

DESCRIPTION

Title of Invention

SHEET FOR FORMING RESIN FILM AND COMPOSITE SHEET FOR FORMING RESIN FILM

Technical Field

[0001]

The present invention relates to a resin film-forming sheet, and a resin film-forming composite sheet.

Background Art

[0002]

These days, the fabricating of a semiconductor device using a mounting method of what is called the face-down system is performed. In the face-down system, a semiconductor chip (hereinafter, occasionally simply referred to as a "chip") having electrodes such as bumps on a circuit surface is used, and the electrodes are joined to a substrate. Hence, there is a case where the surface of a chip on the side opposite to the side bonded to the circuit surface (hereinafter, occasionally simply referred to as "the back surface of the chip") is exposed.

[0003]

On the exposed back surface of the chip, a resin film of an organic material may be formed, and may be incorporated into a semiconductor device as a resin film-having chip. The resin film is formed as a protective film for preventing cracking in a singulation step or after packaging, or as an adhesive film for adhering the resultant chip onto any other member such as a die pad member or any other different semiconductor chip or the like.

In general, the resin film-having chip may be produced according to a spin coating method or the like where a solution of a resin-containing composition is applied onto the back surface of a wafer to form a coating film thereon and then the coating film is dried and cured to give a resin film, and thereafter the resultant resin film-having wafer is singulated.

[0004]

As such a material for forming, on the back surface of a chip or on the back surface of a wafer, a protective film or an adhesive film, various resin film-forming

sheets have been proposed.

For example, PTL 1 discloses a chip-protective film having such a configuration in which an energy ray-curable protective film-forming layer containing a polymer component of an acrylic copolymer, an energy ray-curable component, a dye or a pigment, an inorganic filler and a photopolymerization initiator is sandwiched between two release sheets.

The description in PTL 1 says that the chip-protective film can form a protective film having good laser marking recognition performance, hardness and adhesiveness to wafer through irradiation with energy rays, and that the process for the film can be simplified as compared with that for conventional chip-protective films.

[0005]

PTL 2 discloses a singulation tape-integrated wafer back surface-protective film, which has a singulation tape having a substrate and a pressure sensitive adhesive layer, and which has, on the pressure sensitive adhesive layer of the singulation tape, a wafer back surface-protective film colored and having a given elastic modulus.

The description in PTL 2 says that the wafer back surface-protective film exhibits a good holding power to a semiconductor wafer in a step of singulation of semiconductor wafers.

Citation List

Patent Literature

[0006]

PTL 1: JP-A 2009-138026

PTL-2: JP-A 2010-199543

Summary of Invention

Technical Problem

[0007]

In a step of sticking the protective film described in PTLs 1 and 2 to a wafer, where the position of the protective film misaligns or where a protective film is stuck along with some unnoticed foreign substances on a wafer, it is difficult to rework the wafer by peeling the protective film.

The protective films disclosed in PTLs 1 and 2 are for improving the

adhesiveness thereof to wafer in sticking, and for improving the holding power thereof to wafer after sticking, and therefore once stuck onto a wafer, the protective film exhibits high adhesiveness to the wafer and is therefore problematic in reworkability. When a protective film once stuck to a wafer is tried to be forcibly peeled, the wafer may be broken by the peeling force or a part of the protective film may remain on the wafer. Consequently, the wafer once stuck to a protective film is difficult to reuse.

In other words, in PTLs 1 and 2, the protective films described therein are investigated in point of the adhesiveness thereof to wafer in sticking and in point of the holding power to wafer after sticking, but nothing is investigated therein in point of the reworking possibility of the protective films.

[0008]

The present invention has been made in consideration of the above-mentioned problems, and its object is to provide a resin film-forming sheet excellent in reworkability, and a resin film-forming composite sheet that has the resin film-forming sheet and a support.

Solution to Problem

[0009]

The present inventors have found that a resin film-forming sheet of such that the surface roughness of the surface thereof on the side that is to be stuck to a silicon wafer is controlled to be a predetermined value or more can solve the above-mentioned problems, and have completed the present invention.

[0010]

Specifically, the present invention provides the following [1] to [15].

[1] A resin film-forming sheet to be stuck to a silicon wafer to form a resin film on the silicon wafer, wherein:

the surface roughness (Ra) of the surface (α) of the sheet on the side to be stuck to a silicon wafer is 40 nm or more.

[2] The resin film-forming sheet according to the above [1], which contains a polymer component (A) and a curable component (B).

[3] The resin film-forming sheet according to the above [2], wherein the polymer component (A) contains an acrylic polymer (A1).

[4] The resin film-forming sheet according to any one of the above [1] to [3], which contains a heat-curable component (B1).

[5] The resin film-forming sheet according to any one of the above [1] to [4], which contains a filler (C).

[6] The resin film-forming sheet according to the above [5], wherein the content of the filler (C) is 10 to 80% by mass relative to the total amount of the resin film-forming sheet.

[7] The resin film-forming sheet according to the above [5] or [6], wherein the mean particle size of the filler (C) is 100 to 1000 nm.

[8] The resin film-forming sheet according to any one of the above [1] to [7], which is a protective film-forming sheet for forming a protective film on a silicon wafer.

[9] The resin film-forming sheet according to any one of the above [1] to [8], wherein, after the surface (α) of the resin film-forming sheet is stuck to a silicon wafer, the gloss value measured from the surface (β') opposite to the silicon wafer of the resin film formed from the resin film-forming sheet is 25 or more.

[10] A resin film-forming composite sheet including the resin film-forming sheet of any one of the above [1] to [9] and a support.

[11] A resin film-forming composite sheet including a resin film-forming sheet, which is to be stuck to a silicon wafer to form a resin film on the silicon wafer, and a support (I), and further including a configuration in which the surface (α) of the resin film-forming sheet on the side to be stuck to a silicon wafer and the surface (i) of the support (I) having a surface roughness of 40 nm or more are directly laminated.

[12] The resin film-forming composite sheet according to the above [11], wherein the surface roughness (Ra) of the surface (α) of the resin film-forming sheet exposed when the support (I) is removed from the resin film-forming composite sheet is 40 nm or more.

[13] The resin film-forming composite sheet according to the above [11] or [12], wherein the resin film-forming sheet contains a heat-curable component (B1).

[14] The resin film-forming composite sheet according to the above [11] or [12], which has a configuration in which a second support (II) is further laminated directly on the surface (β) opposite to the surface (α) of the resin film-forming sheet, and in which the resin film-forming sheet contains the heat-curable component (B1).

[15] The resin film-forming composite sheet according to the above [14], wherein the support (II) is a pressure sensitive adhesive sheet having a pressure sensitive adhesive layer, and the pressure sensitive adhesive layer is directly laminated on

the surface (β) of the resin film-forming sheet.

Advantageous Effects of Invention

[0011]

The resin film-forming sheet of the present invention is excellent in reworkability. Accordingly, in the case where, after the resin film-forming sheet of the present invention has been stuck to a silicon wafer, resticking the sheet is considered to be necessary, the resin film-forming sheet can be peeled without breaking the silicon wafer and with preventing generation of residue, and after the resin film-forming sheet is peeled, the silicon wafer can be reused.

[0012]

In this description, "reworkability of a resin film-forming sheet" means a property of the sheet of such that, when a resin film-forming sheet is stuck to a silicon wafer and then again peeled, the resin film-forming sheet can be peeled without breaking the silicon wafer and leaving a part of the resin film-forming sheet on the silicon wafer.

Brief Description of Drawing

[0013]

Fig. 1 is a cross-sectional view of a resin film-forming composite sheet of one aspect of the present invention.

Description of Embodiments

[0014]

In this description, values of a mass-average molecular weight (M_w) and a number-average molecular weight (M_n) of each component are standard polystyrene-equivalent values measured according to a gel permeation chromatography (GPC) method, and specifically, they are values measured according to the method described in the section of Examples.

In this description, for example, "(meth)acrylate" is used as a term indicating both "acrylate" and "methacrylate", and the same shall apply to the other terms similar thereto.

Also in this description, "energy ray" indicates, for example, ultraviolet ray, electron beam and the like.

[0015]

[Resin Film-Forming Sheet]

The resin film-forming sheet of the present invention is a sheet to be stuck to a silicon wafer to form a resin film on the silicon wafer, wherein the surface roughness (Ra) of the surface (α) of the sheet on the side to be stuck to a silicon wafer (hereinafter this may be simply referred to as the "surface roughness (Ra) of the surface (α)") is 40 nm or more.

[0016]

The surface roughness (Ra) of the surface (α) of the resin film-forming sheet of the present invention is 40 nm or more, and therefore, even after the resin film-forming sheet is once stuck to a silicon wafer, the resin film-forming sheet can be peeled without breaking the silicon wafer and with preventing generation of residue, and the resin film-forming sheet is therefore excellent in reworkability.

On the other hand, when a resin film-forming sheet of such that the surface roughness (Ra) of the surface (α) thereof is less than 40 nm is tried to be peeled after stuck to a silicon wafer, a residue of the resin film-forming sheet may remain on the silicon wafer. In addition, when the sheet is forcedly peeled, the silicon wafer may be broken.

[0017]

From the above-mentioned viewpoint, the surface roughness (Ra) of the surface (α) of the resin film-forming sheet of the present invention is preferably 45 nm or more, more preferably 50 nm or more, even more preferably 53 nm or more, still more preferably 55 nm or more.

[0018]

The upper limit of the surface roughness (Ra) of the surface (α) is not specifically limited from the viewpoint of bettering reworkability.

However, from the viewpoint of providing a resin film-forming sheet having better adhesiveness to a silicon wafer, the surface roughness (Ra) of the surface (α) of the resin film-forming sheet of the present invention is preferably 150 nm or less, more preferably 100 nm or less, even more preferably 80 nm or less.

[0019]

In this description, the surface roughness (Ra) of the surface (α) means a value measured according to the method described in the section of Examples.

The surface roughness (Ra) of the surface (α) may be controlled, for

example, by suitably defining the kind, the mean particle size and the content of the fine particle components of the inorganic filler, the colorant and the like to be contained in the resin film-forming sheet. It may also be controlled by sticking a support having a rough surface to the sheet.

