

DESCRIPTION

Title of Invention

5 SEMICONDUCTOR DEVICE PRODUCTION METHOD, DICING
DIE-BONDING INTEGRATED FILM, AND PRODUCTION
METHOD THEREFOR

Technical Field

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

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 a
pressure-sensitive adhesive film for dicing is stuck to a wafer.
15 Subsequently, an expanding step, a pickup step, a die-bonding step, and
the like are carried out.

[0003] In a process for producing a semiconductor device, a film called
a dicing/die-bonding integrated film is used. This film has a structure
in which a base material layer, a pressure-sensitive adhesive layer, and
20 an adhesive layer are laminated in order, and the film is used, for
example, as follows. First, the surface on the adhesive layer is stuck to
a wafer, and the wafer is diced in a state in which the wafer is fixed with
a dicing ring. As a result, the wafer is singulated into a large number
of chips. Subsequently, the tack force of the pressure-sensitive
25 adhesive layer with respect to the adhesive layer is weakened by
irradiating the pressure-sensitive adhesive layer with ultraviolet

radiation, and then chips are picked up, together with adhesive layer pieces formed by singulating the adhesive layer, from the pressure-sensitive adhesive layer. Subsequently, a semiconductor device is produced by performing a step of mounting a chip on a substrate or the like, with the adhesive piece interposed therebetween. Incidentally, a laminated body composed of a chip obtainable by performing a dicing step; and an adhesive piece attached to this chip, is referred to as an adhesive piece-attached chip.

[0004] As described above, a pressure-sensitive adhesive layer (dicing film) in which the tack force is weakened by irradiation with ultraviolet radiation, is referred to as a UV-curable type. In contrast, a pressure-sensitive adhesive layer in which the tack force remains constant without being irradiated with ultraviolet radiation 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 pressure-sensitive adhesive layer has merits in terms of that a user (mainly a semiconductor device manufacturer) does not need to perform a step of irradiating ultraviolet radiation, and that facilities for this purpose are unnecessary. Patent Literature 1 discloses a dicing/die-bonding film, which can be said to be a UV-curable type from the viewpoint that the pressure-sensitive adhesive layer contains a component curable by ultraviolet radiation, and which can also be said to be a pressure-sensitive type from the viewpoint that only a predetermined portion of the pressure-sensitive adhesive layer has been irradiated in advance with ultraviolet radiation so that the user does not need to irradiate ultraviolet radiation in the

production process for a semiconductor device.

Citation List

Patent Literature

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

5 Summary of Invention

Technical Problem

[0006] The pressure-sensitive adhesive layer of a dicing/die-bonding integrated film is required to have high tack force with respect to the adhesive layer and the dicing ring in the dicing step. When the tack force of the pressure-sensitive adhesive layer is insufficient, a phenomenon occurs in which peeling between the adhesive layer and the pressure-sensitive adhesive layer occurs along with high-speed rotation of a dicing blade while the adhesive layer breaks, and scraps of the adhesive layer scatter away. This phenomenon is referred to as "DAF scattering". Meanwhile, DAF means a Die attach film. Alternatively, a phenomenon in which the dicing ring is peeled from the pressure-sensitive adhesive layer by the water flow of cutting water (hereinafter, this phenomenon is referred to as "ring peeling") occurs. Furthermore, in recent years, a process of singulating the wafer and the adhesive layer by cooling and expansion along with wafer thinning is increasingly carried out. Even in the cooling and expansion step, when the tack force of the pressure-sensitive adhesive layer is insufficient, the outer peripheral portion of the DAF breaks due to the impact and stress during expansion, a phenomenon in which scraps scatter away (DAF scattering) occurs, or peeling between the edges of an adhesive piece-attached chip and the pressure-sensitive adhesive layer (chip edge

peeling) occurs, and inconvenience may occur in the subsequent steps.

[0007] Users who use a dicing/die-bonding integrated film have a need to perform irradiation with active energy rays (for example, ultraviolet radiation) under constant conditions as far as possible. Therefore, for example, even when the tack force of the pressure-sensitive adhesive layer has been changed along with a change in the formulation of the dicing/die-bonding integrated film, it is difficult under the current circumstances to require a user to flexibly adjust the conditions for irradiation with active energy rays.

[0008] The present disclosure provides a dicing/die-bonding integrated film that can be conveniently used by users and is useful for efficiently producing a semiconductor device, and a method for producing the dicing/die-bonding integrated film. Furthermore, the present disclosure provides a method for producing a semiconductor device, the method using the above-described dicing/die-bonding integrated film.

Solution to Problem

[0009] An aspect of the present disclosure relates to a method for producing a semiconductor device. This production method includes the following steps:

(A) preparing a dicing/die-bonding integrated film having a base material layer, a pressure-sensitive adhesive layer, and an adhesive layer laminated in order, the pressure-sensitive adhesive layer having a first region in which the tack force with respect to the adhesive layer has been decreased in advance by irradiation with active energy rays;

(B) subjecting a wafer to stealth dicing or half-cutting by means of a blade;

(C) sticking the wafer to a region corresponding to the first region in the adhesive layer;

(D) singulating the wafer and the adhesive layer by expanding the base material layer under cooling conditions to obtain an adhesive piece-attached chip;

(E) irradiating the pressure-sensitive adhesive layer with active energy rays to decrease the tack force of the pressure-sensitive adhesive layer with respect to the adhesive piece-attached chip;

(F) picking up the adhesive piece-attached chip from the pressure-sensitive adhesive layer in a state in which the base material layer is expanded; and

(G) mounting the adhesive piece-attached chip on a substrate or another chip.

Further, in the dicing/die-bonding integrated film in step (A), the tack force of the first region with respect to the adhesive layer is from 6.0 N/25 mm to 12.5 N/25 mm 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.

[0010] According to the above-described production method, a dicing/die-bonding integrated film in which the tack force of the pressure-sensitive adhesive layer with respect to the adhesive layer has been adjusted in advance by irradiation (first irradiation) with active energy rays is used, and the tack force of the pressure-sensitive adhesive layer with respect to the adhesive piece-attached chip is decreased by irradiation (second irradiation) with active energy rays in step (E). For this reason, the occurrence of DAF scattering or chip edge peeling in

step (D) can be sufficiently suppressed, and excellent pickup properties can be achieved in step (F).

[0011] The adhesive piece-attached chip obtainable in step (D) may be a chip having a relatively large size. That is, the adhesive piece-attached chip may be a chip having a square or rectangular shape as viewed in a plan view and having a side measuring 6.0 mm or more. An adhesive piece-attached chip having a relatively large size is likely to warp, which causes the adhesive piece-attached chip to peel off in step (D), and the chip is likely to crack or pickup failure is likely to occur in step (F). According to the production method related to the present disclosure, these inconveniences in step (F) can be sufficiently suppressed.

[0012] The pressure-sensitive adhesive layer may have a second region in which the tack force with respect to the adhesive layer is larger than that of the first region. In this case, a dicing ring can be stuck to the second region simultaneously with step (C) or before step (D).

[0013] The dicing/die-bonding integrated film according to an aspect of the present disclosure includes a base material layer; an adhesive layer; and a pressure-sensitive adhesive layer disposed between the base material layer and the adhesive layer and having a first region in which the tack force with respect to the adhesive layer has been decreased in advance by irradiation with active energy rays, wherein the tack force of the first region with respect to the adhesive layer is from 6.0 N/25 mm to 12.5 N/25 mm 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.

