

DESCRIPTION

TITLE OF INVENTION

RESIN-FILM FORMING COMPOSITE SHEET, AND METHOD OF
MANUFACTURING CHIP HAVING RESIN FILM

TECHNICAL FIELD

[0001]

The present invention relates to a resin film-forming composite sheet, and a method for producing a resin film-having chip using the 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 method is performed. In the face-down method, a semiconductor chip (hereinafter, occasionally simply referred to as a "chip") having electrodes such as bumps on a circuit surface of a semiconductor chip is used, and the electrodes are bonded to a substrate. Hence, there is a case where the surface of a chip on the side opposite to the side bonded to a substrate (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 may be given a function as a protective film for preventing cracking in a dicing step or after packaging, or a function 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 diced.

[0004]

Another method is also employable where a curable resin film-forming sheet is stuck onto the back surface of a wafer and, before and after wafer dicing, the resin film-forming sheet is cured through energy ray irradiation or heating to form a resin film, thereby producing a resin film-having wafer and a resin film-having chip.

As such a material for forming a resin film on the back surface of a chip or on the back surface of a wafer, various resin film-forming films have been proposed.

For example, PTL 1 discloses a chip-protective film having such a configuration that 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 dicing tape-integrated wafer back surface-protective film, which has a dicing tape having a pressure sensitive adhesive layer on a substrate, and which has a wafer back surface-protective film colored and having a given elastic modulus on the pressure sensitive adhesive layer of the dicing tape,.

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 dicing 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 sticking the protective film described in PTLs 1 and 2 to a wafer, there may occur some problems that the position of the protective film to be stuck to the wafer may misalign, or some foreign substances may stick to a wafer and a protective film may be stuck to the wafer along with the foreign substances kept existing therebetween. In such cases, the protective film may be desired to be reworked (removed for resticking) from the wafer.

However, it is often difficult to cleanly rework the protective film once stuck to a wafer, from the wafer with no residue left thereon.

In particular, 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 is extremely difficult to rework from the wafer since the adhesiveness to wafer is high.

In other words, wafer may be broken by the power applied thereto for forcibly releasing the protective film once stuck to the wafer, or even when the protective film could be released, a part of the protective film may remain on the wafer and therefore the wafer could no more be reused.

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 film once stuck to a wafer.

[0008]

An object of the present invention is to provide a resin film-forming composite sheet which has good rework capability and which can be released even after stuck to a silicon wafer, and a method for producing a resin film-having chip using the resin film-forming composite sheet.

Solution to Problem

[0009]

The present inventors have found that, in a resin film-forming composite sheet having such a configuration that a resin film-forming film is directly laminated on a supporting sheet, when the release force necessary for releasing the resin film-forming sheet from an adherend, silicon wafer and the release force necessary for releasing the resin film-forming film from the supporting sheet are

controlled, the above-mentioned problems can be solved, and have completed the present invention.

[0010]

Specifically, the present invention provides the following [1] to [9].

[1] A resin film-forming composite sheet which is so configured that a resin film-forming film capable of forming a resin film is directly laminated on a supporting sheet and which satisfies the following requirements (I) and (II):

Requirement (I): a release force ($\alpha 1$) required for releasing the resin film-forming film from a silicon wafer, as measured in an environment at 23°C and under releasing conditions (x) of a pulling rate of 300 mm/min and a pulling angle of 180° after a surface (α) of the resin film-forming film on the side thereof to be stuck to the silicon wafer has been stuck to a silicon wafer, is 0.05 to 10.0 N/25 mm; and

Requirement (II): a release force ($\beta 1$) required for releasing the supporting sheet from a surface (β) of the resin film-forming film on the side thereof directly laminated on the supporting sheet, as measured under the above-mentioned releasing conditions(x), is a value equal to or greater than the release force ($\alpha 1$).