[0020]

In one aspect of the present invention, the surface roughness (Ra) of the surface (β) opposite to the surface (α) of the resin film-forming sheet is not specifically limited but is preferably 5 to 80 nm, more preferably 8 to 60 nm, even more preferably 10 to 45 nm.

Falling within the range, the gloss value of the surface (β') of the resin film to be mentioned below, which is formed from the resin film-forming sheet, can be readily controlled to be high. In addition, in the case where a silicon wafer having the resin film formed from the resin film-forming sheet, or a chip or the like obtained from the silicon wafer is inspected with an electromagnetic ray such as an IR ray or the like, the electromagnetic ray permeability can be increased.

[0021]

After the surface (α) of the resin film-forming sheet of one aspect of the present invention has been stuck to a silicon wafer, the gloss value measured from the surface (β') opposite to the silicon wafer of the resin film formed from the resin film-forming sheet is preferably 25 or more, more preferably 30 or more, even more preferably 35 or more, still more preferably 40 or more.

When the gloss value of the surface (β') of the resin film is 25 or more, the resin film can be excellent in visibility for laser printing.

[0022]

In one aspect of the present invention, the light transmittance at a wavelength of 1250 nm through the resin film-forming sheet and through resin film formed from the resin film-forming sheet is preferably 25% or more, more preferably 30% or more, even more preferably 35% or more, still more preferably 40% or more.

When the light transmittance is 25% or more, IR permeation is good, and the silicon wafer or chip provided with the resin film-forming sheet or with a resin film formed from the resin film-forming sheet can be subjected to IR ray inspection. In other words, cracks and the like that may have occurred in a silicon wafer or chip can be readily detected via the resin film-forming sheet or the resin film, and therefore the product yield can be increased.

The light transmittance at a wavelength of 1250 nm through the resin film-forming sheet means a value measured according to the method described in the section of Examples.

[0023]

The form of the resin film-forming sheet of the present invention is not specifically limited and includes, for example, a long tape-like form, a single-leaf label-like form, etc.

The resin film-forming sheet of the present invention may be a single-layered sheet of one layer formed of one kind of a composition, or may also be a multilayered sheet formed of two or more kinds of compositions.

In the case where the resin film-forming sheet of the present invention is a multilayered sheet, the kinds of the components as well as the blending amount thereof to be contained in the composition (α') of a forming material for the layer on the side of the surface (α) are preferably so controlled that the surface roughness (Ra) of the surface (α) could fall within the above-mentioned range.

[0024]

In one aspect of the present invention, the thickness of the resin film-forming sheet may be suitably defined depending on the use thereof, and is preferably 1 to 300 μm , more preferably 3 to 250 μm , even more preferably 5 to 200 μm , still more preferably 7 to 150 μm .

In addition, in particular, when the silicon wafer to which the resin film-forming sheet is to be stuck is thin, the thickness of the resin film-forming sheet is preferably 1 to 20 μm , more preferably 3 to 15 μm .

Also in the case where the resin film-forming sheet is a multilayered sheet formed of two or more layers, the total thickness of the multilayered sheet preferably falls within the above-mentioned range.

[0025]

<Constituent Components of Resin Film-Forming Sheet>

The constituent components of the resin film-forming sheet of one aspect of the present invention are not specifically limited so far as the surface roughness (Ra) of the surface (α) of the sheet falls within the above-mentioned range.

However, from the viewpoint of providing a resin film-forming sheet having good shape retentiveness, preferably, the resin film-forming sheet of one aspect of the present invention contains a polymer component (A) and a curable component (B).

From the viewpoint of controlling the surface roughness (Ra) of the surface (α) to fall within the above-mentioned range, and from the viewpoint of controlling the thermal expansion coefficient of the resin film to be formed from the resin film-forming sheet to fall within a suitable range, the resin film-forming sheet of one aspect of the present invention preferably contains a filler (C).

Further, within a range not detracting from the advantageous effects of the present invention, the resin film-forming sheet of one aspect of the present invention may further contain one or more selected from a colorant (D), a coupling agent (E), and a wide-use additive (F).

The above-mentioned components (A) to (F) that may be the constituent components of the resin film-forming sheet of one aspect of the present invention are described below.

[0026]

[Polymer Component (A)]

In this description, the "polymer component" means a compound in the form of a polymer to be obtained through polymerization reaction and having at least one kind of repeating unit.

The resin film-forming sheet for use in one aspect of the present invention contains a polymer component (A) and therefore can be given flexibility with ease and can better sheet property retentiveness. As a result, the storage elastic modulus of the resin film-forming sheet can be controlled to fall within the above-mentioned range.

The mass-average molecular weight (Mw) of the polymer component (A) is, from the viewpoint of controlling the storage elastic modulus of the resultant resin film-forming sheet to fall within the above-mentioned range, preferably 20,000 or more, more preferably 20,000 to 3,000,000, even more preferably 100,000 to 2,000,000, still more preferably 150,000 to 1,500,000.

[0027]

The glass transition temperature (T_g) of the acrylic polymer (A1) is preferably -40°C or higher, more preferably -30 to 50°C, even more preferably -20 to 20°C, still more preferably -15 to 0°C.

[0028]

In this description, the value of the glass transition temperature (T_g) of the acrylic polymer or the like is a value as determined by converting the glass transition temperature (T_{gK}) thereof expressed as an absolute temperature (unit:

K) as calculated according to the following formula (1), into a value of temperature centigrade (unit: °C).

[Math. 1]

$$\frac{100}{Tg_K} = \frac{W_1}{Tg_1} + \frac{W_2}{Tg_2} + \frac{W_3}{Tg_3} + \frac{W_4}{Tg_4} + \dots \quad (1)$$

wherein $W_1, W_2, W_3, W_4 \dots$ each indicate the mass fraction (% by mass) of each monomer component constituting the polymer component, and $Tg_1, Tg_2, Tg_3, Tg_4 \dots$ each indicate the glass transition temperature (unit: K) of the homopolymer of each monomer component constituting the polymer component.

[0029]

The content of the polymer component (A) in the resin film-forming sheet of one aspect of the present invention is preferably 5 to 60% by mass relative to the total amount (100% by mass) of the resin film-forming sheet, more preferably 8 to 50% by mass, even more preferably 10 to 45% by mass, still more preferably 15 to 40% by mass.

[0030]

In this description, the "content of the component (A) relative to the total amount of the resin film-forming sheet" has the same meaning as that of the "content of the component (A) relative to the total amount of the active ingredient in the composition that is a forming material for the resin film-forming sheet", and the same shall apply to the content of the other components to be described hereinunder.

Further, the above-mentioned "active ingredient" means an ingredient excluding substances that would not have any direct or indirect influence on the reaction and on the physical properties of the sheet to be formed, such as solvent or the like in the composition. Specifically, it means an ingredient other than solvent such as water and organic solvent or the like.

[0031]

The polymer component (A) preferably contains an acrylic polymer (A1).

The polymer component (A) may also contain a non-acrylic polymer (A2) along with the acrylic polymer (A1).

One alone or two or more of these polymer components may be used either singly or as combined.

[0032]

The content of the acrylic polymer (A1) relative to the total amount (100%

by mass) of the polymer component (A) contained in the resin film-forming sheet of one aspect of the present invention is preferably 50 to 100% by mass, more preferably 60 to 100% by mass, even more preferably 70 to 100% by mass, still more preferably 80 to 100% by mass.

[0033]

(Acrylic Polymer (A1))

The mass-average molecular weight (Mw) of the acrylic polymer (A1) is, from the viewpoint of imparting flexibility and film formability to the resin film-forming sheet and from the viewpoint of controlling the storage elastic modulus of the resin film-forming sheet to fall within the above-mentioned range, preferably 20,000 to 3,000,000, more preferably 100,000 to 1,500,000, even more preferably 150,000 to 1,200,000, still more preferably 250,000 to 1,000,000.

[0034]

The acrylic polymer (A1) includes a polymer containing an alkyl (meth)acrylate as the main component, and specifically, an acrylic polymer containing a structural unit (a1) derived from an alkyl (meth)acrylate in which the alkyl group has 1 to 18 carbon atoms is preferred, and the polymer may also be an acrylic copolymer containing any other structural unit (a2) than the structural unit (a1).

[0035]

One alone or two or more kinds of acrylic polymers (A1) may be used either singly or as combined.

In the case where the acrylic polymer (A1) is a copolymer, the morphology of the copolymer may be any of a block copolymer, a random copolymer, an alternate copolymer or a graft copolymer.

[0036]

(Structural Unit (a1))

The carbon number of the alkyl group of the alkyl (meth)acrylate that constitutes the structural unit (a1) is, from the viewpoint of imparting flexibility and film formability to the resin film-forming sheet, preferably 1 to 18, more preferably 1 to 12, even more preferably 1 to 8.

[0037]

Examples of the alkyl (meth)acrylate include methyl (meth)acrylate, ethyl (meth)acrylate, propyl (meth)acrylate, butyl (meth)acrylate, pentyl (meth)acrylate, 2-ethylhexyl (meth)acrylate, isooctyl (meth)acrylate, n-octyl

(meth)acrylate, n-nonyl (meth)acrylate, isononyl (meth)acrylate, decyl (meth)acrylate, lauryl (meth)acrylate, stearyl (meth)acrylate, etc.

One alone or two or more of these alkyl (meth)acrylates may be used either singly or as combined.

[0038]

Among these, an alkyl (meth)acrylate with an alkyl group having 1 to 3 carbon atoms is preferred, and methyl (meth)acrylate is more preferred.

The content of the structural unit (a11) derived from an alkyl (meth)acrylate with an alkyl group having 1 to 3 carbon atoms in the acrylic polymer (A1) is preferably 5 to 80% by mass relative to the total structural units (100% by mass) of the acrylic polymer (A1), more preferably 15 to 70% by mass, even more preferably 25 to 60% by mass.

[0039]

An alkyl (meth)acrylate with an alkyl group having 4 to 12 carbon atoms is also preferred, and butyl (meth)acrylate is more preferred.

The content of the structural unit (a12) derived from an alkyl (meth)acrylate with an alkyl group having 4 to 12 carbon atoms in the acrylic polymer (A1) is preferably 5 to 80% by mass relative to the total structural units (100% by mass) of the acrylic polymer (A1), more preferably 15 to 70% by mass, even more preferably 20 to 60% by mass.