[0014] In this dicing/die-bonding integrated film, the tack force of the

pressure-sensitive adhesive with respect to the adhesive layer has been adjusted in advance by irradiation with active energy rays. For example, even when the tack force of the pressure-sensitive adhesive layer has been changed along with a change in the formulation of the dicing/die-bonding integrated film, as a manufacturer of this film adjusts in advance the tack force of the pressure-sensitive adhesive layer and provides the film to a user, the user can continue production of semiconductor devices while maintaining the previous conditions without changing the conditions for the irradiation with active energy rays.

[0015] With regard to the dicing/die-bonding integrated film, from the viewpoint of having excellent pickup properties, it is preferable that after the first region is irradiated with ultraviolet radiation in an amount of 150 mJ/cm^2 , the tack force of the first region with respect to the adhesive layer is 1.2 N/25 mm or less 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 . The dicing/die-bonding integrated film can be applied to a semiconductor device production process including a step of singulating a wafer into a plurality of chips each having an area of 30 to 250 mm^2 .

[0016] An aspect of the present disclosure relates to a method for producing the above-described dicing/die-bonding integrated film. A first embodiment of this production method includes successive steps of: producing a laminated body on the surface of the base material layer, wherein the laminated body includes a pressure-sensitive adhesive layer formed from a composition whose tack force is decreased by irradiation

with active energy rays and an adhesive layer formed on the surface of the pressure-sensitive adhesive layer; and irradiating a region constituting the first region of the pressure-sensitive adhesive layer included in the laminated body with active energy rays. On the other hand, a second embodiment of the production method includes successive steps of: forming a pressure-sensitive adhesive layer on a surface of the base material layer, wherein the pressure-sensitive adhesive layer is formed from a composition whose tack force is decreased by irradiation with active energy rays; irradiating a region constituting the first region of the pressure-sensitive adhesive layer with active energy rays; and laminating an adhesive layer on a surface of the pressure-sensitive adhesive layer after being irradiated with active energy rays.

Advantageous Effects of Invention

[0017] According to the present disclosure, there are provided a dicing/die-bonding integrated film which can be conveniently used by a user and is useful for efficiently producing a semiconductor device, and a method for producing the dicing/die-bonding integrated film. Furthermore, according to the present disclosure, a method for producing a semiconductor device using the dicing/die-bonding integrated film is provided.

Brief Description of Drawings

[0018] 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 a pressure-sensitive adhesive layer of a dicing/die-bonding integrated film, and a wafer is stuck to the surface of an adhesive layer.

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

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

FIG. 5(a) and FIG. 5(b) are cross-sectional views schematically illustrating a process for producing an adhesive piece-attached chip.

FIG. 6(a) to FIG. 6(c) are cross-sectional views schematically illustrating a process for producing an adhesive piece-attached chip.

FIG. 7(a) and FIG. 7(b) are cross-sectional views schematically illustrating a process for producing the semiconductor device shown in FIG. 4.

Description of Embodiments

[0019] 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.

[0020] <Dicing/die-bonding integrated film>

FIG. 1(a) is a plan view illustrating the 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 of FIG. 1. The dicing/die-bonding integrated film 10 (hereinafter, depending on the circumstances, simply referred to as "film 10") includes a base material layer 1; a pressure-sensitive 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 an adhesive layer 5 provided so as to cover the central portion of the second surface F2 of the pressure-sensitive adhesive layer 3, in order. According to the present embodiment, a situation in which one laminated body of the pressure-sensitive adhesive layer 3 and the adhesive layer 5 is formed on a square-shaped base material layer 1 is described 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 the pressure-sensitive adhesive layer 3 and the adhesive layer 5 are disposed at a predetermined interval so as to line up in the longitudinal direction of the base material layer 1, is also acceptable.

[0021] (Pressure-sensitive adhesive layer)

The pressure-sensitive adhesive layer 3 has a first region 3a that includes at least a region R_w corresponding to the sticking position for a wafer W in the adhesive layer 5; and a second region 3b located so as to surround the first region 3a. The broken line in FIG. 1(a) represents 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 before the irradiation with active energy rays. The first region 3a is a region in a state in which the tack force has been decreased as compared with the second region 3b by being irradiated

with active energy rays such as ultraviolet radiation. The second region 3b is a region to which a dicing ring DR is stuck (see FIG. 2). The second region 3b is a region that has not been irradiated with active energy rays and has high tack force with respect to the dicing ring DR.

5 [0022] The tack force of the first region 3a with respect to the adhesive layer 5 is from 6.0 N/25 mm to 12.5 N/25 mm. This tack force is 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 the situation in
10 which the 30° peel strength of the pressure-sensitive adhesive layer 3 is measured in a state in which the adhesive layer 5 of a measurement sample (25 mm in width × 100 mm in length) is fixed to a support plate 80. By setting the tack force (30° peel strength) of the first region 3a with respect to the adhesive layer 5 to the above-described range, DAF scattering and chip edge peeling during cooling and expansion can be
15 sufficiently suppressed. As a result, it is possible to produce a semiconductor device with a sufficiently high product yield. The lower limit value of this tack force may be 6.5 N/25 mm or 7.0 N/25 mm, and the upper limit value may be 11.5 N/25 mm or 10.5 N/25 mm.

20 [0023] The tack force of the first region 3a with respect to the adhesive layer 5 after the first region 3a is irradiated with ultraviolet radiation (main wavelength: 365 nm) in an amount of 150 mJ/cm² is preferably 1.2 N/25 mm or less and may be from 0.4 N/25 mm to 1.2 N/25 mm, or from 0.5 N/25 mm to 1.1 N/25 mm. According to a film 10 including
25 such a pressure-sensitive adhesive layer 3, excellent pickup properties can be achieved. Incidentally, this tack force is 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 as described above (see FIG. 3).

5 [0024] It is preferable that the tack force of the second region 3b with respect to a stainless steel substrate is 0.2 N/25 mm or more. This tack 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 tack force is 0.2 N/25 mm or more, ring peeling during dicing can be sufficiently suppressed. The lower limit value of
10 this tack force may be 0.3 N/25 mm or 0.4 N/25 mm, and the upper limit value is, for example, 2.0 N/25 mm and may be 1.0 N/25 mm.

[0025] The pressure-sensitive adhesive layer before irradiation with active energy rays is formed from, for example, a pressure-sensitive adhesive composition including a (meth)acrylic resin, a
15 photopolymerization initiator, and a crosslinking agent. The second region 3b that is not irradiated with active energy rays is formed from the same composition as that of the pressure-sensitive adhesive layer before irradiation with active energy rays. In the following description, the components contained in the pressure-sensitive adhesive
20 composition will be described in detail.

[0026] [(Meth)acrylic resin]

It is preferable that the pressure-sensitive adhesive composition includes a (meth)acrylic resin having a functional group capable of chain polymerization, and the functional group is at least one selected
25 from an acryloyl group and a methacryloyl group. The content of the functional group in the pressure-sensitive adhesive layer before

irradiation with active energy rays is, for example, 0.1 to 1.2 mmol/g and may be 0.3 to 1.0 mmol/g or 0.5 to 0.8 mmol/g. When the content of the functional group is 0.1 mmol/g or more, a region in which the tack force has been appropriately decreased by irradiation with active energy rays (first region 3a) is easily formed, and when the content is 1.2 mmol/g or less, excellent pickup properties are likely to be achieved.

