, a film 10 including a base material layer 1, an adhesive layer 3, and a bonding adhesive layer 5 in this order has been

described as an example; however, an embodiment that does not include a bonding adhesive layer 5 is also acceptable. Furthermore, the film 10 may further include a cover film (not shown in the diagram) that covers the bonding adhesive layer 5.

5 **Examples**

[0079] Hereinafter, the present disclosure will be more specifically described based on Examples; however, the present invention is not intended to be limited to these Examples. Incidentally, unless particularly stated otherwise, reagents were used for all the chemicals.

10 [0080] <Production Example 1>

 [Synthesis of acrylic resin (A-1)]

 The following components were introduced into a flask equipped with a three-one motor, a stirring blade, and a nitrogen inlet tube and having a capacity of 2000 mL.

- 15 · Ethyl acetate (solvent): 635 parts by mass
 · 2-Ethylhexyl acrylate: 395 parts by mass
 · 2-Hydroxyethyl acrylate: 100 parts by mass
 · Methacrylic acid: 5 parts by mass
 · Azobisisobutyronitrile: 0.08 parts by mass

20 [0081] The contents were stirred until the contents became sufficiently uniform, subsequently bubbling was performed for 60 minutes at a flow rate of 500 mL/min, and dissolved oxygen in the system was degassed. The temperature was increased up to 78°C for one hour, and after the temperature increase, polymerization was performed for 6 hours. Next,
25 the reaction solution was transferred into an autoclave equipped with a three-one motor, a stirring blade, and a nitrogen inlet tube and having a

capacity of 2000 mL, and the reaction solution was heated for 4.5 hours under the conditions of 120°C and 0.28 MPa and then cooled to room temperature (25°C; hereinafter, the same).

[0082] Next, 490 parts by mass of ethyl acetate was added thereto, subsequently the mixture was stirred, and the contents were diluted. To this, 0.10 parts by mass of dioctyltin dilaurate as a urethanization catalyst was added, subsequently 48.6 parts by mass of 2-methacryloyloxyethyl isocyanate (manufactured by Showa Denko K.K., KARENZ MOI (trade name)) was added thereto, and the mixture was reacted for 6 hours at 70°C and then cooled to room temperature. Next, ethyl acetate was further added thereto, the non-volatile component content in the acrylic resin solution was adjusted to be 35% by mass, and a solution including an acrylic resin (A-1) having a functional group capable of chain polymerization of Production Example 1 was obtained.

[0083] The solution including the acrylic resin (A-1) obtained as described above was dried overnight in a vacuum at 60°C. The solid content obtained by this process was subjected to elemental analysis with a fully automated elemental analyzer (manufactured by Elementar Analysensysteme GmbH, trade name: varioEL), the content of the functional group derived from the introduced 2-methacryloxyethyl isocyanate was calculated from the nitrogen content, and the content was 0.50 mmol/g.

[0084] Furthermore, the polystyrene-equivalent weight average molecular weight of the acrylic resin (A-1) was determined by using the following apparatus. That is, GPC measurement was carried out using SD-8022/DP-8020/RI-8020 manufactured by Tosoh Corp., using

Gelpack GL-A150-S/GL-A160-S manufactured by Hitachi Chemical Co., Ltd. as columns; and using tetrahydrofuran as an eluent. As the result, the polystyrene-equivalent weight average molecular weight was 800000. The hydroxyl group value and the acid value measured according to the method described in JIS K0070 were 56.1 mg KOH/g and 6.5 mg KOH/g, respectively. The results are shown together in Table 1.

[0085] <Production Example 2>

[Synthesis of acrylic resin (A-2)]

A solution including an acrylic resin (A-2) of Production Example 2 was obtained by a technique similar to that of Production Example 1, except that the raw material monomer composition shown in Production Example 1 of Table 1 was changed to the raw material monomer composition shown in Production Example 2 of Table 1. The measurement results for the characteristics of the acrylic resin (A-2) of Production Example 2 are shown in Table 1.