[0040]

The acrylic polymer (A1) for use in one aspect of the present invention is preferably an acrylic copolymer containing both the above-mentioned structural unit (a11) and the structural unit (a12).

The content ratio of the structural unit (a11) to the structural unit (a12) of the acrylic copolymer [(a11)/(a12)] (ratio by mass) is preferably 20/80 to 95/5, more preferably 30/70 to 90/10, even more preferably 40/60 to 85/15, still more preferably 52/48 to 75/25.

[0041]

The content of the structural unit (a1) in the acrylic polymer (A1) is preferably 50% by mass or more relative to the total structural units (100% by mass) of the acrylic polymer (A1), more preferably 50 to 99% by mass, even more preferably 55 to 98% by mass, still more preferably 60 to 97% by mass.

[0042]

(Structural Unit (a2))

The acrylic polymer (A1) for use in one aspect of the present invention may contain any other structural unit (a2) than the above-mentioned structural unit (a1), within a range not detracting from the advantageous effects of the present invention.

Examples of the monomer to constitute the structural unit (a2) include a functional group-containing monomer such as a hydroxy group-containing monomer, a carboxy group-containing monomer, an epoxy group-containing monomer, etc.; a vinyl ester monomer such as vinyl acetate, vinyl propionate, etc.; an olefin monomer such as ethylene, propylene, isobutylene, etc.; an aromatic vinyl monomer such as styrene, methylstyrene, vinyltoluene, etc.; a dienic monomer such as butadiene, isoprene, etc.; a nitrile monomer such as (meth)acrylonitrile, etc.

Among these, a functional group-containing monomer is preferred, and one or more selected from a hydroxy group-containing monomer and an epoxy group-containing monomer are preferred.

[0043]

Examples of the hydroxy group-containing monomer include a hydroxyalkyl (meth)acrylate such as 2-hydroxyethyl (meth)acrylate, 2-hydroxypropyl (meth)acrylate, 3-hydroxypropyl (meth)acrylate, 2-hydroxybutyl (meth)acrylate, 3-hydroxybutyl (meth)acrylate, 4-hydroxybutyl (meth)acrylate, etc.; an unsaturated alcohol such as vinyl alcohol, allyl alcohol, etc.

Among these, 2-hydroxyethyl (meth)acrylate is preferred.

[0044]

The carboxy group-containing monomer includes (meth)acrylic acid, maleic acid, fumaric acid, itaconic acid, etc.

[0045]

Examples of the epoxy group-containing monomer include an epoxy group-containing (meth)acrylate such as glycidyl (meth)acrylate, β -methylglycidyl (meth)acrylate, (3,4-epoxycyclohexyl)methyl (meth)acrylate, 3-epoxycyclo-2-hydroxypropyl (meth)acrylate, etc.; a non-acrylic epoxy group-containing monomer such as glycidyl crotonate, allyl glycidyl ether, etc.

The acrylic polymer having a structural unit derived from an epoxy group-containing monomer and having Mw of 20,000 or more is heat-curable; however, this is not the curable component (B) but is included in the concept of the polymer component (A).

[0046]

The acrylic polymer (A1) for use in one aspect of the present invention preferably contains a structural unit (a21) derived from a hydroxy group-containing monomer.

The content of the structural unit (a21) derived from a hydroxy group-containing monomer in the acrylic polymer (A1) is preferably 1 to 40% by mass relative to the total structural units (100% by mass) of the acrylic polymer (A1), more preferably 5 to 30% by mass, even more preferably 8 to 25% by mass, still more preferably 10 to 20% by mass.

[0047]

Also preferably, the acrylic polymer (A1) for use in one aspect of the present invention contains a structural unit (a22) derived from an epoxy group-containing monomer.

The content of the structural unit (a22) derived from an epoxy group-containing monomer in the acrylic polymer (A1) is preferably 1 to 40% by mass relative to the total structural units (100% by mass) of the acrylic polymer (A1), more preferably 5 to 30% by mass, even more preferably 8 to 25% by mass.

[0048]

In the case where an epoxy-type heat-curable component is used as the curable component (B) to be mentioned below, a carboxyl group may react with the epoxy group in the epoxy-type heat-curable component, and therefore, the content of the structural unit derived from a carboxyl group-containing monomer in the acrylic polymer (A1) is preferably smaller.

In the case where an epoxy-type heat-curable component is used as the curable component (B), the content of the structural unit derived from a carboxy group-containing monomer is preferably 0 to 10% by mass relative to the total structural units (100% by mass) of the acrylic polymer (A1), more preferably 0 to 5% by mass, even more preferably 0 to 2 % by mass, still more preferably 0% by mass.

[0049]

The content of the structural unit (a2) in the acrylic polymer (A1) is preferably 1 to 50% by mass relative to the total structural units (100% by mass) of the acrylic polymer (A1), more preferably 2 to 45% by mass, even more preferably 3 to 40% by mass.

[0050]

(Non-acrylic Resin (A2))

As needed, the resin film-forming sheet of one aspect of the present invention may contain a non-acrylic polymer (A2) as the other polymer component than the above-mentioned acrylic polymer (A1).

Examples of the non-acrylic polymer (A2) include polyester, phenoxy resin, polycarbonate, polyether, polyurethane, polysiloxane, rubber polymer, etc.

One alone or two or more kinds of these non-acrylic polymers (A2) may be used either singly or as combined.

[0051]

The mass-average molecular weight (Mw) of the non-acrylic polymer (A2) is preferably 20,000 or more, more preferably 20,000 to 100,000, even more preferably 20,000 to 80,000.

[0052]

[Curable Component (B)]

The curable component (B) plays a role of curing the resin film-forming sheet to form a hard resin film, and is a compound having a mass-average molecular weight (Mw) of less than 20,000.

The resin film-forming sheet for use in the present invention preferably contains at least one of a heat-curable component (B1) and an energy ray-curable component (B2) as the curable component (B), and from the viewpoint of making the curing reaction progressing sufficiently and from the viewpoint of cost reduction, the film more preferably contains a heat-curable component (B1).

The heat-curable component (B1) preferably contains a compound having at least a functional group capable of reacting by heat.

The energy ray-curable component (B2) contains a compound (B21) having a polymerizable functional group that reacts through irradiation with energy rays, and polymerizes and cures through irradiation with energy rays.

The functional groups that these curable components have react with each other to form a three-dimensional network structure, thereby realizing curing.

The mass-average molecular weight (Mw) of the curable component (B) is, from the viewpoint of controlling the viscosity of the composition for forming the resin film-forming sheet to thereby enhance the handleability of the composition by combined use with the component (A), preferably less than 20,000, more preferably 10,000 or less, even more preferably 100 to 10,000.

[0053]

(Heat-Curable Component (B1))

The heat-curable component (B1) is preferably an epoxy-type heat-curable component.

The epoxy-type heat-curable component is preferably a combination of an epoxy group-containing component (B11) and a heat-curing agent (B12).

[0054]

Examples of the epoxy group-containing compound (B11) (hereinafter also referred to as "epoxy compound (B11)") include epoxy compounds having 2 or more functional groups in the molecule, such as a polyfunctional epoxy resin, a bisphenol A diglycidyl ether and a hydrogenate thereof, a novolak-type epoxy resin such as a cresol/novolak epoxy resin, etc., a dicyclopentadiene-type epoxy resin, a biphenyl-type epoxy resin, a bisphenol A-type epoxy resin, a bisphenol F-type epoxy resin, a phenylene skeleton-containing epoxy resin, etc.

One alone or two or more kinds of these epoxy compounds (B11) may be used either singly or as combined.

Among these, one or more selected from a novolak-type epoxy resin and a biphenyl-type epoxy resin is preferably contained.

[0055]

In one aspect of the present invention, the epoxy compound (B11) preferably contains an epoxy compound liquid at 25°C (hereinafter this may also be referred to as "a liquid epoxy compound").

When the epoxy compound (B11) contains a liquid epoxy compound, the value of the fracture elongation of the resin film-forming sheet can be increased and therefore the resin film-forming sheet can be excellent in reworkability.

In one aspect of the present invention, from the above-mentioned viewpoint, the content of the liquid epoxy compound is preferably 10% by mass or more relative to the total amount (100% by mass) of the epoxy compound (B11) in the resin film-forming sheet, more preferably 15% by mass or more, even more preferably 30% by mass or more, still more preferably 40% by mass or more.

On the other hand, from the viewpoint of improving the reliability of the resin film-attached chip produced using the resin film-forming sheet, the content of the liquid epoxy compound is preferably 90% by mass or less relative to the total amount (100% by mass) of the epoxy compound (B11) in the resin film-forming sheet, more preferably 80% by mass or less, even more preferably 75% by mass or less, still more preferably 70% by mass or less.

In this description, the "liquid epoxy compound" means an epoxy compound having a viscosity at 25°C of 40 Pa·s or less. In this description, the viscosity at 25°C of the epoxy compound is a value measured according to JIS Z 8803 and according to an E-type viscometer at 25°C.

[0056]

The content of the epoxy compound (B11) is preferably 1 to 500 parts by mass relative to 100 parts by mass of the component (A), more preferably 3 to 300 parts by mass, even more preferably 5 to 150 parts by mass, still more preferably 10 to 100 parts by mass.

[0057]

(Heat-Curing Agent (B12))

The heat-curing agent (B12) functions as a curing agent for the epoxy compound (B11).

The heat-curing agent is preferably a compound having 2 or more functional groups capable of reacting with an epoxy group, in one molecule.

The functional group includes a phenolic hydroxyl group, an alcoholic hydroxyl group, an amino group, a carboxyl group, an acid anhydride, etc. Among these, a phenolic hydroxyl group, an amino group and an acid anhydride are preferred, a phenolic hydroxyl group and an amino group are more preferred, and an amino group is even more preferred.

[0058]

Examples of the phenolic heat-curing agent having a phenolic hydroxyl group include a polyfunctional phenol resin, a biphenol, a novolak-type phenol resin, a dicyclopentadiene-type phenol resin, a xyloc phenol resin, an aralkyl phenol resin, etc.

Examples of the amino group-having amine-type heat-curing agent include dicyandiamide (DICY), etc.

One alone or two or more kinds of these heat-curing agent (B12) may be used either singly or as combined.

Among these, an amine-type heat-curing agent is preferably contained.