[0027] 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 RAFTP (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.

[0028] 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.

[0029] 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 (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, mono(2-(meth)acryloyloxyethyl) succinate; alicyclic (meth)acrylates such as cyclopentyl (meth)acrylate, cyclohexyl (meth)acrylate, dicyclopentanyl (meth)acrylate, dicyclopentenyl (meth)acrylate, isobornyl (meth)acrylate, mono(2-(meth)acryloyloxyethyl) tetrahydrophthalate, 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 (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,
 5 2-hydroxy-3-(1-naphthoxy)propyl (meth)acrylate, and
 2-hydroxy-3-(2-naphthoxy)propyl (meth)acrylate; heterocyclic
 (meth)acrylates such as 2-tetrahydrofurfuryl (meth)acrylate,
 N-(meth)acryloyloxyethyl hexahydrophthalimide, and
 2-(meth)acryloyoxyethyl N-carbazole; compounds having an
 10 ethylenically unsaturated group and an epoxy group, such as
 caprolactone modification 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
 15 (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;
 20 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,
 25 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, and intended (meth)acrylic resins can be obtained by appropriately combining these.

[0030] It is preferable that the (meth)acrylic resin has at least one functional group selected from a hydroxyl group, a glycidyl 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, and these can be used singly or in combination of two or more kinds thereof.

[0031] 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, and these can be used singly or in combination of two or more kinds thereof.

[0032] It is preferable that 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 a (meth)acrylic resin synthesized as described above, for example,

by reacting the (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-hydroxybutyl ethyl (meth)acrylate; and an acryloyl monoisocyanate compound obtainable

by a reaction between a diisocyanate compound or a polyisocyanate compound and a polyol compound and hydroxyethyl (meth)acrylate.

Among these, 2-methacryloyloxyethyl isocyanate is particularly preferred. Regarding these compounds, one kind thereof can be used alone, or two or more kinds thereof can be used in combination.

[0033] [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 (at least one selected from ultraviolet radiation, electron beam, and visible light), and examples 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.

[0034] 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'-tetramethyl-4,4'-diaminobenzophenone,
 N,N'-tetraethyl-4,4'-diaminobenzophenone, and
 4-methoxy-4'-dimethylaminobenzophenone; quinone compounds such
 as 2-ethylantraquinone, phenanthrenequinone,
 5 2-tert-butylantraquinone, octamethylantraquinone,
 1,2-benzanthraquinone, 2,3-benzanthraquinone, 2-phenylantraquinone,
 2,3-diphenylantraquinone, 1-chloroanthraquinone,
 2-methylantraquinone, 1,4-naphthoquinone, 9,10-phenanthraquinone,
 2-methyl-1,4-naphthoquinone, and 2,3-dimethylantraquinone; benzoin
 10 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.
 15 [0035] The content of the photopolymerization initiator in the
 pressure-sensitive adhesive composition is, for example, 0.1 to 30 parts
 by mass with respect to 100 parts by mass of the content of the
 (meth)acrylic resin, and the content is preferably 0.3 to 10 parts by
 mass, and more preferably 0.5 to 5 parts by mass. When the content of
 20 the photopolymerization initiator is less than 0.1 parts by mass, the
 pressure-sensitive adhesive layer is insufficiently cured after being
 irradiated with active energy rays, and pickup failure is likely to occur.
 When the content of the photopolymerization initiator is more than 30
 parts by mass, contamination of the adhesive layer (transfer of the
 25 photopolymerization initiator to the adhesive layer) is likely to occur.
 [0036] [Crosslinking agent]

The crosslinking agent is used for the purpose of, for example, controlling the elastic modulus and/or pressure-sensitive adhesiveness of the pressure-sensitive 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 amino group, and the like carried by the (meth)acrylic resin. Examples of the bond formed by a reaction between a crosslinking agent and a (meth)acrylic resin include an ester bond, an ether bond, an amide bond, an imide bond, a urethane bond, and a urea bond.

[0037] According to the present embodiment, it is preferable to employ a compound having two or more isocyanate groups in one molecule as the crosslinking agent. When such a compound 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.

[0038] Examples of the compound 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-methyldiphenylmethane diisocyanate, hexamethylene diisocyanate, isophorone diisocyanate, dicyclohexylmethane-4,4'-diisocyanate, dicyclohexylmethane-2,4'-diisocyanate, and lysine isocyanate.

[0039] As the crosslinking agent, a reaction product (isocyanate group-containing oligomer) of the above-mentioned isocyanate

compound and a polyhydric alcohol having two or more OH groups in one molecule may be employed. Examples of the polyhydric alcohol having two or more OH 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, pentaerythritol, dipentaerythritol, 1,4-cyclohexanediol, and 1,3-cyclohexanediol.

[0040] Among these, it is more desirable that the crosslinking agent is a reaction product (isocyanate group-containing oligomer) of a polyfunctional isocyanate having two or more isocyanate groups in one molecule and a polyhydric alcohol having three or more OH groups in one molecule. By using such an isocyanate group-containing oligomer as the crosslinking agent, the pressure-sensitive adhesive layer 3 forms a compact crosslinked structure, and as a result, the pressure-sensitive adhesive adhering to the adhesive layer 5 in the pickup step can be sufficiently suppressed.

[0041] The content of the crosslinking agent in the pressure-sensitive adhesive composition may be appropriately set according to the cohesive force and the elongation percentage at break required for the pressure-sensitive adhesive layer, the adhesiveness to the adhesive layer 5, and the like. Specifically, the content of the crosslinking agent is, for example, 3 to 30 parts by mass with respect to 100 parts by mass of the content of the (meth)acrylic resin, and the content is preferably 4 to 15 parts by mass, and more preferably 7 to 10 parts by mass. By setting the content of the crosslinking agent to the above-described range, both the characteristics required for the pressure-sensitive

adhesive layer in the dicing step and the characteristics required for the pressure-sensitive adhesive layer 3 in the die bonding step can be achieved in a well-balanced manner, and excellent pickup properties can also be achieved.

5 [0042] When the content of the crosslinking agent is less than 3 parts by mass with respect to 100 parts by mass of the content of the (meth)acrylic resin, formation of the crosslinked structure is likely to be insufficient, and due to this, the interface adhesive force to the adhesive layer 5 is not sufficiently decreased while failure is likely to occur at the
10 time of picking up in the pickup step. On the other hand, when the content of the crosslinking agent is more than 30 parts by mass with respect to 100 parts by mass of the content of the (meth)acrylic resin, the pressure-sensitive adhesive layer 3 is likely to be excessively hard, and due to this, semiconductor chips are likely to peel off in the
15 expansion step.

[0043] The content of the crosslinking agent with respect to the total mass of the pressure-sensitive adhesive composition is, for example, 0.1% to 20% by mass and may be 3% to 17% by mass or 5% to 15% by mass. When the content of the crosslinking agent is 0.1% by mass or
20 more, a region in which the tack force has been appropriately decreased (first region 3a) by irradiation with active energy rays is easily formed, and when the content is 15% by mass or less, excellent pickup properties are likely to be achieved.