[0086] <Production Example 3>

[Synthesis of acrylic resin (A-3)]

A solution including an acrylic resin (A-3) of Production Example 3 was obtained by a technique similar to that of Production Example 1, except that the raw material monomer composition shown in Production Example 1 of Table 1 was changed to the raw material monomer composition shown in Production Example 3 of Table 1. The measurement results for the characteristics of the acrylic resin (A-3) of Production Example 3 are shown in Table 1.

[0087] Table 1

Acrylic resin		Production Example 1	Production Example 2	Production Example 3
		(A-1)	(A-2)	(A-3)
Raw material monomer (parts by mass)	2-Ethylhexyl acrylate	79	79	79
	2-Hydroxyethyl acrylate	20	20	20
	Methacrylic acid	1	1	1
	(Total)	(100)	(100)	(100)
	2-Methacryloxyethyl isocyanate	9.7	4.9	16.2
Weight average molecular weight		80×10^4	80×10^4	80×10^4
Hydroxyl group value (mgKOH/g)		56.1	75.5	32.8
Acid value (mgKOH/g)		6.5	6.4	6.5
Content of functional group capable of chain polymerization (mmol/g)		0.5	0.3	0.9

[0088] <Example 1>

[Production of dicing film (adhesive layer)]

A varnish of an active energy ray-curable adhesive (varnish for forming an adhesive layer) was prepared by mixing the following components (see Table 2). The amount of ethyl acetate (solvent) was adjusted such that the total solid content of the varnish was 25% by mass.

· Solution including acrylic resin (A-1) of Production Example 1: 100 parts by mass (solid content)

· Photopolymerization initiator (B-1) (1-hydroxycyclohexyl phenyl ketone, manufactured by Ciba Specialty Chemicals, Inc., IRGACURE 184, "IRGACURE" is a registered trademark): 1.0 parts by mass

· Crosslinking agent (C-1) (polyfunctional isocyanate (reaction product between tolylene diisocyanate and trimethylolpropane), manufactured by Nippon Polyurethane Industry Co., Ltd., CORONATE L, solid content 75%): 8.0 parts by mass (solid content)

· Ethyl acetate (solvent)

[0089] A polyethylene terephthalate film (width 450 mm, length 500 mm, thickness 38 μ m) that had been subjected to a release treatment on one surface was prepared. The varnish of the active energy ray-curable adhesive was applied using an applicator on the surface that had been subjected to a release treatment, and then the varnish was dried for 5 minutes at 80°C. As a result, a laminated body (dicing film) composed of a polyethylene terephthalate film and an adhesive layer having a thickness of 30 μ m and formed thereon was obtained.

[0090] A polyolefin film (width 450 mm, length 500 mm, thickness 80

μm) that had been subjected to a corona treatment on one surface was prepared. The surface that had been subjected to a corona treatment and the adhesive layer of the above-described laminated body were stuck together at room temperature. Next, the adhesive layer was transferred onto the polyolefin film (cover film) by pressing the assembly with a rubber roll. Subsequently, the assembly was left to stand for three days at room temperature to obtain a cover film-attached dicing film.

[0091] [Production of die-bonding film (adhesive layer)]

A varnish for forming a bonding adhesive layer was prepared by mixing the following components. First, cyclohexanone (solvent) was added to a mixture including the following components, the mixture was stirred and mixed, and then the mixture was further kneaded for 90 minutes using a bead mill.

- Epoxy resin (YDCN-700-10 (trade name), manufactured by Nippon Steel & Sumikin Chemical Co., Ltd., cresol novolac type epoxy resin, epoxy equivalent: 210, molecular weight: 1200, softening point: 80°C): 14 parts by mass

- Phenol resin (MILEX XLC-LL (trade name), manufactured by Mitsui Chemicals, Inc., phenol resin, hydroxyl group equivalent: 175, coefficient of water absorption: 1.8%, heating weight reduction rate at 350°C: 4%): 23 parts by mass

- Silane coupling agent (NUC A-189 (trade name), manufactured by Nippon Unicar Co., Ltd., γ-mercaptopropyltrimethoxysilane): 0.2 parts by mass

- Silane coupling agent (NUCA-1160 (trade name), manufactured by Nippon Unicar Co., Ltd., γ-ureidopropyltriethoxysilane): 0.1 parts by

mass

· Filler (SC2050-HLG (trade name), manufactured by Admatechs Co., Ltd., silica, average particle size 0.500 μm): 32 parts by mass

[0092] The following components were further added to the mixture obtained as described above, and the mixture was subjected to processes of stirring, mixing, and vacuum degassing to obtain a varnish for forming a bonding adhesive layer (varnish of a bonding adhesive composition including at least a reactive group-containing (meth)acrylic copolymer, a curing accelerator, and a filler).