[0059]

The content of the heat-curing agent (B12) is preferably 0.1 to 500 parts by mass relative to 100 parts by mass of the epoxy compound (B11), more preferably 0.5 to 300 parts by mass, even more preferably 1 to 200 parts by mass.

[0060]

(Curing Accelerator (B13))

The resin film-forming sheet of one aspect of the present invention may contain, from the viewpoint of controlling the heat-curing rate of the sheet by heating, a curing accelerator (B13).

Preferably, the curing accelerator (B13) is used along with an epoxy compound (B11) as the heat-curable component (B1).

[0061]

Examples of the curing accelerator (B13) include tertiary amines such as triethylenediamine, benzyldimethylamine, triethanolamine, dimethylaminoethanol, tris(dimethylaminomethyl)phenol, etc.; imidazoles such as 2-methylimidazole, 2-phenylimidazole, 2-phenyl-4-methylimidazole, 2-phenyl-4,5-dihydroxymethylimidazole, 2-phenyl-4-methyl-5-hydroxymethylimidazole, etc.; organic phosphines such as tributyl phosphine, diphenyl phosphine, triphenyl phosphine, etc.; tetraphenylboron salts such as tetraphenylphosphonium tetraphenylborate, triphenylphosphine tetraphenylborate, etc.

One alone or two or more kinds of these curing accelerators (B13) can be used either singly or as combined.

[0062]

The content of the curing accelerator (B13) is, from the viewpoint of improving the adhesiveness of the resin film formed of the resin film-forming sheet, preferably 0.01 to 10 parts by mass relative to 100 parts by mass of the total of the epoxy compound (B11) and the heat-curing agent (B12), more preferably 0.1 to 6 parts by mass, even more preferably 0.3 to 4 parts by mass.

[0063]

(Energy Ray-Curable Component (B2))

As the energy ray-curable component (B2), a compound (B21) having a functional group that reacts through irradiation with energy rays may be used singly, or the compound (B21) may be used as combined with a photopolymerization initiator (B22). The energy ray-curable component (B2) is preferably one curable with UV rays.

[0064]

(Compound (B21) having a functional group that reacts through irradiation with energy rays)

Examples of the compound (B21) having a functional group that reacts

through irradiation with energy rays (hereinafter also referred to as "energy ray-reactive compound (B21)") include trimethylolpropane tri(meth)acrylate, pentaerythritol tri(meth)acrylate, pentaerythritol tetra(meth)acrylate, dipentaerythritol monohydroxy-penta(meth)acrylate, dipentaerythritol hexa(meth)acrylate, 1,4-butyleneglycol di(meth)acrylate, 1,6-hexanediol di(meth)acrylate, oligoester (meth)acrylate, urethane (meth)acrylate oligomer, epoxy (meth)acrylate, polyether (meth)acrylate, itaconic acid oligomer, etc.

One alone or two or more kinds of these energy ray-reactive compounds (B21) may be used either singly or as combined.

The mass-average molecular weight (Mw) of the energy ray-reactive compound (B21) is preferably 100 to 30,000, more preferably 200 to 20,000, even more preferably 300 to 10,000.

[0065]

The content of the energy ray-reactive compound (B21) is preferably 1 to 1500 parts by mass relative to 100 parts by mass of the component (A), more preferably 3 to 1200 parts by mass, even more preferably 5 to 1000 parts by mass.

[0066]

(Photopolymerization Initiator (B22))

As combined with the above-mentioned energy ray-reactive compound (B21), a photopolymerization initiator (B22) may be used to shorten the polymerization curing time, thereby prosecuting the curing of the resin film-forming sheet even though the photoirradiation dose is small.

[0067]

Examples of the photopolymerization initiator (B22) include benzoin compounds, acetophenone compounds, acylphosphine oxide compounds, titanocene compounds, thioxanthone compounds, peroxide compounds, etc.

More specifically, examples of the photopolymerization initiator include 1-hydroxycyclohexyl phenyl ketone, benzoin, benzoin methyl ether, benzoin ethyl ether, benzoin isopropyl ether, benzyldiphenyl sulfide, tetramethylthiuram monosulfide, azobisisobutyronitrile, dibenzyl, diacetyl, β -chloroanthraquinone, 2,4,6-trimethylbenzoyldiphenyl phosphine oxide, etc.

One alone or two or more kinds of these photopolymerization initiators may be used either singly or as combined.

[0068]

The content of the photopolymerization initiator (B22) is, from the

viewpoint of sufficiently prosecuting the curing reaction of the resin film-forming sheet and of preventing the formation of residues, preferably 0.1 to 10 parts by mass relative to 100 parts by mass of the energy ray-reactive compound (B21), more preferably 0.5 to 8 parts by mass, even more preferably 1 to 5 parts by mass. [0069]

In one aspect of the present invention, the content of the curable component (B) in the resin film-forming sheet is preferably 5 to 50% by mass relative to the total amount (100% by mass) of the resin film-forming sheet, more preferably 8 to 40% by mass, even more preferably 10 to 30% by mass, still more preferably 12 to 25% by mass.

The "content of the curable component (B)" indicates a total content of the heat-curable component (B1) including the above-mentioned epoxy compound (B11), the heat-curing agent (B12) and the curing accelerator (B13), as well as the energy ray-curable component (B2) including the energy ray-reactive compound (B21) and the photopolymerization initiator (B22).

[0070]

[Filler (C)]

Preferably, the resin film-forming sheet of one aspect of the present invention further contains a filler (C).

Containing a filler (C), the surface roughness (Ra) of the surface (α) of the resin film-forming sheet can be readily controlled to fall within the above-mentioned range.

In addition, the resin film-forming sheet containing a filler (C) can control the thermal expansion coefficient of the formed resin film to fall within a suitable range, and therefore the thermal expansion coefficient of a chip having the resin film can be optimized and the reliability of the semiconductor device with the chip incorporated therein can be thereby increased. In addition, the moisture absorption of the resin film to be formed of the resin film-forming sheet can be reduced.

[0071]

The filler (C) includes an organic filler such as a polymethyl methacrylate filler, rubber particles, etc., as well as an inorganic filler such as powders of silica, alumina, talc, calcium carbonate, titanium oxide, iron oxide, silicon carbide, boron nitride, etc., and beads produced by shaping them into spherical forms, and single crystal fibers, glass fibers, etc.

One alone or two or more kinds of these fillers (C) may be used either singly or as combined.

Among these, in the case where the resin film-forming sheet is heat-curable, an inorganic filler is preferred from the viewpoint of excellent heat resistance, and silica or alumina is more preferred.

[0072]

In one aspect of the present invention, from the viewpoint that the surface roughness (Ra) of the surface (α) of the resin film-forming sheet to be formed is controlled to fall within the above-mentioned range with ease, the mean particle size of the filler (C) is preferably 3 to 20 μm , more preferably 5 to 15 μm .

Using a filler whose mean particle size falls within the above-mentioned range, the surface roughness (Ra) of the surface (α) of the resin film-forming sheet to be formed can be readily controlled to fall within the range even in the case where the content of the filler (C) is relatively small.

[0073]

However, even in the case where the content of the filler (C) to be added is relatively large or where a filler (C) having a relatively small mean particle size is used in the resin film-forming composite sheet to be described hereinafter, the surface roughness (Ra) of the surface (α) of the resin film-forming sheet to be formed can be controlled to fall within the above-mentioned range.

In the above case, the mean particle size of the filler (C) is preferably 100 to 1000 nm, more preferably 200 to 900 nm, even more preferably 200 to 800 nm, still more preferably 300 to 750 nm, further more preferably 400 to 700 nm.

When the mean particle size of the filler (C) is 100 nm or more, the surface roughness (Ra) of the surface (α) of the resin film-forming sheet can be readily controlled to fall within the above-mentioned range by controlling the content of the filler (C).

[0074]

On the other hand, use of the filler (C) whose mean particle size is 1000 nm or less provides the following advantages (1) to (4).

(1) After the surface (α) of the resin film-forming sheet is stuck to a silicon wafer, and the gloss value measured from the surface (β') opposite to the silicon wafer of the resin film formed from the resin film-forming sheet can be high.

(2) The IR ray and the like electromagnetic ray permeability through the resin film-forming sheet and the resin layer can be readily improved. As a result,

in the case where a silicon wafer, a chip or the like having the resin film-forming sheet or the resin layer is inspected with an electromagnetic ray, the inspection operation efficiency is bettered since the electromagnetic ray permeability through the specimen is high.

(3) In a process of irradiating a silicon wafer having the resin film-forming sheet or the resin film, with a laser, a problem of laser diffusion owing to the presence of the resin film-forming sheet or the resin film can be readily evaded.

(4) In a coating step of coating with a composition of a forming material for the resin film-forming sheet in the case of producing a thin resin film-forming sheet having a thickness of, for example 20 μm or less, it is easy to evade a problem of coating film formation failure to be caused by a filler having a large particle size.

[0075]

In the case where the resin film-forming sheet of one aspect of the present invention is a multilayered sheet formed of two or more kinds of compositions, the composition of a forming material for the side of the surface (α) of the resin film-forming sheet preferably contains a filler (C) having a mean particle size that falls within the above-mentioned range to control the surface roughness (Ra) of the surface (α).

On the other hand, from the viewpoint of improving the gloss value measured from the surface (β') opposite to the silicon wafer of the resin film formed from the resin film-forming sheet, preferably, a filler (C') having a mean particle size smaller than the above-mentioned range is incorporated in the composition of a forming material for the side of the surface (β).

The mean particle size of the filler (C') is generally 1 to 400 nm, preferably 1 to 250 nm, more preferably 1 to 100 nm.

[0076]

In this description, the mean particle size of the fillers (C) and (C') means a value measured using a dynamic light-scattering particle sizer (Nanotrack Wave-UT151, manufactured by Nikkiso Co., Ltd.).

[0077]

In one aspect of the present invention, the content of the filler (C) in the resin film-forming sheet is, from the viewpoint of controlling the surface roughness (Ra) of the surface (α) of the resin film-forming sheet to fall within the above-mentioned range and from the viewpoint of bettering the reliability of a

resin film-attached chip produced using the resin film-forming sheet, preferably 10 to 80% by mass relative to the total amount (100% by mass) of the resin film-forming sheet, more preferably 20 to 70% by mass, even more preferably 30 to 65% by mass, still more preferably 40 to 60% by mass.