[0044] The thickness of the pressure-sensitive adhesive layer 3 may be
25 appropriately set according to the conditions (temperature, tensile force, and the like) of the expansion step, and for example, the thickness is 1

to 200 μm , preferably 5 to 50 μm , and more preferably 10 to 20 μm . When the thickness of the pressure-sensitive adhesive layer 3 is less than 1 μm , pressure-sensitive adhesiveness is likely to be insufficient, and when the thickness is more than 200 μm , the kerf width is narrow at the time of expanding (stress is relieved when the pin is pushed up), and pickup is likely to be achieved insufficiently.

[0045] The pressure-sensitive adhesive layer 3 is formed on the base material layer 1. Regarding the method for forming the pressure-sensitive adhesive layer 3, a known technique can be employed. For example, a laminated body of the base material layer 1 and the pressure-sensitive adhesive layer 3 may be formed by a two-layer extrusion method; a varnish for forming the pressure-sensitive adhesive layer 3 may be prepared, and this varnish may be applied on the surface of the base material layer 1; or the pressure-sensitive adhesive layer 3 may be formed on a release-treated film, and this may be transferred onto the base material layer 1.

[0046] It is preferable that the varnish for forming the pressure-sensitive adhesive layer 3 is prepared using an organic solvent that can dissolve the (meth)acrylic resin, the photopolymerization initiator, and the crosslinking agent, the organic solvent being 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-methylpyrrolidone.

[0047] Among these, from the viewpoints of solubility and the boiling point, preferred examples include 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. Regarding these organic solvents, one kind thereof may be used alone, or two or more kinds thereof may be used in combination. The solid content concentration of the varnish is usually preferably 10% to 60% by mass.

5 [0048] (Base material layer)

Regarding the base material layer 1, a known polymer sheet or film can be used, and the polymer sheet or film is not particularly limited as long as the expansion step can be carried out using it under low temperature conditions. Specific examples of the base material

10 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; polyesters such as an ethylene-vinyl acetate copolymer, an ionomer

15 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, polyethylene terephthalate, and polyethylene naphthalate; polycarbonate, polyimide, polyether ether ketone, polyimide,

20 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.

25 [0049] It is preferable that the base material layer 1 has a surface having at least one resin selected from polyethylene, polypropylene, a

polyethylene-polypropylene random copolymer, and a polyethylene-polypropylene block copolymer as a main component, this surface being in contact with the pressure-sensitive adhesive layer 3. These resins are 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 but may also have a multilayer structure in which layers formed from different materials are laminated, as necessary. In order to control the adhesiveness to the pressure-sensitive 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.

[0050] (Adhesive layer)

To the adhesive layer 5, an adhesive composition that constitutes a known die-bonding film can be applied. Specifically, it is preferable that the adhesive composition constituting the adhesive layer 5 contains an epoxy group-containing acrylic copolymer, an epoxy resin, and an epoxy resin curing agent. An adhesive layer 5 including these components have features that the 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, which is preferable.

[0051] 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, and bifunctional epoxy resins and novolac type epoxy resins, such as alkyl-substituted products, halides, and hydrogenation products of these. 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.

[0052] Regarding the epoxy resin curing agent, for example, an agent such as 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-xyleneol, 2,6-xyleneol, 3,5-xyleneol, 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.

5 These phenol compounds may be used singly, or two or more kinds thereof may be used as mixtures. Regarding the xylylene compound as 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, examples include α,α' -dichloro-p-xylene,

10 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,

15 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,

20 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

25 can be used singly or in combination of two or more kinds thereof.

[0053] When the above-described phenol compound and a xylylene compound are caused to react, an epoxy resin curing agent 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 may vary depending on the raw materials and the reaction temperature; however, the reaction time is approximately about 1 hour to 15 hours, and practically, the reaction time may be determined while tracking the reaction composition by GPC (gel permeation chromatography) or the like.

[0054] It is preferable that the epoxy group-containing acrylic copolymer is a copolymer obtained by using glycidyl acrylate or glycidyl methacrylate as a raw material in an amount of 0.5% to 6% by mass with respect to the obtainable copolymer. When this amount is 0.5% by mass or more, high adhesive force is likely to be obtained, while on the other hand, when the amount is 6% by mass or less,

gelation can be suppressed. For the remaining portion, a mixture of alkyl acrylates and alkyl methacrylates having an alkyl group with 1 to 8 carbon atoms, such as methyl acrylate and methyl methacrylate, styrene, acrylonitrile, and the like can be used. Among these, ethyl (meth)acrylate and/or butyl (meth)acrylate is particularly preferred. It is preferable that the mixing ratio is adjusted by considering the Tg of the copolymer. When the Tg is below -10°C, the tackiness of the adhesive layer 5 in the B stage state tends to increase, and handleability tends to be deteriorated. Incidentally, the upper limit value of the glass transition point (Tg) of the epoxy group-containing acrylic copolymer is, for example, 30°C. The polymerization method is not particularly limited, and examples include pearl polymerization and solution polymerization. Examples of a commercially available epoxy group-containing acrylic copolymer include HTR-860P-3 (trade name, manufactured by Nagase ChemteX Corp.).

[0055] The weight average molecular weight of the epoxy group-containing acrylic copolymer is 100000 or more, high adhesiveness and heat resistance are obtained when the weight average molecular weight is in this range, and the weight average molecular weight is preferably 300000 to 3000000, and more preferably 500000 to 2000000. When the weight average molecular weight is 3000000 or less, the fillability between a semiconductor chip and a substrate supporting this semiconductor chip can be suppressed from decreasing. The weight average molecular weight is a polystyrene-equivalent value obtained by gel permeation chromatography (GPC) using a calibration curve based on polystyrene standards.

[0056] The adhesive layer 5 may further contain a curing accelerator such as a tertiary amine, an imidazole, or a quaternary ammonium salt, as necessary. 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.

[0057] The adhesive layer 5 may further contain an inorganic filler as necessary. 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.

[0058] The thickness of the adhesive layer 5 is, for example, 1 to 300 μm , and the thickness is preferably 5 to 150 μm , and more preferably 10 to 100 μm . When the thickness of the adhesive layer 5 is less than 1 μm , adhesiveness is likely to become insufficient, and when the thickness is more than 300 μm , the dividability at the time of expansion and the pickup properties are likely to become insufficient.

[0059] Incidentally, the adhesive layer 5 may be an embodiment that does not include a thermosetting resin. For example, when the adhesive layer 5 includes a reactive group-containing (meth)acrylic copolymer, the adhesive layer 5 may be a layer including a reactive group-containing (meth)acrylic copolymer, a curing accelerator, and a

filler.

[0060] <Method for producing dicing/die-bonding integrated film>

5 A method for producing the film 10 includes a step of producing, on the surface of a base material layer 1, a laminated body including a pressure-sensitive adhesive layer formed from a pressure-sensitive adhesive composition whose tack force is decreased by irradiation with active energy rays, and an adhesive layer 5 formed on the surface of the pressure-sensitive adhesive layer; and a step of irradiating a region constituting the first region 3a of the pressure-sensitive adhesive layer included in the laminated body with active energy rays, in this order. The amount of irradiation with active energy rays for the region constituting the first region 3a is, for example, 10 to 1000 mJ/cm² and may be 100 to 700 mJ/cm² or 200 to 500 mJ/cm².