· Epoxy group-containing acrylic copolymer (HTR-860P-3 (trade name), manufactured by Nagase ChemteX Corp., weight average molecular weight: 800000): 16 parts by mass

· Curing accelerator (CUREZOL 2PZ-CN (trade name), manufactured by Shikoku Chemicals Corp., 1-cyanoethyl-2-phenylimidazole, "CUREZOL" is a registered trademark): 0.1 parts by mass

[0093] A polyethylene terephthalate film (thickness 35 μm) that had been subjected to a release treatment on one surface was prepared. The varnish for forming a bonding adhesive layer was applied using an applicator on the surface that had been subjected to a release treatment, and then the varnish was heated and dried for 5 minutes at 140°C. As a result, a laminated body (die-bonding film) composed of a polyethylene terephthalate film (carrier film) and a bonding adhesive layer (B stage state) having a thickness of 25 μm formed thereon was obtained.

[0094] [Production of dicing die-bonding integrated film]

The die-bonding film composed of a bonding adhesive layer and

a carrier film was cut, together with the carrier film, into a circular shape having a diameter of 335 mm. To the cut die-bonding film, a dicing film from which the polyethylene terephthalate film had been peeled off was stuck at room temperature, and then the assembly was left to stand for one day at room temperature. Subsequently, the dicing film was cut into a circular shape having a diameter of 370 mm to obtain a laminated body. A region (first region of the adhesive layer) corresponding to a sticking position for a wafer in the bonding adhesive layer of the laminated body obtained as such, was irradiated with ultraviolet radiation as follows. That is, the laminated body was partially irradiated with ultraviolet radiation at 70 W in an amount of irradiation of 300 mJ/cm² using a pulsed xenon lamp. Incidentally, the irradiation with ultraviolet radiation was carried out on a portion having an inner diameter of 318 mm from the center of the film using a blackout curtain. In this manner, a plurality of dicing die-bonding integrated films of Example 1 to be supplied to various evaluation tests that will be described below were obtained.

[0095] <Example 2>

A plurality of dicing die-bonding integrated films of Example 2 were obtained in the same manner as in Example 1, except that the amount of irradiation with ultraviolet radiation was changed from 300 mJ/cm² to 200 mJ/cm².

[0096] <Example 3>

A plurality of dicing die-bonding integrated films of Example 3 were obtained in the same manner as in Example 1, except that the amount of irradiation with ultraviolet radiation was changed from 300

mJ/cm² to 500 mJ/cm².

[0097] <Example 4>

A plurality of dicing die-bonding integrated films of Example 4 were obtained in the same manner as in Example 1, except that the photopolymerization initiator (B-1) used when producing the dicing film was changed to a photopolymerization initiator (B-2) (2-hydroxy-1-{4-[4-(2-hydroxy-2-methylpropionyl)-benzyl]-phenyl}-2-methyl-propan-1-one, manufactured by Ciba Specialty Chemicals, Inc., IRGACURE 127, "IRGACURE" is a registered trademark).

[0098] <Example 5>

A plurality of dicing die-bonding integrated films of Example 5 were obtained in the same manner as in Example 3, except that the acrylic resin (A-1) used when producing the dicing film was changed to the acrylic resin (A-2).

[0099] <Comparative Example 1>

A plurality of dicing die-bonding integrated films of Comparative Example 1 were obtained in the same manner as in Example 1, except that the acrylic resin (A-1) used when producing the dicing film was changed to the acrylic resin (A-3).

[0100] [Evaluation tests]

(1) Measurement of adhesive force (30° peel strength) of adhesive layer with respect to adhesive layer

The adhesive force (f1) of the first region of the adhesive layer with respect to the bonding adhesive layer and the adhesive force (f2) of the second region of the adhesive layer with respect to the bonding adhesive layer were evaluated by measuring the 30° peel strength.