[0078]

In one aspect of the present invention, the total content of the polymer component (A), the curable component (B) and the filler (C) in the resin film-forming sheet is preferably 60% by mass or more relative to the total amount (100% by mass) of the resin film-forming sheet, more preferably 70% by mass or more, even more preferably 80% by mass or more, still more preferably 90% by mass or more.

[0079]

[Colorant (D)]

The resin film-forming sheet of one aspect of the present invention may further contain a colorant (D).

When the resin film-forming sheet contains a colorant (D) and when a semiconductor chip having a resin film formed of the resin film-forming sheet is incorporated in a device, the polishing scar to form in polishing the semiconductor wafer is hardly visible and the appearance of the semiconductor chip may be well organized.

[0080]

As the colorant (D), organic or inorganic pigments and dyes can be used.

The dye may be any dye and examples thereof include acidic dyes, reactive dyes, direct dyes, disperse dyes, cationic dyes, etc.

The pigment is not specifically limited, and may be suitably selected from any known pigments. For example, there are mentioned a phthalocyanine blue pigment, an isoindolinone yellow pigment, a diketopyrrolopyrrole red pigment, as well as a black pigment such as carbon black, iron oxide, manganese dioxide, aniline black, activated carbon, etc.

One alone or two or more kinds of these colorants (D) may be used either singly or as combined.

Using a mixture of a phthalocyanine blue pigment, an isoindolinone yellow pigment and a diketopyrrolopyrrole red pigment makes it possible to readily produce a resin film having an improved IR-range ray permeability and having a low visible light permeability.

[0081]

The mean particle size of the colorant (D) is preferably 400 nm or less, more preferably 300 nm or less, even more preferably 200 nm or less, still more preferably 100 nm or less, and is preferably 10 nm or more, more preferably 20 nm or more.

[0082]

In one aspect of the present invention, the content of the colorant (D) in the resin film-forming sheet is preferably 0.01 to 20% by mass relative to the total amount (100% by mass) of the resin film-forming sheet, more preferably 0.05 to 15% by mass, even more preferably 0.1 to 10% by mass, still more preferably 0.15 to 5% by mass.

[0083]

[Coupling Agent (E)]

The resin film-forming sheet of one aspect of the present invention may further contain a coupling agent (E).

Containing a coupling agent (E), the resin film formed of the resultant resin film-forming sheet can have improved waterproofness without interfering with heat resistance. In addition, the agent may contribute toward improving the edge adhesiveness of the sheet after stuck to a silicon wafer.

[0084]

The coupling agent (E) is preferably a compound to react with the functional group that the component (A) and the component (B) have, and is more preferably a silane coupling agent.

Examples of the silane coupling agent include γ -glycidoxypentyltrimethoxysilane, γ -glycidoxypentylmethyldiethoxysilane, β -(3,4-epoxycyclohexyl)ethyltrimethoxysilane, γ -(methacryloxypropyl)trimethoxysilane, γ -aminopentyltrimethoxysilane, N-6-(aminoethyl)- γ -aminopentyltrimethoxysilane, N-6-(aminoethyl)- γ -aminopentylmethyldiethoxysilane, N-phenyl- γ -aminopentyltrimethoxysilane, γ -ureidopentyltriethoxysilane, γ -mercaptopentyltrimethoxysilane, γ -mercaptopentylmethyldimethoxysilane, bis(3-triethoxysilylpropyl)tetrasulfane, methyltrimethoxysilane, methyltriethoxysilane, vinyltrimethoxysilane, vinyltriacetoxysilane, imidazolesilane, etc.

One alone or two or more kinds of these coupling agents (E) may be used

either singly or as combined.

[0085]

The coupling agent (E) is preferably an oligomer-type coupling agent.

The molecular weight of the coupling agent (E) including an oligomer-type coupling agent is preferably 100 to 15000, more preferably 150 to 10000, even more preferably 200 to 5000, still more preferably 250 to 3000, further more preferably 350 to 2000.

[0086]

The content of the coupling agent (E) in the resin film-forming sheet of one aspect of the present invention is 0.01 to 3.0% by mass relative to the total amount (100% by mass) of the resin film-forming sheet, more preferably 0.03 to 1.5% by mass, even more preferably 0.05 to 0.8% by mass, further more preferably 0.1 to 0.3% by mass.

[0087]

[Wide-Use Additive (F)]

Within a range not detracting from the advantageous effects of the present invention, the resin film-forming sheet for use in one aspect of the present invention may contain, as needed, a wide-use additive (F) in addition to the above-mentioned components.

Examples of the wide-use additive (F) include a crosslinking agent, a plasticizer, a leveling agent, an antistatic agent, an antioxidant, an ion scavenger, a gettering agent, a chain transfer agent, etc.

[0088]

The content of each of such wide-use additives (F) in the resin film-forming sheet of one aspect of the present invention is preferably 0 to 10% by mass relative to the total amount (100% by mass) of the resin film-forming sheet, more preferably 0 to 5% by mass, even more preferably 0 to 2% by mass.

[0089]

<Method for Producing Resin Film-Forming Sheet>

The method for producing a resin film-forming sheet of the present invention is not specifically limited, and the sheet can be produced according to a known method.

For example, a resin film-forming composition containing the above-mentioned components, which is to be a forming material for the resin film-forming sheet, is prepared, and then properly diluted with an organic solvent

added thereto to give a solution of the resin film-forming composition. With that, the solution of the resin film-forming composition is applied onto a support to be mentioned below, according to a known coating method to form a coating film, and the coating film is dried to produce a resin film-forming sheet.

[0090]

From the viewpoint of controlling the surface roughness (Ra) of the surface (α) of the resultant resin film-forming sheet to fall within the above-mentioned range, the production method for the resin film-forming sheet preferably includes a step of applying a resin film-forming composition of a forming material for the resin film-forming sheet, onto the surface having a surface roughness (Ra) of 40 nm or more of a support to form a coating film thereon, and drying the coating film.

The resin film-forming composition may be suitably diluted with a solvent added thereto to be in the form of a solution of the resin film-forming composition.

The surface roughness (Ra) of the surface of the support is preferably 40 nm or more, more preferably 70 nm or more, even more preferably 100 nm or more, still more preferably 200 nm or more, further more preferably 300 nm or more, and is preferably 1000 nm or less, more preferably 800 nm or less, even more preferably 500 nm or less.

[0091]

In the case where the resin film-forming sheet of one aspect of the present invention is a multilayered sheet, a method for producing the resin film-forming sheet includes a step of, for example, applying a solution of a resin film-forming composition for each layer individually onto each of two or more supports to form a coating film thereon, then sticking the coating films to give a layered coating film, and drying it.

[0092]

Examples of the organic solvent for use in preparing the solution of a resin film-forming composition include toluene, ethyl acetate, methyl ethyl ketone, etc.

The solid concentration of the solution of a resin film-forming composition containing an organic solvent added thereto is preferably 10 to 80% by mass, more preferably 20 to 70% by mass, even more preferably 30 to 65% by mass.

Examples of the coating method include a spin coating method, a spray coating method, a bar coating method, a knife coating method, a roll coating method, a roll knife coating method, a blade coating method, a die coating method,

a gravure coating method, etc.

[0093]

[Use of Resin Film-Forming Sheet]

The resin film-forming sheet of one aspect of the present invention may be stuck to the back surface of a workpiece of a silicon wafer such as a semiconductor wafer for chips or a semiconductor chip or the like of a face-down system to form a resin film on the workpiece. The resin film has a function as a protective film for protecting the back surface of a workpiece such as a semiconductor wafer, a semiconductor chip or the like. For example, in the case where the sheet is stuck to a semiconductor wafer, the resin film has a function of reinforcing the wafer and therefore the wafer can be prevented from being broken.

In other words, the resin film-forming sheet of one aspect of the present invention is preferably a protective film-forming sheet for forming a protective film on a silicon wafer.

[0094]

The resin film formed of the resin film-forming sheet of one aspect of the present invention can be given a function as an adhesive film. In other words, in the case where the resin film formed using the resin film-forming sheet of one aspect of the present invention has a function as an adhesive film, the chip having the resin film may be adhered onto a die pad part or to any other member of a different semiconductor chip or the like (onto a chip-moulding part), and can therefore contribute toward improving the productivity for producing semiconductor devices.

In other words, the resin film-forming sheet of one aspect of the present invention can be an adhesive film-forming sheet for forming an adhesive film on a silicon wafer.

[0095]

[Configuration of Resin Film-forming Composite Sheet]

The resin film-forming composite sheet of the present invention (hereinafter simply referred to as "composite sheet") has the resin film-forming sheet of the present invention and a support.

The form of the composite sheet of one aspect of the present invention is not specifically limited and includes, for example, a long tape-like form, a single-leaf label-like form, etc.

Fig. 1 is a cross-sectional view of a resin film-forming composite sheet of

one aspect of the present invention.

The composite sheet of one aspect of the present invention includes a composite sheet 1a having a configuration in which a resin film-forming sheet 10 is directly laminated on a support 11, as shown in Fig. 1(a).

The form of the resin film-forming sheet 10 of the composite sheet of one aspect of the present invention may be nearly the same form as that of a silicon wafer of an adherend, or may be a form capable of including the form of a silicon wafer.

[0096]

In the composite sheet 1a of Fig. 1(a), the support 11 and the resin film-forming sheet 10 have nearly the same form, but as shown in Fig. 1(b) of a composite sheet 1b, the form of the resin film-forming sheet 10 may be smaller than the form of the support 11.

[0097]

The composite sheet of one aspect of the present invention also includes a composite sheet 1c having a ring-like jig-adhering layer 12, as shown in Fig. 1(c).

The ring-like jig-adhering layer 12 is provided for the purpose of improving the adhesion power to a jig in adhering the sheet to a jig such as a ring frame or the like, and may be formed of a double-face pressure sensitive adhesive sheet having a substrate (core material) or of a pressure sensitive adhesive.

In the composite sheet 1c shown in Fig. 1(c), the jig-adhering layer 12 is arranged on the composite sheet 1a of Fig. 1(a), but the composite sheet of one aspect of the present invention may also include such a configuration that the jig-adhering layer 12 is arranged on the surface of the support 11 of the composite sheet 1b shown in Fig. 1(b).