15 [0061] The above-described production method is a method of first producing a laminated body of a pressure-sensitive adhesive layer and an adhesive layer 5 and then irradiating a particular region of the pressure-sensitive adhesive layer with active energy rays. As will be described below, the first region 3a may also be formed by irradiating the pressure-sensitive adhesive layer before being stuck to the adhesive layer 5, with active energy rays. That is, the method for producing the film 10 may include a step of forming a pressure-sensitive adhesive layer formed from a composition whose tack force is decreased by irradiation with active energy rays, on the surface of a base material layer 1; a step of irradiating a region constituting the first region 3a of the pressure-sensitive adhesive layer with active energy rays; and a step

of laminating an adhesive layer 5 on the surface of the pressure-sensitive adhesive layer after being irradiated with active energy rays, in this order.

[0062] <Semiconductor device and method for producing the same>

5 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
10 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.

[0063] The substrate 70 is, for example, an organic substrate and may be a metal substrate such as a lead frame. From the viewpoint of
15 suppressing warpage of the semiconductor device 100, the thickness of the substrate 70 is, for example, 70 to 140 μm and may be 80 to 100 μm .

[0064] The four chips S1, S2, S3, and S4 are laminated with a cured product 5C of an adhesive piece 5P interposed therebetween. The
20 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 30 to 250 mm^2 and may be 40 to 200 mm^2 or 50 to 150 mm^2 . The length of one side of the chips S1, S2, S3, and S4 is, for example, 6.0 mm or more and may be 7.0 to 18 mm or 8.0 to 15 mm. The
25 thickness of the chips S1, S2, S3, and S4 is, for example, 10 to 150 μm and may be 20 to 80 μm . Incidentally, the length of one side of the

four chips S1, S2, S3, and S4 may be identical or may be different from each other, and the same also applies to the thickness. Furthermore, the four chips S1, S2, S3, and S4 may be chips having a relatively small size. That is, the area of the chips S1, S2, S3, and S4 may be less than 30 mm² and may be, for example, 0.1 to 20 mm² or 1 to 15 mm².

[0065] A method for producing the semiconductor device 100 includes the following steps:

(A) preparing a film 10;

(B) subjecting a wafer W to stealth dicing or half-cutting by means of a blade;

(C) sticking the wafer W to a region R_w corresponding to the first region in the adhesive layer 5;

(D) singulating the wafer W and the adhesive layer 5 by expanding the base material layer 1 under cooling conditions and obtaining an adhesive piece-attached chip 8;

(E) irradiating the pressure-sensitive adhesive layer 3 with active energy rays to decrease the tack force of the pressure-sensitive adhesive layer 3 with respect to the adhesive piece-attached chip 8;

(F) picking up from the adhesive piece-attached chip 8 from the pressure-sensitive adhesive layer 3 in a state in which the base material layer 1 is expanded; and

(G) mounting the adhesive piece-attached chip 8 on the substrate or another chip.

[0066] An example of the method for producing the semiconductor device 100 will be specifically described. First, a protective film (also called BG tape) is stuck to a circuit surface Wa of a wafer W. The

wafer W is irradiated with a laser to form a plurality of scheduled cutting lines L (stealth dicing). Subsequently, the wafer W is treated by back grinding and polishing as necessary. Incidentally, stealth dicing by means of a laser has taken as an example herein; however, it is also acceptable to subject the wafer W to half-cutting by means of a blade. Half-cutting means forming incisions corresponding to the scheduled cutting lines L of the wafer W, instead of cutting the wafer W. [0067] Next, as shown in FIG. 5(a), the film 10 is stuck to the back surface Wb of the wafer W such that the adhesive layer 5 comes into contact with the back surface Wb. Furthermore, a dicing ring DR is stuck to the second region 3b of the pressure-sensitive adhesive layer 3. Subsequently, the wafer W and the adhesive layer 5 are singulated by cooling and expansion under the temperature conditions of 0°C to -15°C. That is, as shown in FIG. 5(b), tensile force is applied to the base material layer 1 by pushing up the base material layer 1 at an inner region 1a of the dicing ring DR with a ring Ra. As a result, the wafer W is divided along the scheduled cutting lines L, and concomitantly with this, the adhesive layer 5 is divided into adhesive pieces 5P, so that a plurality of adhesive piece-attached chips 8 are obtained on the surface of the pressure-sensitive adhesive layer 3. An adhesive piece-attached chip 8 is composed of a chip S and an adhesive piece 5P. [0068] The inner region 1a of the dicing ring DR in the base material layer 1 is caused to shrink by heating the inner region 1a. FIG. 6(a) is a cross-sectional view schematically illustrating the situation in which the inner region 1a is heated by means of blowing by a heater H. By causing the inner region 1a to shrink in an annular form to apply tensile

force to the base material layer 1, the distances between adjacent adhesive piece-attached chips 8 can be widened. As a result, the occurrence of pickup errors can be further suppressed, and the visibility of the adhesive piece-attached chips 8 in the pickup step can be enhanced.

[0069] Next, as shown in FIG. 6(b), the tack force of the pressure-sensitive adhesive layer 3 is decreased by irradiation with activation energy (for example, ultraviolet radiation UV). The amount of irradiation of the pressure-sensitive adhesive layer 3 with active energy rays is, for example, 10 to 1000 mJ/cm² and may be 100 to 700 mJ/cm² or 200 to 500 mJ/cm². Subsequently, as shown in FIG. 6(c), the adhesive piece-attached chip 8 is peeled from the pressure-sensitive adhesive layer 3 by pushing up the adhesive piece-attached chip 8 with a push-up jig 42, and the adhesive piece-attached chip 8 is suctioned with a suction collet 44 and picked up.

[0070] The adhesive piece-attached chip 8 is conveyed to a semiconductor device assembling apparatus (not shown in the diagram) and pressure-bonded on a circuit substrate or the like. As shown in FIG. 7(a), a first-stage chip S1 (chip S) is pressure-bonded at a predetermined position of the substrate 70, with the adhesive piece 5P interposed therebetween. Next, the adhesive piece 5P is cured by heating. As a result, the adhesive piece 5P is cured to form a cured product 5C. The curing treatment of the adhesive piece 5P may be carried out in a pressurized atmosphere, from the viewpoint of reducing voids.

[0071] A second-stage chip S2 is mounted on the surface of the chip S1

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(b) is produced. The chips S1, S2, S3, and S4 and the substrate 70 are electrically connected with wires W1, W2, W3, and W4, and then the semiconductor elements and the wires are encapsulated by an encapsulation layer 50 to complete the semiconductor device 100 shown in FIG. 4.

Examples

[0072] Hereinafter, the present disclosure will be more specifically described based on Examples; however, the present invention is not limited to these Examples. Incidentally, unless particularly stated otherwise, reagents were used for all the chemicals.

[0073] <Example 1>

[Synthesis of acrylic resin]

An acrylic resin to be blended into the pressure-sensitive adhesive layer was synthesized as follows. That is, 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.