Incidentally, f_1 corresponds to the adhesive force of the first region of the adhesive layer after irradiation with ultraviolet radiation with respect to the bonding adhesive layer, and f_2 corresponds to the adhesive force of the region that constitutes the first region of the adhesive layer before irradiation with ultraviolet radiation with respect to the bonding adhesive layer. Accordingly, measurement of the adhesive force (30° peel strength) was performed using the dicing die-bonding integrated film after irradiation with ultraviolet radiation in the section [Production of dicing die-bonding integrated film] for f_1 , and using the laminated body before irradiation with ultraviolet radiation for f_2 . A measurement sample was obtained by preparing a dicing die-bonding integrated film and a laminated body and cutting each of these to a size of 25 mm in width and 100 mm in length. The peel strength of the first region of the adhesive layer after irradiation with ultraviolet radiation with respect to the bonding adhesive layer and the peel strength of the region that constituted the first region of the adhesive layer before irradiation with ultraviolet radiation with respect to the bonding adhesive layer (peel strength of the second region of the adhesive layer with respect to the bonding adhesive layer) were measured from each of the measurement samples using a tensile testing machine (manufactured by Shimadzu Corp., AUTOGRAPH "AGS-1000"). The measurement conditions were set to a peeling angle of 30° and a peeling speed of 60 mm/min. Incidentally, the storage of the samples and the measurement of the peel strength were carried out in an environment at a temperature of 23°C and a relative humidity of 40%. The results are presented in Table 2.

[0101] (2) Measurement of adhesive force (90° peel strength) of adhesive

layer with respect to stainless steel substrate

The adhesive force of the second region of the adhesive layer with respect to a stainless steel substrate was evaluated by measuring the 90° peel strength. Incidentally, this adhesive force corresponds to the adhesive force of the adhesive layer before irradiation with ultraviolet radiation with respect to a stainless steel substrate. Accordingly, regarding this adhesive force, the measurement of the adhesive force (90° peel strength) was carried out using a laminated body before irradiation with ultraviolet radiation in the section [Production of dicing die-bonding integrated film]. A measurement sample was obtained by preparing a laminated body, cutting this into a size of 25 mm in width and 100 mm in length, and sticking the surface on the adhesive layer side to a stainless substrate (SUS430BA). The peel strength of the adhesive layer with respect to the stainless steel substrate was measured from the measurement sample using a tensile testing machine (manufactured by Shimadzu Corp., AUTOGRAPH "AGS-1000"). The measurement conditions were set to a peeling angle of 90° and a peeling speed of 50 mm/min. The results are presented in Table 2.

[0102] (3) Measurement of curing shrinkage ratio of adhesive layer

Two sheets of a polyethylene terephthalate film (width 450 mm, length 500 mm, thickness 38 μm) that had been subjected to a release treatment on one surface were prepared. On the release-treated surface of one sheet of the polyethylene terephthalate film, a varnish of an active energy ray-curable adhesive was applied using an applicator and then dried for 5 minutes at 80°C, and an adhesive layer was formed. Next, the release-treated surface of the other sheet of the polyethylene

terephthalate film and the adhesive layer were stuck together at room temperature and pressed with a rubber roll, and thereby a laminated body composed of a polyethylene terephthalate film, an adhesive layer having a thickness of 30 μm , and a polyethylene terephthalate film was obtained.

5 A plurality of such laminated bodies were produced. Next, the polyethylene terephthalate film on one side of the laminated body was peeled off, the adhesive layers were laminated such that no voids entered, and lamination of the adhesive layers using other laminated bodies were repeated until the thickness of the adhesive layer reached about 1 mm, to
10 obtain a laminated body composed of two sheets of a polyethylene terephthalate film and an adhesive layer having a thickness of about 1 mm interposed between those polyethylene terephthalate film sheets.