[0098]

As well the composite sheet of one aspect of the present invention may be a composite sheet 1d where a resin film-forming sheet 10 is sandwiched between two supports 11 and 11' as shown in Fig. 1(d).

Like in the configuration of the composite sheet 1d, any other support than the support 11 may be arranged on the exposed surface of the resin film-forming sheet 10 of the composite sheet 1b of Fig. 1(b).

Also similarly, any other support than the support 11 may be arranged on the surface of the resin film-forming sheet 10 and on the surface of the jig-adhering layer 12 of the composite sheet 1c shown in Fig. 1(c).

[0099]

<Support>

The support that the composite sheet of one aspect of the present invention has is a release sheet for preventing adhesion of dust and others to the surface of the resin film-forming sheet, or a sheet that plays a role of a singulation sheet or the like for protecting the surface of the resin film-forming sheet in the singulation step or the like.

[0100]

The support for use in the present invention preferably has a configuration having a resin film.

Examples of the resin film include a polyethylene film such as a low-density polyethylene (LDPE) film, a linear low-density polyethylene (LLDPE) film, etc., and an ethylene-propylene copolymer film, a polypropylene film, a polybutene film, a polybutadiene film, a polymethylpentene film, a polyvinyl chloride film, a vinyl chloride copolymer film, a polyethylene terephthalate film, a polyethylene naphthalate film, a polybutylene terephthalate film, a polyurethane film, an ethylene-vinyl acetate copolymer film, an ionomer resin film, an ethylene-(meth)acrylic acid copolymer film, an ethylene-(meth)acrylate copolymer film, a polystyrene film, a polycarbonate film, a polyimide film, a fluororesin film, etc.

The substrate for use in one aspect of the present invention may be a single-layer film formed of one kind of a resin film, or may be a laminate film produced by laminating two or more kinds of resin films.

[0101]

The resin film may be a crosslinked film.

Also, a sheet produced by coloring the resin film or by printing on the resin film may be used.

Further, the resin film may be formed as a sheet through extrusion of a thermoplastic resin, or may also be a stretched one. A curable resin may be formed into a film and cured to be a sheet according to a predetermined method, and the sheet may be used.

[0102]

Among these resin films, a substrate containing a polypropylene film is preferred from the viewpoint that it is excellent in heat resistance and is expandable as having suitable flexibility and that it can readily maintain a good

pickup aptitude.

Regarding the configuration of the substrate that contains a polypropylene film, it may have a single-layer structure of a polypropylene film alone, or a multilayered sheet formed of a polypropylene film and any other resin film.

In the case where the resin film-forming sheet is thermally curable, the resin film to constitute the substrate has heat resistance and can prevent the support from being damaged by heat of the substrate to prevent occurrence of defects in a production process for semiconductor devices.

[0103]

In the case where the support is used as release sheet for preventing adhesion of dust and others to the surface of the resin film-forming sheet, the support is preferably a resin film that can be readily peeled from the resin film-forming sheet when stuck to a silicon wafer or in a singulation step.

[0104]

As the support, a resin film that has been processed for lubrication on the surface of the above-mentioned resin film may also be used.

As the method for lubrication treatment, a method of arranging a release film formed of a release agent on the surface of the resin film is preferred.

Examples of the release agent include a release agent containing a resin selected from an acrylic resin, an alkyd resin, a silicone resin, a fluororesin, an unsaturated polyester resin, a polyolefin resin, a wax resin, etc.

[0105]

In the case where the support is used as a singulation sheet for fixing the resin film-forming sheet in a singulation step or the like, the support is preferably a pressure sensitive adhesive sheet having a pressure sensitive adhesive layer formed of a pressure sensitive adhesive on the above-mentioned resin film.

Examples of the pressure sensitive adhesive resin that is contained in the pressure sensitive adhesive include, when the structure of the pressure sensitive adhesive resin is specifically noted, an acrylic resin, a urethane resin, a rubber resin, a silicone resin, a vinyl ether resin, etc.; but when the function thereof is specifically noted, examples of the pressure sensitive adhesive resin include an energy ray-curable resin, etc.

In one aspect of the present invention, a pressure sensitive adhesive containing an energy ray-curable resin is preferred from the viewpoint of

bettering the aptitude.

[0106]

The thickness of the support may be suitably selected depending on the use thereof, but is preferably 10 to 500 μm , more preferably 20 to 350 μm , even more preferably 30 to 200 μm .

The thickness of the support includes not only the thickness of the resin film that constitutes the support but also in the case where the support has a pressure sensitive adhesive layer or a release film, the thickness thereof includes the thickness of the pressure sensitive adhesive layer or the release film.

[0107]

<Jig-Adhering Layer>

The jig-adhering layer may be formed of a double-face pressure sensitive adhesive sheet having a substrate (core material) or of a pressure sensitive adhesive composition containing a pressure sensitive adhesive.

The substrate (core material) includes a resin film that can be used as the above-mentioned substrate, and is preferably a polypropylene film.

Examples of the pressure sensitive adhesive include an acrylic resin, a urethane resin, a rubber resin, a silicone resin, a vinyl ether resin, etc.

The thickness of the jig-adhering layer is preferably 1 to 80 μm , more preferably 5 to 60 μm , even more preferably 10 to 40 μm .

[0108]

[Resin Film-Forming Composite Sheet of Different Aspect of Invention]

Another aspect of the present invention is the following resin film-forming composite sheet (hereinafter this may be referred to as a "composite sheet (1)").

The composite sheet (1) of one aspect of the present invention has a resin film-forming sheet to be stuck to a silicon wafer for forming a resin film on the silicon wafer and a support (I), and has the same configuration as that of the composite sheets 1a to 1d shown in Fig. 1.

However, the composite sheet (1) has a configuration in which the surface (α) of the resin film-forming sheet on the side to be stuck to a silicon wafer is directly laminated on the surface (i) of the support (I) having a surface roughness of 40 nm or more.

The surface (α) of the resin film-forming sheet to be exposed out when the support (I) is removed from the composite sheet (1) is considered to be roughened in such a manner that an irregularity having a surface roughness (Ra) of 40 nm or

more formed on the surface (i) of the support (I) is transferred in the same degree or in such a manner that the surface could have a surface roughness (Ra) smaller than the surface roughness (Ra) formed on the surface (i) of the support (I).

Accordingly, the surface roughness (Ra) of the surface (α) of the resin film-forming sheet after removal of the support (I) from the composite sheet (1) is considered to be a predetermined level or more that can exhibit an effect of improving reworkability, and like the resin film-forming sheet of the present invention described above, the composite sheet has an effect of improving reworkability.

[0109]

Preferably, the resin film-forming sheet that the composite sheet (1) of one aspect of the present invention has is heat-curable.

When the resin film-forming sheet is heat-curable, the irregularities of the surface (α) of the resin film-forming sheet can readily deform in the heating step after the resin film-forming sheet has been stuck to a silicon wafer, and therefore gaps to be caused by the irregularities of the surface (α) of the resin film-forming sheet would hardly form in the interface between the surface and the silicon wafer. As a result, in the resin film formed on the silicon wafer, light scattering to be caused of the gaps could be prevented to thereby facilitate observation such as inspection of silicon wafers and chips having the resin film by a visual inspection or an electrographic wave such as an infrared ray.

The resin film-forming sheet that the composite sheet (1) of one aspect of the present invention has preferably contains the above-mentioned heat-curable component (B1) from the viewpoint of imparting heat curability to the sheet.

[0110]

The surface roughness (Ra) of the resin film-forming sheet after removal of the support (I) from the composite sheet (1) is preferably 40 nm or more, more preferably 45 nm or more, even more preferably 50 nm or more, still more preferably 53 nm or more, further preferably 55 nm or more, and is preferably 200 nm or less, more preferably 150 nm or less, even more preferably 100 nm or less.

[0111]

The surface roughness (Ra) of the surface (i) of the support (I) is preferably 40 nm or more, more preferably 70 nm or more, even more preferably 100 nm or more, still more preferably 200 nm or more, further preferably 300 nm or more, and is preferably 1000 nm or less, more preferably 800 nm or less, even more

preferably 500 nm or less.

[0112]

The support (I) that the composite film (1) has is not specifically limited so far as it is surface-treated in such a manner that the surface roughness (Ra) thereof could fall within the above-mentioned range and so far as it is a peelable support, but is preferably formed of paper or a resin film. From the viewpoint of reducing the possibility of dust generation, the support is more preferably formed of a resin film.

[0113]

Examples of the method for controlling the surface roughness (Ra) of the surface (i) of the support (I) include a method of incorporating a filler into the resin film to constitute the support (I), and a method of providing a release film formed of a release agent that contains a filler.

In the case where the support (I) is formed of a resin film produced through melt extrusion, a molten resin may be ejected out onto a roll having a rough surface to form thereon a resin film whose surface roughness (Ra) is controlled to fall within the above-mentioned range.

Apart from the above, a material whose surface could be rough owing to the property thereof, such as paper, nonwoven fabric or the like may be used as a forming material for the support (I) so as to control the surface roughness (Ra) of the surface (i) of the support (I).

[0114]

The composite sheet (1) may be a composite sheet which is so configured that, like the composite sheet 1d shown by Fig. 1(d), a second support (II) is further laminated directly on the surface (β) opposite to the surface (α) of the resin film-forming sheet.

The resin film-forming sheet that the composite sheet has is preferably heat-curable. Accordingly, the resin film-forming sheet of this type preferably contains the above-mentioned heat-curable component (B1).

[0115]

Regarding the composite sheet (1) having such a configuration that a resin film-forming sheet is sandwiched between the support (I) and the support (II), as shown in Fig. 1(d), when the surface (α) of the resin film-forming sheet is stuck to a silicon wafer and then without the support (II) is not peeled and in the state where the support (II) and the resin film-forming sheet are kept laminated, the

resin film-forming sheet is heat cured, and the gloss value measured from the surface (β') opposite to the silicon wafer of the formed resin film tends to be high. The gloss value is higher than the gloss value of the surface (β') of the resin film formed using the composite sheet not having the support (II) or the gloss value of the surface (β') of the resin film formed by heat-curing in the state where the support (II) is peeled and the surface (β) of the resin film-forming sheet is exposed out.