- Ethyl acetate (solvent): 635 g
- 2-Ethylhexyl acrylate: 395 g
- 2-Hydroxyethyl acrylate: 100 g
- Methacrylic acid: 5 g
- Azobisisobutyronitrile: 0.2 g

[0074] 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, 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 at 120°C and 0.28 MPa and then cooled to room temperature (25°C; hereinafter, the same).

[0075] Next, 490 g of ethyl acetate was added thereto, and then the mixture was stirred and diluted. To this, 0.025 g of methoquinone as a polymerization inhibitor and 0.10 g of dioctyltin dilaurate as a urethanization catalyst were added, subsequently 81 g of 2-methacryloxyethyl 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. Subsequently, ethyl acetate was added thereto, the non-volatile component content in the acrylic resin solution was adjusted to be 35% by mass, and (A) an acrylic resin solution having a functional group capable of chain polymerization was obtained.

[0076] The solution including the (A) acrylic resin 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 introduced 2-methacryloxyethyl isocyanate was calculated from the nitrogen content, and the content was 0.89 mmol/g.

[0077] Furthermore, the polystyrene-equivalent weight average molecular weight of the (A) acrylic resin 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
5 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 350000.

[0078] [Production of dicing film]

10 A varnish for forming a pressure-sensitive adhesive layer was prepared by mixing the following components. A pressure-sensitive adhesive layer formed by this varnish is cured by being irradiated with ultraviolet radiation. The amount of ethyl acetate (solvent) was adjusted such that the total solid content of the varnish was 25% by
15 mass.

(A) Acrylic resin solution: 100 parts by mass (solid content)

(B) Photopolymerization initiator (1-hydroxycyclohexyl phenyl ketone, manufactured by Ciba Specialty Chemicals, Inc., IRGACURE 184, "IRGACURE" is a registered trademark): 2.0 parts by mass

20 (C) Crosslinking agent (polyfunctional isocyanate, manufactured by Nippon Polyurethane Industry Co., Ltd., CORONATE L, solid content 75%): 1.1 parts by mass (solid content)

Ethyl acetate (solvent)

[0079] A polyethylene terephthalate film (width 450 mm, length 500
25 mm, thickness 38 μ m) that had been subjected to a release treatment on one surface was prepared. The varnish for forming a

pressure-sensitive adhesive layer was applied using an applicator on the surface that had been subjected to a peeling 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 a pressure-sensitive adhesive layer (thickness 10 μm) formed thereon was obtained.

[0080] A polyolefin film (width 450 mm, length 500 mm, thickness 100 μm) that had been subjected to a release treatment on one surface was prepared. The surface that had been subjected to a corona treatment and the pressure-sensitive adhesive layer of the laminated body were stuck together at room temperature. Next, the pressure-sensitive 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 dicing film including a pressure-sensitive adhesive layer.

[0081] [Production of die-bonding film]

Cyclohexanone was added to the following components, the mixture was stirred and mixed, and then the mixture was kneaded for 90 minutes using a bead mill.

Epoxy resin (YDCN-703 (trade name), manufactured by Nippon Steel Chemical & Material Co., Ltd., cresol novolac type epoxy resin, epoxy equivalent 210, molecular weight 1200, softening point 80°C): 55 parts by mass

Phenol resin (MILEX XLC-LL (trade name), manufactured by Mitsui Chemicals, Inc., hydroxyl group equivalent 175, coefficient of water absorption 1.8%, heating weight reduction rate at 350°C 4%): 45

parts by mass

Silane coupling agent 1 (NUC A-189 (trade name),
manufactured by Nippon Unicar Co., Ltd.,
 γ -mercaptopropyltrimethoxysilane): 1.7 parts by mass

5 Silane coupling agent 2 (NUCA-1160 (trade name),
manufactured by Nippon Unicar Co., Ltd.,
 γ -ureidopropyltriethoxysilane): 3.2 parts by mass

10 Filler (AEROSIL R972 (trade name), manufactured by Nippon
Aerosil Co., Ltd., silica, average particle size 0.016 μ m): 32 parts by
mass

15 Incidentally, "AEROSIL R972" is silica particles having an
organic group (for example, a methyl group) on the surface and is a
product obtained by coating the surface of silica particles with
dimethyldichlorosilane and performing hydrolysis in a reactor at 400°C.
[0082] The following components were added to the mixture of the
above-described components, and the mixture was stirred and mixed.
Subsequently, vacuum degassing was performed to obtain a varnish for
forming an adhesive layer.

20 Acrylic rubber (HTR-860P-3 (trade name), manufactured by
Nagase ChemteX Corp., content of glycidyl acrylate or glycidyl
methacrylate: 3% by mass, weight average molecular weight 800000):
280 parts by mass

25 Curing accelerator (CUREZOL 2PZ-CN (trade name),
"CUREZOL" is a registered trademark, manufactured by Shikoku
Chemicals Corp., 1-cyanoethyl-2-phenylimidazole): 0.5 parts by mass
[0083] A polyethylene terephthalate film (thickness 35 μ m) that had

been subjected to a release treatment on one surface was prepared. The varnish for forming an adhesive layer was applied on the surface that had been subjected to a peeling treatment, and then the film 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 an adhesive layer in the B stage state (thickness 10 μm) formed thereon was obtained.

[0084] [Production of dicing/die-bonding integrated film]

The die-bonding film obtained as described above was cut into a circular shape (diameter: 312 mm) together with the carrier film. To this, a dicing tape from which the cover 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 tape was cut into a circular shape (diameter: 370 mm). A region (first region of pressure-sensitive adhesive layer) corresponding to a wafer sticking position in the adhesive layer of the dicing/die-bonding integrated film obtained as such, was irradiated with ultraviolet radiation under the following conditions using a high-pressure mercury lamp.

Main wavelength of ultraviolet radiation: 365 nm

Illuminance of ultraviolet radiation: 13 mW/cm²

Amount of irradiation with ultraviolet radiation: 20 mJ/cm²

First region of pressure-sensitive adhesive layer: Circular shape having a diameter of 302 mm

[0085] The dicing/die-bonding integrated film according to the present embodiment was obtained as described above. Incidentally, a plurality of dicing/die-bonding integrated films to be subjected to the various

evaluation tests that will be described below were produced.

[0086] <Example 2>

5 A plurality of dicing/die-bonding integrated films were obtained in the same manner as in Example 1, except that the amount of irradiation with ultraviolet radiation was set to 30 mJ/cm², instead of 20 mJ/cm².

[0087] <Example 3>

10 A plurality of dicing/die-bonding integrated films were obtained in the same manner as in Example 2, except that when the varnish for forming a pressure-sensitive adhesive layer was prepared, the amount of the crosslinking agent was set to 0.45 parts by mass, instead of 1.1 parts by mass.

[0088] <Comparative Example 1>

15 A plurality of dicing/die-bonding integrated films were obtained in the same manner as in Example 2, except that when the varnish for forming a pressure-sensitive adhesive layer was prepared, the amount of the crosslinking agent was set to 4.1 parts by mass, instead of 1.1 parts by mass.

[0089] <Comparative Example 2>

20 A plurality of dicing/die-bonding integrated films were obtained in the same manner as in Example 2, except that the amount of irradiation with ultraviolet radiation was set to 50 mJ/cm², instead of 30 mJ/cm².

[0090] <Comparative Example 3>

25 A plurality of dicing/die-bonding integrated films were obtained in the same manner as in Example 1, except that ultraviolet irradiation

was not carried out.