[0103] The obtained laminated body was punched into a size of 10 mm ϕ , the polyethylene terephthalate films on both sides were peeled off, and
15 the resultant was disposed on a slide glass such that no voids entered. Next, an aluminum foil with one black side was similarly punched into a size of 10 mm ϕ and disposed on the top face of the adhesive layer on the opposite side of the slide glass to obtain a sample. The obtained sample was irradiated with ultraviolet radiation under the conditions similar to
20 the conditions in the section [Production of dicing die-bonding integrated film], and the curing shrinkage ratio was measured using a resin curing shrinkage analyzer (manufactured by AcroEdge Co., Ltd., Custron) from the difference between the thicknesses excluding the slide glass and the aluminum foil obtained before and after irradiation with ultraviolet
25 radiation. The results are presented in Table 2.

[0104] (4) Measurement of edge peel strength of chip

The edge peel strength is measured by performing the following steps. FIG. 9(a), FIG. 9(b), and FIG. 9(c) are cross-sectional views schematically illustrating the steps of measuring the edge peel strength.

· A step of sticking a silicon wafer Ws having a thickness of 50 μm to the bonding adhesive layer 5 and sticking a dicing ring DR to the second surface F2 of the adhesive layer 3 (see FIG. 9(a))

· A step of singularizing the silicon wafer Ws and the bonding adhesive layer 5 into a plurality of adhesive piece-attached chips Ta (laminated bodies of a chip Ts and adhesive piece 5p) (see FIG. 9(b))

· A step of pushing up a central part of a bonding adhesive piece-attached chip Ta at a velocity of 60 mm/min from the base material layer 1 side at a temperature of 23°C (see FIG. 9(c)), and measuring the edge peel strength when the edges of the bonding adhesive piece-attached chip Ta are peeled off from the adhesive layer 3

[0105] First, a dicing die-bonding integrated film was stuck to a silicon wafer (diameter: 12 inches, thickness: 50 μm) and a dicing ring under the following conditions (see FIG. 9(a)). The elongation in the MD Direction of the dicing die-bonding integrated film after the silicon wafer and the dicing ring were stuck was about 1.0% to 1.3%.

[0106] <Conditions for sticking>

- Sticking apparatus: DFM2800 (manufactured by DISCO Corp.)
- Sticking temperature: 70°C
- Sticking speed: 10 mm/s
- Sticking tension level: Level 6

[0107] Next, the dicing die-bonding integrated film-attached silicon wafer was singularized into a plurality of adhesive piece-attached chips

(size 2 mm × 2 mm) by blade dicing (see FIG. 9(b)).

[0108] <Conditions for dicing>

- Dicer: DFD6361 (manufactured by DISCO Corp.)
- Blade: ZH05-SD4000-N1-70-BB (manufactured by DISCO

5 Corp.)

- Speed of blade rotation: 40000 rpm
- Dicing velocity: 30 mm/second
- Blade height: 90 μm
- Incision depth from the surface of the adhesive layer to the base

10 material layer: 20 μm

- Amount of water at the time of dicing

Blade cooler: 1.5 L/min

Shower: 1.0 L/min

Spray: 1.0 L/min

15 [0109] One day after performing dicing, the edge peel strength of the bonding adhesive piece-attached chips was measured by pushing up the bonding adhesive piece-attached chips from the base material layer side using a push-up jig P under the following measurement conditions (see FIG. 9(c)). FIG. 10 is a graph showing an example of the relationship
20 between the displacement (mm) caused by pushing up and the push-up force (N). When the edges of a chip are peeled off, as shown in FIG. 10, the push-up force is temporarily decreased, and a changing point is generated in the graph. The value of the push-up force at this changing point is defined as the edge peel strength. Incidentally, the surface of
25 the base material layer corresponding to the central part of the chip was marked with an oil-based pen before measurement. FIG. 11 is a plan

view schematically illustrating the state in which the positions corresponding to the central part of the chips to be measured are marked. The marks M at the central part of the chips were identified by measuring with a ruler. Measurement was performed with $N = 10$. One chip was measured, and then the next measurement was performed after skipping a space equivalent to three chips (see FIG. 11). The results are presented in Table 2.

[0110] <Measurement conditions>

- Measuring apparatus: Small-sized tabletop testing machine EZ-SX (manufactured by Shimadzu Corp.)

- Load cell: 50 N

- Push-up jig: Attachment attached to ZTS series (shape: conical shape, manufactured by Imada Co., Ltd.)