In other words, for example, even in the case where the gloss value of the surface (β') of the resin film is low owing to use of a filler having a large mean particle size as the filler (C), a resin film having high visibility for laser printing can be formed by heat-curing the resin film-forming sheet in a state where the composite sheet (1) is stuck to a silicon wafer and then without peeling the support (II) and in a state where the support (II) and the resin film-forming sheet are kept laminated.

In order that the resin film-forming sheet could be heat-curable, the above-mentioned heat-curable component (B1) may be incorporated into the resin film-forming sheet.

[0116]

The support (II) includes the same as those of the support that the composite sheet of the present invention has. Specifically, there are mentioned the above-mentioned resin film, the resin film having a release film, and a pressure sensitive adhesive sheet having a pressure sensitive adhesive layer.

In the case where the support (II) is an pressure sensitive adhesive sheet having a pressure sensitive adhesive layer, the composite sheet (1) preferably has a configuration in which the pressure sensitive adhesive layer is directly laminated on the surface (β) of the resin film-forming sheet. In this configuration, the pressure sensitive adhesive layer may be formed of a pressure sensitive adhesive that contains an energy ray-curable resin and may be previously cured through energy ray irradiation to be a pressure sensitive adhesive layer, and in the state where the support (II) and the resin film-forming sheet are kept laminated, the resin film-forming sheet may be heat-cured to thereby improve the gloss value of the surface (β') of the formed resin film.

[0117]

[Silicon Wafer Regeneration Method]

An example of a method for regenerating a silicon wafer by peeling the

resin film-forming sheet from a laminate where the surface (α) of the resin film-forming sheet of the present invention has been stuck to a silicon wafer is a silicon wafer regeneration method including the following steps (1) and (2).

Step (1): A step of sticking the pressure sensitive adhesive layer of a pressure sensitive adhesive sheet having a substrate and a pressure sensitive adhesive layer, to the surface (β) opposite to the surface (α) to which the silicon wafer has been stuck, of the resin film-forming sheet of the laminate.

Step (2): A step of peeling the resin film-forming sheet stuck to the silicon wafer, by pulling the pressure sensitive adhesive sheet stuck in the step (1).

[0118]

The silicon wafer regeneration method of the present invention utilizes the property of the resin film-forming sheet of the present invention having excellent reworkability in that, after stuck to a silicon wafer, the sheet can be peeled without breaking the silicon wafer and without leaving a residue.

The silicon wafer regeneration method is applicable not only to a laminate just after the surface (α) of the resin film-forming sheet of the present invention has been stuck onto a silicon wafer, but also to a laminate in such a state where after a lapse of 24 hours after the sticking, the adhesiveness between the silicon wafer and the resin film-forming sheet has increased.

[0119]

<Step (1)>

The step (1) is a step of sticking the pressure sensitive adhesive layer of a pressure sensitive adhesive sheet that has a substrate and a pressure sensitive adhesive layer onto the surface (β) opposite to the surface (α) stuck to a silicon wafer of the resin film-forming sheet of the laminate.

The silicon wafer is not limited to a wafer before singulation, but also singulated one that have been prepared by singulating a silicon wafer into individual chips, for example, according to a pre-singulation method where the surface of a silicon wafer opposite to that thereof to be polished is processed to form grooves thereon and then the wafer is polished to reach the grooves to thereby singulate into individual chips.

[0120]

The pressure sensitive adhesive sheet for use in this step has a substrate and a pressure sensitive adhesive layer. In the case where the composite sheet (1) having the support (II) formed of a pressure sensitive adhesive sheet is stuck

to a silicon wafer, the support (II) may be used as the "pressure sensitive adhesive sheet" in this step.

The substrate is preferably a resin film, and includes the resin film as exemplified in the section of the above-mentioned support.

The pressure sensitive adhesive to form the pressure sensitive adhesive layer is not specifically limited so far as it has an adhesive strength on a level capable of peeling the resin film-forming sheet from a silicon wafer in the step (2).

Specifically, examples of the pressure sensitive adhesive include an acrylic pressure sensitive adhesive, a urethane pressure sensitive adhesive, a silicone pressure sensitive adhesive, etc.

[0121]

The form of the pressure sensitive adhesive sheet is not specifically limited, but from the viewpoint of the handleability in the next step (2), a pressure sensitive adhesive sheet having the same form as the resin film-forming sheet or having a larger form than the resin film-forming sheet is preferred.

[0122]

Regarding the sticking method for the surface (β) to the pressure sensitive adhesive layer of the pressure sensitive adhesive sheet in this step, the sticking may be carried out by machine or by hand.

[0123]

In the case where the surface (α) of the resin film-forming sheet that the composite sheet of one embodiment of the present invention has is stuck to a silicon wafer and where the pressure sensitive adhesive sheet such as a singulation sheet serving as a support has already been laminated on the side of the surface (β) thereof, the pressure sensitive adhesive sheet may also be used as the pressure sensitive adhesive sheet in this step.

[0124]

<Step (2)>

The step (2) is a step of peeling the resin film-forming sheet from the silicon wafer by pulling the pressure sensitive adhesive sheet stuck in the step (1).

In this step, by pulling the pressure sensitive adhesive sheet stuck to the surface (β) in the step (1), the resin film-forming sheet can be together peeled from the silicon wafer, since the surface roughness (Ra) of the surface (α) stuck to a silicon wafer of the resin film-forming sheet of the present invention has been controlled to fall within the above-mentioned range.

[0125]

The peeling rate and the peeling angle of the pressure sensitive adhesive sheet are not specifically limited, and may be defined in any desired manner.

In this step, the pressure sensitive adhesive sheet may be pulled by machine, but from the viewpoint of operability, it is preferable that the pressure sensitive adhesive sheet is pulled by hand to peel the resin film-forming sheet from the silicon wafer.

[0126]

In this step, after the resin film-forming sheet has been peeled, if desired, the surface of the silicon wafer may be washed with an organic solvent such as ethanol, etc.

After the above-mentioned steps, the silicon wafer to which a resin film-forming sheet has been once stuck can be regenerated.

Examples

[0127]

<Measurement of Mass-Average Molecular Weight (Mw), Number-Average Molecular Weight (Mn)>

Using a gel permeation chromatography apparatus (trade name "HLC-8220GPC" manufactured by Tosoh Corporation), the measurement was carried out under the condition mentioned below, and a standard polystyrene-equivalent value of the found data was used.

(Measurement Condition)

Columns: "TSK Guard Column HXL-L", "TSK Gel GMHXL ($\times 2$)", and "TSK Gel G2000HXL" (all manufactured by Tosoh Corporation) connected sequentially.

Column temperature: 40°C

Developing solvent: tetrahydrofuran

Flow rate: 1.0 mL/min

[0128]

<Mean Particle Size of Component in Resin Film-Forming Composition>

Measured with a dynamic light-scattering particle sizer (trade name Nanotrack Wave-UT151, manufactured by Nikkiso Co., Ltd.).

[0129]

<Measurement of Surface Roughness (Ra)>

The surface roughness (Ra) of the surface of the object to be measured was measured using an optical interferotype surface profiler (trade name "WYKO WT1100" manufactured by Veeco Metrology Group Corporation), in a PSI mode at a magnification of 10 powers.

[0130]

<Evaluation of Reworkability of Resin Film-Forming Sheet>

The support (I) was removed from the resin film-forming composite sheet produced in Examples and Comparative Examples, and the exposed surface (α) of the resin film-forming sheet was laminated on the polished surface of a #2000-polished silicon wafer (diameter: 200 mm, thickness: 280 μ m) and stuck thereto, using a tape mounter (trade name "Adwill RAD-3600 F/12" manufactured by Lintec Corporation), with heating at 70°C.

After thus stuck, the support (II) was also removed from the resin film-forming composite sheet at room temperature (25°C), and the pressure sensitive adhesive layer surface of a commercially-available general-purpose singulation tape (trade name "Adwill D-510T" manufactured by Lintec Corporation) was stuck to the exposed surface of the resin film-forming sheet.

With that, the general-purpose singulation tape was pulled by hand, and checked as to whether or not the resin film-forming sheet could be peeled together from the silicon wafer and as to the presence or absence of a residue on the surface of the peeled silicon wafer. Based on the following criteria, the reworkability of the resin film-forming sheet was evaluated.

A: The resin film-forming sheet was completely peeled from the silicon wafer. After peeled, any visible residue of the resin film-forming sheet was not detected on the silicon wafer.

B: The resin film-forming sheet was removed from the silicon wafer. Some residue of the resin film-forming sheet was detected on the peeled silicon wafer, but was completely removed by wiping with ethanol.

C: The silicon wafer broke during peeling, or even though the silicon wafer could be peeled without breaking, a residue of the resin film-forming sheet remained on the peeled silicon wafer in such a degree that the residue could not be wiped off with ethanol was confirmed.

[0131]

<Measurement of Gloss Value of Resin Film>

The support (I) was removed from the resin film-forming composite sheet

produced in Examples and Comparative Examples, and the exposed surface (α) of the resin film-forming sheet was laminated on the polished surface of a #2000-polished silicon wafer (diameter: 200 mm, thickness: 280 μm) and stuck thereto, using a tape mounter (trade name "Adwill RAD-3600 F/12" manufactured by Lintec Corporation), with heating at 70°C.

After thus stuck, the support (II) was also removed from the resin film-forming composite sheet, then the sheet was put into a hot oven at 130°C and left therein for 2 hours, so that the resin film-forming sheet was cured to form a resin film on the silicon wafer.

With that, the specular gloss at 60 degrees of the surface of the formed resin film from the side opposite to the side having the silicon wafer thereon was measured, according to JIS Z 8741 and using a gloss meter (trade name "VG 2000" manufactured by Nippon Denshoku Industries Co., Ltd.). The specular gloss value was referred to as the gloss value of the resin film.

[0132]

<Measurement of Light Transmittance of Resin Film at a wavelength of 1250 nm>

The support (I) was removed from the resin film-forming composite sheet produced in Examples and Comparative Examples, and the exposed surface (α) of the resin film-forming sheet was laminated on the flat surface of a glass plate having a thickness of 2 mm, and stuck thereto with heating at 70°C using a laminator.

After thus stuck, the support (II) was also removed from the resin film-forming composite sheet, then the sheet was put into a hot oven at 130°C and left therein for 2 hours, so that the resin film-forming sheet was cured to form a resin film on the glass plate.