[0091] <Comparative Example 4>

A plurality of dicing/die-bonding integrated films were obtained in the same manner as in Example 3, except that ultraviolet irradiation was not carried out.

[0092] [Evaluation tests]

(1) Measurement of tack force (30° peel strength) of pressure-sensitive adhesive layer (after the first ultraviolet irradiation)

The tack force of the pressure-sensitive adhesive layer with respect to the adhesive layer of the dicing/die-bonding integrated films according to Examples and Comparative Examples was evaluated by measuring the 30° peel strength. That is, a sample having a width of 25 mm and a length of 100 mm was cut out from each dicing/die-bonding integrated film. The peel strength of the pressure-sensitive adhesive layer with respect to the adhesive layer was measured using a tensile testing machine. The measurement conditions were set to a peeling angle of 30° and a tensile speed of 60 mm/min. Incidentally, the storage of the sample 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 dicing/die-bonding integrated films according to Examples 1 to 3 and Comparative Examples 1 and 2 are films that were subjected to ultraviolet irradiation once. The results are shown in Table 1 and Table 2. Comparative Examples 3 and 4 were not irradiated with ultraviolet radiation in the process for the dicing/die-bonding integrated films; however, the results are described in the column of "First ultraviolet irradiation" in Table 2

for convenience.

[0093] (2) Measurement of tack force (30° peel strength) of pressure-sensitive adhesive layer (after the second ultraviolet irradiation)

5 The dicing/die-bonding integrated films according to Examples 1 to 3 and Comparative Examples 1 and 2 were irradiated with ultraviolet radiation for the second time under the following conditions corresponding to the second ultraviolet irradiation that is carried out before the picking up of adhesive piece-attached chips. Subsequently, regarding the tack force of the pressure-sensitive adhesive layer with respect to the adhesive layer, the 30° peel strength was measured under the conditions such as described above. The results are shown in Table 1 and Table 2. Incidentally, since Comparative Examples 3 and 4 were not irradiated with ultraviolet radiation in the process for the dicing/die-bonding integrated films, although the irradiation was the first ultraviolet irradiation, the results are described in the column of "Second ultraviolet irradiation" in Table 2 for convenience.

<Conditions for the second ultraviolet irradiation>

Main wavelength of ultraviolet radiation: 365 nm

20 Illuminance of ultraviolet radiation: 100 mW/cm²

Amount of irradiation with ultraviolet radiation: 150 mJ/cm²

[0094] (2) Evaluation of processing properties

(i) Production of sample for evaluation of processing properties

25 A protective tape (BG tape) was stuck to the surface of a silicon wafer (diameter: 12 inches, thickness: 775 μm). Subsequently, the silicon wafer was subjected to stealth dicing. That is, a modified layer

was formed in the inner part of the silicon wafer by irradiating a surface (back surface) of the silicon wafer on the opposite side of the side where the BG tape was stuck, with laser light under the following conditions.

<Conditions for stealth dicing>

5 Stealth dicing apparatus: DFL7361 (manufactured by DISCO Corp.)

Laser oscillator model: Semiconductor laser excitation Q-switch solid-state laser

Wavelength: 1342 nm

10 Main frequency: 90 kHz

Output power: 1.7 W

Number of passes: 2

Chip size: 10 mm × 10 mm

Dicing speed: 700 mm/second

15 [0095] The silicon wafer after stealth dicing was polished until the thickness reached 30 μm. For the polishing, a grinder polisher apparatus (DGP8761, manufactured by DISCO Corp.) was used. A dicing/die-bonding integrated film was stuck to the silicon wafer after polishing and a dicing ring under the following conditions.

20 Subsequently, the BG tape was peeled off from the surface of the silicon wafer.

<Conditions for sticking>

Sticking apparatus: DFM2800 (manufactured by DISCO Corp.)

Sticking temperature: 70°C

25 Sticking speed: 10 mm/s

Sticking tension level: Level 6

[0096] Next, cooling and expansion was performed under the following conditions using a die separator (DDS2300, manufactured by DISCO Corp.). Subsequently, the base material layer (polyethylene terephthalate film) of the dicing/die-bonding integrated film was subjected to heat shrinking under the following conditions. By performing these steps, the silicon wafer and the adhesive layer were singulated into a plurality of adhesive piece-attached chips (size 10 mm × 10 mm).

<Conditions for cooling and expansion>

Cooling temperature: -15°C

Cooling time: 120 seconds

Push-up quantity: 12 mm

Push-up speed: 200 mm/second

Retention time after push-up: 3 seconds

<Conditions for heat shrinking>

Heater temperature: 220°C

Speed of heater rotation: 5°/second

Push-up quantity: 8 mm

Tape cooling waiting time: 10 seconds

[0097] After the silicon wafer and the adhesive layer were singulated, the pressure-sensitive adhesive layer was subjected to ultraviolet irradiation under the following conditions. As a result, the pressure-sensitive adhesive layer was cured to decrease the tack force with respect to the adhesive layer.

<Conditions for ultraviolet irradiation>

Illuminance of ultraviolet radiation: 100 mW/cm²

Amount of irradiation with ultraviolet radiation: 150 mJ/cm²

[0098] (ii) Evaluation of each processing characteristic

(DAF scattering)

5 After the cooling and expansion and the heat shrinking, DAF scattering was evaluated according to the following criteria.

A: DAF scattering did not occur at all.

B: DAF scattering did not occur; however, peeling or lifting was recognized at the interface between the adhesive layer and the pressure-sensitive adhesive layer.

10 C: DAF scattering occurred at at least one site.

[0099] (Chip edge peeling)

15 After the cooling and expansion and the heat shrinking, peeling of the adhesive layer and the pressure-sensitive adhesive layer at the edge portion of the adhesive piece-attached chip was evaluated according to the following criteria.

A: Peeling at the edge portion was not observed at all.

B: Peeling was observed at a length of 1 mm or more and less than 2 mm from the edge portion.

20 C: Peeling was observed at a length of 2 mm or more and less than 3 mm from the edge portion.

D: Peeling was observed at a length of 3 mm or more from the edge portion.

[0100] (Dividability of adhesive layer)

25 The entire surface of the silicon wafer after the cooling and expansion and the heat shrinking was observed with a microscope, and the dividability of the adhesive layer was evaluated according to the

following criteria.

A: The adhesive layer was completely divided.

D: There was an undivided portion at at least one site of the adhesive layer.

5 [0101] (Kerf width)

The distance between the adhesive layer-attached chips after singulation (kerf width) was measured using a microscope. The kerf widths in the MD and TD directions at two sites each of the outer peripheral part (up, down, right, and left) and one site at the center part of the silicon wafer were respectively measured (18 points in total), and the average value was determined. The kerf width was evaluated according to the following criteria.

S: The average value of the kerf width was 100 μm or more and less than 150 μm .

15 A: The average value of the kerf width was 70 μm or more and less than 100 μm .

B: The average value of the kerf width was 50 μm or more and less than 70 μm .

[0102] (Pickup properties)

20 After the above-described evaluations were performed, one hundred adhesive piece-attached chips were picked up under the following conditions.