- Push-up speed: 60 mm/min

- Temperature: 23°C

- Humidity: $45 \pm 10\%$

[0111] (5) Evaluation of pickup properties

After the above-described measurement of the edge peel strength, one hundred adhesive piece-attached chips were picked up under the following conditions.

[0112] <Pickup conditions>

- Die-bonder apparatus: DB800-HSD (manufactured by Hitachi High-Technologies Corp.)

- Push-up pin: EJECTOR NEEDLE SEN2-83-05 (diameter: 0.7 mm, tip shape: hemisphere having a radius of 350 μm , manufactured by Micro-Mechanics Sdn Bhd)

- Push-up height: 200 μm
- Push-up speed: 1 mm/second

5 Incidentally, one push-up pin was disposed at the central part of the chip. The case where the success rate of pickup was 100% was rated as "A"; the case where the success rate was 70% or higher and lower than 100% was rated as "B"; and the case where the success rate was lower than 70% was rated as "C". The results are presented in Table 2.

[0113] Table 2

		Exam. 1	Exam. 2	Exam. 3	Exam. 4	Exam. 5	Comp. Exam. 1
Composition of adhesive layer (ultraviolet-curable adhesive) (parts by mass)	Acrylic resin	(A-1)	100	100	100	-	-
		(A-2)	-	-	-	100	-
		(A-3)	-	-	-	-	100
	Photopolymerization initiator	(B-1)	1	1	-	1	1
		(B-2)	-	-	1	-	-
	Crosslinking agent	(C-1)	8	8	8	8	8
Amount of irradiation with ultraviolet radiation (mJ/cm ²)		300	200	500	300	500	300
Adhesive force of adhesive layer with respect to adhesive layer (N/25mm)	Adhesive force (f2) of second region (active energy ray-unirradiated region)	9.8	9.8	9.8	10.3	10.3	11.6
	Adhesive force (f1) of first region (active energy ray-irradiated region)	2.3	2.8	1.2	2.3	3.7	1.0
	(f2-f1) (N/25mm)	7.5	7.0	8.6	8.0	6.6	10.6
Adhesive force of second region of adhesive layer with respect to stainless steel substrate (N/25mm)		0.33	0.33	0.34	0.33	0.40	0.34
Curing shrinkage ratio of adhesive layer (%)		1.1	0.9	1.3	0.7	1.0	1.8
Edge peel strength of adhesive piece-attached chip (N)		1.1	0.9	1.2	0.9	0.7	1.6
Pickup properties		A	A	A	A	B	C

[0114] As shown in Table 2, the dicing die-bonding integrated films of Examples 1 to 5 exhibited more satisfactory pickup properties than the dicing die-bonding integrated film of Comparative Example 1. Specifically, since the difference of (f2 - f1) in Comparative Example 1 was larger than that of Examples 1 to 5, the curing shrinkage ratio and the edge peel strength were also higher than those of Examples 1 to 5, and the pickup properties were not sufficient. From the above-described results, it was verified that the dicing die-bonding integrated film of the present disclosure is applicable to a production process for a semiconductor device including a step of singularizing a wafer into a plurality of small chips (area 0.1 to 9 mm²) and includes an adhesive layer having excellent pickup properties.

Reference Signs List

[0115] 1: base material layer, 3: adhesive layer, 3a: first region, 3b: second region, 5: bonding adhesive layer, 5P, 5p: adhesive piece, 5C: cured product, 8: DAF, 10: dicing die-bonding integrated film (film), 42: pin, 44: suction collet, 50: encapsulation layer, 60: structure, 70: substrate, 80: support plate, 100: semiconductor device, DR: dicing ring, F1: first surface, F2: second surface, M: mark, P: push-up jig, Rw: region, S1, S2, S3, S4, S, Ts: chip, Ta: adhesive piece-attached chip, W: wafer, Ws: silicon wafer, W1, W2, W3, W4: wire.