With that, the transmittance through the resin film on the glass plate was measured, using a spectrophotometer (trade name "UV-VIS-NIR SPECTROPHOTOMETER UV-3600 manufactured by Shimadzu Corporation), and the light transmittance (%) at a wavelength of 1250 nm was extracted.

For the measurement, a large-size sample room "MPC-3100" (trade name) attached to the spectrophotometer was used, and the built-in integrating sphere was not used. A difference from the light transmittance at a wavelength of 1250 nm of the glass plate alone that had been previously measured was calculated to give the light transmittance at a wavelength of 1250 nm of the resin film.

[0133]

Example 1

The components of the type and the blending amount shown in Table 1 were blended and diluted with methyl ethyl ketone to prepare a solution of a resin film-forming composition having an active ingredient concentration of 51% by mass.

Next, the solution of the resin film-forming composition was applied onto the lubricated surface of a lubricated polyethylene terephthalate (PET) film (trade name "SP-PET381031" manufactured by Lintec Corporation, thickness: 38 μm), as a support (II), and dried to form a resin film-forming sheet having a thickness of 25 μm thereon.

Further, as a support (I), the lubricated surface of a release paper (trade name "SP-8LK Ao" manufactured by Lintec Corporation, thickness: 88 μm , prepared by coating a glassine paper with polyolefin and processed for silicone lubrication, surface roughness (Ra) of the lubricated surface = 370 nm) was stuck to the exposed surface of the formed resin film-forming sheet, then laminated at room temperature (25°C) using a laminator (trade name "VA-400" manufactured by Taisei Laminator Co., Ltd.) thereby producing a resin film-forming composite sheet having a configuration of support (I)/resin film-forming sheet/support (II).

[0134]

Comparative Example 1

A resin film-forming composite sheet having a configuration of support (I)/resin film-forming sheet/support (II) was produced in the same manner as in Example 1, except that, on the exposed surface of the resin film-forming sheet produced in the same manner as in Example 1, the lubricated surface of a lubricated polyethylene terephthalate (PET) film (trade name "SP-PET251130" manufactured by Lintec Corporation, thickness: 25 μm) was stuck as a support (I).

[0135]

The details of each component shown in Table 1, as used in preparing the resin film-forming composition, are as follows.

<Polymer Component (A)>

(A-1): Acrylic copolymer prepared by copolymerization of methyl acrylate (MA), n-butyl acrylate (BA), glycidyl methacrylate (GMA) and 2-hydroxyethyl acrylate (HEA) (BA/MA/GMA/HEA = 37/28/20/15 (% by mass), Mw = 800,000, Tg = -10.1°C).

<Curable Component (B)>

(B-1): Bisphenol A-type epoxy resin (trade name "jER828" manufactured by Mitsubishi Chemical Corporation, epoxy equivalent = 184 to 194 g/eq, Mn = 370, viscosity at 25°C = 120 to 150 P (12 to 15 Pa·s), liquid epoxy resin, compound corresponding to the component (B11)).

(B-2): Bisphenol A-type epoxy resin (trade name "jER1055" manufactured by Mitsubishi Chemical Corporation, epoxy equivalent = 800 to 900 g/eq, Mn = 1600, solid epoxy resin, compound corresponding to the component (B11)).

(B-3): Dicyclopentadiene-type epoxy resin (trade name "Epiclon HP-7200HH" manufactured by DIC Corporation, epoxy equivalent = 255 to 260 g/eq, compound having Mw of less than 20,000, solid epoxy resin, compound corresponding to the component (B11)).

(B-4): Dicyandiamide (trade name "Adeka Hardener EH-3636AS" manufactured by ADEKA Corporation, amine-type curing agent, active hydrogen amount = 21 g/eq, compound corresponding to the component (B12)).

(B-5): 2-Phenyl-4,5-dihydroxymethylimidazole (trade name "Curesol 2PHZ" manufactured by Shikoku Chemicals Corporation, curing accelerator, compound corresponding to the component (B13)).

<Filler (C)>

(C-1): Silica filler (trade name "SC2050MA" manufactured by Admatechs Corporation, mean particle size = 500 nm).

<Colorant (D)>

(D-1): Carbon black (trade name "#MA650" manufactured by Mitsubishi Chemical Corporation, mean particle size = 28 nm).

<Silane Coupling Agent (E)>

(E-1): Silane coupling agent (3-glycidoxypopylthyldimethoxysilane, trade name "KBM-402" manufactured by Shin-Etsu Chemical Co., Ltd., Mn = 220.3).

[0136]

The physical properties of the resin film forming sheets produced in Examples and Comparative Examples based on the above-mentioned method were measured and evaluated, and the results are shown in Table 1.

[0137]

Table 1

			Example 1	Comparative Example 1
Ingredients of Resin Film-Forming Composition (part by mass)	Polymer Component (A)	A-1 (acrylic polymer)	30.00	30.00
	Curable Component (B)	B-1 (liquid epoxy resin)	10.00	10.00
		B-2 (solid epoxy resin)	3.00	3.00
		B-3 (solid epoxy resin)	5.00	5.00
		B-4 (amine-type curing agent)	0.20	0.20
		B-5 (curing accelerator)	0.20	0.20
	Filler (C)	C-1 (mean particle size: 500 nm)	51.10	51.10
	Colorant (D)	D-1 (carbon black)	0.30	0.30
	Silane Coupling Agent (E)	E-1 (3-glycidoxypropylmethyldimethoxysilane)	0.20	0.20
	Total Amount		100.00	100.00
Physical Properties and Evaluation of Sheet	Surface roughness (Ra) of surface (α) of resin film-forming sheet [nm]		55.0	34.0
	Evaluation (1)	Reworkability of resin film-forming sheet	A	C
	Evaluation (2)	Gloss value of resin film	40	40
	Evaluation (3)	Light transmittance (%) at wavelength of 1250 nm through resin film	43	43

[0138]

From Table 1, the results are that the resin film-forming sheet, which the resin film-forming composite sheet produced in Example 1 as one aspect of the present invention had, had excellent reworkability. The resin film formed of the resin film-forming sheet had a high gloss value and a high light transmittance value at a wavelength of 1250 nm.

On the other hand, the value of the surface roughness (Ra) of the surface (α) of the resin film-forming sheet, which the resin film-forming composite sheet produced in Comparative Example 1 had, was small, and therefore, after stuck to a silicon wafer, the sheet was difficult to peel, and the reworkability of the sheet was poor.

Industrial Applicability

[0139]

The resin film-forming sheet of one aspect of the present invention is favorable as a forming material for a protective film for protecting the back surface of a semiconductor chip, or as a forming material for an adhesive film that can be adhered onto a die pad part or onto any other part.

Reference Signs List

[0140]

1a, 1b, 1c, 1d Resin Film-Forming Composite Sheet

10 Resin Film-Forming Sheet

11, 11' Support

12 Jig-Adhering Layer

CLAIMS

[Claim 1]

A resin film-forming sheet to be stuck to a silicon wafer to form a resin film on the silicon wafer, which comprises a polymer component (A) comprising an acrylic polymer (A1) having a glass transition temperature (T_g) of -40 to 0° C, wherein:

the surface roughness (Ra) of the surface (α) of the sheet on the side to be stuck to a silicon wafer is 40 nm or more.

[Claim 2]

The resin film-forming sheet according to claim 1, which comprises a curable component (B).

[Claim 3]

The resin film-forming sheet according to claim 2, wherein the glass transition temperature (T_g) of the acrylic polymer (A1) is -40 to -10.1° C.

[Claim 4]

The resin film-forming sheet according to any one of claims 1 to 3, which comprises a heat-curable component (B1).

[Claim 5]

The resin film-forming sheet according to any one of claims 1 to 4, which comprises a filler (C).

[Claim 6]

The resin film-forming sheet according to claim 5, wherein the content of the filler (C) is 10 to 80% by mass relative to the total amount of the resin film-forming sheet.

[Claim 7]

The resin film-forming sheet according to claim 5 or 6, wherein the mean particle size of the filler (C) is 100 to 1000 nm.

[Claim 8]

The resin film-forming sheet according to any one of claims 1 to 7, which is a protective film-forming sheet for forming a protective film on a silicon wafer.

[Claim 9]

The resin film-forming sheet according to any one of claims 1 to 8, wherein, after the surface (α) of the resin film-forming sheet is stuck to a silicon wafer, the gloss value measured from the surface (β') opposite to the silicon wafer of the resin film formed from the resin film-forming sheet is 25 or more.

[Claim 10]

A resin film-forming composite sheet comprising the resin film-forming sheet of any one of claims 1 to 9 and a support.

[Claim 11]

A resin film-forming composite sheet according to claims 10, wherein comprising a configuration in which the surface (α) of the resin film-forming sheet on the side to be stuck to a silicon wafer and the surface (i) of the support (I) having a surface roughness of 40 nm or more are directly laminated.

[Claim 12]

A resin film-forming composite sheet comprising a resin film-forming sheet, which is to be stuck to a silicon wafer to form a resin film on the silicon wafer and comprises a polymer component (A) comprising an acrylic polymer (A1) having a glass transition temperature (T_g) of -40 to 0°C , and a support (I), and further comprising a configuration in which the surface (α) of the resin film-forming sheet on the side to be stuck to a silicon wafer and the surface (i) of the support (I) having a surface roughness of 40 nm or more are directly laminated.

[Claim 13]

The resin film-forming composite sheet according to claim 12, wherein the surface roughness (R_a) of the surface (α) of the resin

film-forming sheet exposed when the support (I) is removed from the resin film-forming composite sheet is 40 nm or more.

[Claim 14]

The resin film-forming composite sheet according to claim 12 or 13, wherein the resin film-forming sheet comprises a heat-curable component (B1).

[Claim 15]

The resin film-forming composite sheet according to claim 12 or 13, which has a configuration in which a second support (II) is further laminated directly on the surface (β) opposite to the surface (α) of the resin film-forming sheet, and in which the resin film-forming sheet contains the heat-curable component (B1).

[Claim 16]

The resin film-forming composite sheet according to claim 15, wherein the support (II) is a pressure sensitive adhesive sheet having a pressure sensitive adhesive layer, and the pressure sensitive adhesive layer is directly laminated on the surface (β) of the resin film-forming sheet.