<Conditions for pick-up>

25 Die-bonder apparatus: DB-830P (manufactured by Fasford Technology Co., Ltd.)

Push-up pin: EJECTOR NEEDLE SEN2-83-05 (diameter: 0.7

mm, tip shape: hemisphere with a radius of 350 μm , manufactured by Micro-Mechanics Sdn Bhd)

Push-up height: 250 μm

Push-up speed: 1 mm/second

5 Number of push-up pins: 9 units

<Evaluation criteria>

A: The success rate of pick-up was 100%.

B: The success rate of pick-up was 80% or higher and lower than 100%.

10 C: The success rate of pick-up was 60% or higher and lower than 80%.

[0103] [Table 1]

		Ex. 1	Ex. 2	Ex. 3
Blending amount of crosslinking agent in varnish for forming pressure-sensitive adhesive layer (parts by mass)		1.1	1.1	0.45
First ultraviolet irradiation	Amount of irradiation (mJ/cm ²)	20	30	30
	30° peel strength thereafter (N/25 mm)	11.1	8.4	12.0
Second ultraviolet irradiation	Amount of irradiation (mJ/cm ²)	150	150	150
	30° peel strength thereafter (N/25 mm)	1.0	0.96	1.0
Processing properties evaluation results	DAF scattering	A	A	A
	Chip edge peeling	A	A	A
	Adhesive layer dividability	A	A	A
	Kerf width	S	S	A
	Pickup properties	A	A	A

[0104] [Table 2]

		Comp. Ex. 1	Comp. Ex. 2	Comp. Ex. 3	Comp. Ex. 4
Blending amount of crosslinking agent in varnish for forming pressure-sensitive adhesive layer (parts by mass)		4.1	1.1	1.1	0.45
First ultraviolet irradiation	Amount of irradiation (mJ/cm ²)	30	50	-	-
	30° peel strength thereafter (N/25 mm)	5.8	4.1	12.7	17.6
Second ultraviolet irradiation	Amount of irradiation (mJ/cm ²)	150	150	150	150
	30° peel strength thereafter (N/25 mm)	0.90	0.97	1.1	1.1
Processing properties evaluation results	DAF scattering	A	B	A	A
	Chip edge peeling	B	D	A	A
	Adhesive layer dividability	A	A	A	A
	Kerf width	B	B	B	A
	Pickup properties	B	A	B	C

[0105] The films according to Examples 1 to 3 all exhibited satisfactory results for the evaluation of processing properties. Particularly, in Examples 1 and 2, the evaluation of the kerf width was "S". In Example 3, the evaluation of the kerf width was "A", which was the same as that of Comparative Example 3; however, the MD/TD balance was more satisfactory than Comparative Example 3. The kerf width is one of the items considered important for the process of stealth dicing from the viewpoint of achieving excellent pickup properties.

Industrial Applicability

[0106] According to the present disclosure, a dicing/die-bonding integrated film which can be conveniently used by users and are useful

for efficiently producing semiconductor devices, and a method for producing the dicing/die-bonding integrated film are provided. Furthermore, according to the present disclosure, a method for producing a semiconductor device using the above-described dicing/die-bonding integrated film is provided.

Reference Signs List

[0107] 1: base material layer, 3: pressure-sensitive adhesive layer, 3a: first region, 3b: second region, 5: adhesive layer, 8: adhesive piece-attached chip, 10: dicing/die-bonding integrated film, W: wafer.

CLAIMS

1. A method for producing a semiconductor device, the method comprising steps of:

5 (A) preparing a dicing/die-bonding integrated film having a base material layer, a pressure-sensitive adhesive layer, and an adhesive layer laminated in order, the pressure-sensitive adhesive layer having a first region in which a tack force with respect to the adhesive layer has been decreased in advance by irradiation with active energy rays;

10 (B) subjecting a wafer to stealth dicing or half-cutting by means of a blade;

(C) sticking the wafer to a region corresponding to the first region in the adhesive layer;

15 (D) singulating the wafer and the adhesive layer by expanding the base material layer under cooling conditions to obtain an adhesive piece-attached chip;

(E) irradiating the pressure-sensitive adhesive layer with active energy rays to decrease the tack force of the pressure-sensitive adhesive layer with respect to the adhesive piece-attached chip;

20 (F) picking up the adhesive piece-attached chip from the pressure-sensitive adhesive layer in a state in which the base material layer is expanded; and

(G) mounting the adhesive piece-attached chip on a substrate or another chip,

25 wherein with regard to the dicing/die-bonding integrated film in step (A), the tack force of the first region with respect to the adhesive layer is from 6.0 N/25 mm to 12.5 N/25 mm as measured under

conditions of a peeling angle of 30° and a peeling speed of 60 mm/min at a temperature of 23°C.

2. The method for producing a semiconductor device according to claim 1, wherein the adhesive piece-attached chip obtainable in step (D) has a square or rectangular shape in a plan view and has a side measuring 6.0 mm or more.

3. The method for producing a semiconductor device according to claim 1 or 2,

wherein the pressure-sensitive adhesive layer has a second region in which the tack force with respect to the adhesive layer is larger than that of the first region, and a dicing ring is stuck to the second region simultaneously with step (C) or before step (D).

4. A dicing/die-bonding integrated film comprising:

a base material layer;

an adhesive layer; and

a pressure-sensitive adhesive layer disposed between the base material layer and the adhesive layer and having a first region in which a tack force with respect to the adhesive layer has been decreased in advance by irradiation with active energy rays,

wherein the tack force of the first region with respect to the adhesive layer is from 6.0 N/25 mm to 12.5 N/25 mm as measured under conditions of a peeling angle of 30° and a peeling speed of 60 mm/min at a temperature of 23°C.

5. The dicing/die-bonding integrated film according to claim 4, wherein after the first region is irradiated with ultraviolet radiation in an amount of 150 mJ/cm², the tack force of the first region with respect to

the adhesive layer is 1.2 N/25 mm or less 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.

5 6. The dicing/die-bonding integrated film according to claim 4 or 5, wherein the dicing/die-bonding integrated film is applied to a semiconductor device production process including a step of singulating a wafer into a plurality of chips each having an area of 30 to 250 mm².

10 7. The dicing/die-bonding integrated film according to any one of claims 4 to 6, wherein the pressure-sensitive adhesive layer has a second region in which the tack force with respect to the adhesive layer is larger than that of the first region.

8. A method for producing the dicing/die-bonding integrated film according to any one of claims 4 to 7, the method comprising successive steps of:

15 producing a laminated body on a surface of the base material layer, wherein the laminated body includes a pressure-sensitive adhesive layer formed from a composition whose tack force is decreased by irradiation with active energy rays; and the adhesive layer formed on a surface of the pressure-sensitive adhesive layer; and

20 irradiating a region constituting the first region of the pressure-sensitive adhesive layer included in the laminated body with active energy rays.

25 9. A method for producing the dicing/die-bonding integrated film according to any one of claims 4 to 7, the method comprising successive steps of:

 forming a pressure-sensitive adhesive layer on a surface of the

base material layer, wherein the pressure-sensitive adhesive layer is formed from a composition whose tack force is decreased by irradiation with active energy rays;

5 irradiating a region constituting the first region of the pressure-sensitive adhesive layer with active energy rays; and

 laminating the adhesive layer on a surface of the pressure-sensitive adhesive layer after being irradiated with active energy rays.