CLAIMS

1. A dicing die-bonding integrated film, comprising:

a base material layer;

an adhesive layer having a first surface facing the base material
5 layer and a second surface on the opposite side of the first surface, the
adhesive layer being formed from an active energy ray-curable adhesive;
and

a bonding adhesive layer provided so as to cover a central part of
the second surface,

10 wherein the adhesive layer has a first region including at least a
region corresponding to a sticking position for a wafer in the bonding
adhesive layer and a second region located so as to surround the first
region,

the first region is a region in a state of having an adhesive force
15 decreased as compared with the second region, by irradiation with active
energy rays,

when the adhesive force of the first region of the adhesive layer
with respect to the bonding adhesive layer as measured under conditions
of a peeling angle of 30° and a peeling speed of 60 mm/min at a
20 temperature of 23°C is designated as f1 (N/25 mm), and the adhesive
force of the second region of the adhesive layer with respect to the
bonding adhesive layer as measured under the conditions of a peeling
angle of 30° and a peeling speed of 60 mm/min at a temperature of 23°C
is designated as f2 (N/25 mm), the difference (f2 - f1) between f2 and f1
25 is 6.5 to 9.0 N/25 mm, and

the dicing die-bonding integrated film is applied to a production

process for a semiconductor device including singularizing a wafer into a plurality of chips each having an area of 0.1 to 9 mm².

2. The dicing die-bonding integrated film according to claim 1,
wherein the difference ($f_2 - f_1$) between f_2 and f_1 is 7.0 to 9.0
5 N/25 mm.

3. The dicing die-bonding integrated film according to claim 1 or 2,
wherein the f_1 is 1.1 to 4.5 N/25 mm.

4. The dicing die-bonding integrated film according to any one of
claims 1 to 3,

10 wherein the f_1 is 1.1 to 3.0 N/25 mm.

5. The dicing die-bonding integrated film according to any one of
claims 1 to 4,

wherein the adhesive force of the second region of the adhesive
layer with respect to a stainless steel substrate as measured under the
15 conditions of a peeling angle of 90° and a peeling speed of 50 mm/min at
a temperature of 23°C is 0.2 N/25 mm or more.

6. The dicing die-bonding integrated film according to any one of
claims 1 to 5,

wherein the active energy ray-curable adhesive includes a
20 (meth)acrylic resin having a functional group capable of chain
polymerization,

the functional group is at least one selected from an acryloyl
group and a methacryloyl group, and

the content of the functional group in the (meth)acrylic resin is
25 0.1 to 1.2 mmol/g.

7. The dicing die-bonding integrated film according to claim 6,

wherein the active energy ray-curable adhesive further includes a crosslinking agent, and

the content of the crosslinking agent with respect to the total mass of the active energy ray-curable adhesive is 0.1% to 15% by mass.

5 8. The dicing die-bonding integrated film according to claim 7,

wherein the crosslinking agent is a reaction product between a polyfunctional isocyanate having two or more isocyanate groups in one molecule and a polyhydric alcohol having three or more hydroxy groups in one molecule.

10 9. The dicing die-bonding integrated film according to any one of claims 1 to 8,

wherein the amount of irradiation with active energy rays is 10 to 1000 mJ/cm².

15 10. The dicing die-bonding integrated film according to any one of claims 1 to 9,

wherein the bonding adhesive layer is formed from a bonding adhesive composition including a reactive group-containing (meth)acrylic copolymer, a curing accelerator, and a filler.

20 11. A method for producing the dicing die-bonding integrated film according to any one of claims 1 to 10, the method comprising, in the following order:

25 producing, on the surface of a base material layer, a laminated body including an adhesive layer formed from an active energy ray-curable adhesive and the bonding adhesive layer formed on the surface of the adhesive layer; and

irradiating a region constituting the first region of the adhesive

layer included in the laminated body with active energy rays.

12. A method for producing a semiconductor device, the method comprising:

5 preparing the dicing die-bonding integrated film according to any one of claims 1 to 10;

sticking a wafer to the bonding adhesive layer of the dicing die-bonding integrated film and sticking a dicing ring to the second surface of the adhesive layer;

singularizing the wafer into a plurality of chips;

10 picking up the chip, together with a bonding adhesive piece obtained by singularizing the bonding adhesive layer, from the adhesive layer; and

mounting the chip on a substrate or another chip, with the bonding adhesive piece interposed therebetween.

15