[2] The resin film-forming composite sheet according to the above [1], further satisfying the following requirement (III):

Requirement (III): a release force ($\beta 2$) required for releasing the supporting sheet from a surface (β') of the resin film on the side on which the supporting sheet is directly laminated, as measured under the above-mentioned releasing conditions (x) after the resin film has been formed from the resin film-forming film, is 0.02 to 5.0 N/25 mm.

[3] The resin film-forming composite sheet according to the above [1] or [2], wherein the release force ($\beta 1$) is 0.05 to 20.0 N/25 mm.

[4] The resin film-forming composite sheet according to any one of the above [1] to [3], wherein the supporting sheet is a sheet formed of a substrate alone.

[5] The resin film-forming composite sheet according to any one of the above [1] to [3], wherein the supporting sheet is a pressure sensitive adhesive sheet having a pressure sensitive adhesive layer on a substrate and is so configured that the pressure sensitive adhesive layer of the pressure sensitive adhesive sheet is laminated directly on the surface (β) of the resin film-forming film.

[6] The resin film-forming composite sheet according to the above [5], wherein the pressure sensitive adhesive layer is a layer formed of a pressure sensitive

adhesive composition containing an energy ray-curable resin.

[7] The resin film-forming composite sheet according to any one of the above [1] to [6], wherein the resin film-forming film contains a polymer component (A) and a curable component (B).

[8] The resin film-forming composite sheet according to any one of the above [1] to [7], wherein the resin film-forming film is a forming material for a protective film or an adhesive film.

[9] A method for producing a resin film-having chip, including the following steps (1) to (4):

step (1): a step of sticking the resin film-forming composite sheet of any one of claims 1 to 8, onto the back surface of a workpiece;

step (2): a step of dicing the workpiece;

step (3): a step of forming a resin film from the resin film-forming film;
and

step (4): a step of picking up the workpiece that has been diced via the step (2) to thereby obtain a chip.

Advantageous Effects of Invention

[0011]

The resin film-forming composite sheet of the present invention is excellent in reworking performance and can be released after stuck to a silicon wafer, and the released silicon wafer can be reused. Accordingly, the production method for a resin film-having chip using the resin film-forming composite sheet of the present invention is advantageous in point of productivity and economic potential.

Brief Description of Drawings

[0012]

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

Fig. 2 is a cross-sectional view showing a configuration in sticking the resin film-forming composite sheet of one aspect of the present invention onto a silicon wafer.

Fig. 3 is a cross-sectional view showing a configuration in forming a resin film on a silicon wafer using the resin film-forming composite sheet of one aspect

of the present invention.

Description of Embodiments

[0013]

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, "energy ray" indicates, for example, ultraviolet ray, electron beam and the like, and is preferably ultraviolet ray.

[0014]

[Configuration of Resin Film-Forming Composite Sheet]

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

The resin film-forming composite sheet of the present invention (hereinafter simply referred to as "composite sheet") is, as shown in Fig. 1, so configured that a resin film-forming film capable of forming a resin layer is directly laminated on a supporting sheet.

The form of the composite 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.

[0015]

The composite sheet of one aspect of the present invention includes a composite sheet 1a having a configuration where a resin film-forming film 20 is directly laminated on the surface of a supporting sheet 10, as shown in Fig. 1(a).

The form of the resin film-forming film 20 of the composite sheet of one aspect of the present invention is preferably nearly the same form as that of a silicon wafer of an adherend, or is a form capable of including the form of a silicon wafer.

[0016]

In the composite sheet 1a of Fig. 1(a), the supporting sheet 10 and the resin film-forming film 20 have nearly the same form, but as shown in Fig. 1(b) of a composite sheet 1b, the form of the resin film-forming film 20 may be smaller than the form of the supporting sheet 10.

[0017]

The composite sheet of one aspect of the present invention also includes a

composite sheet 1c having a ring-like jig-adhering layer 40, as shown in Fig. 1(c).

The ring-like jig-adhering layer 40 is provided for the purpose of improving the adhesion power to a jig in adhering the sheet to a jig such as a ring flame or the like, and may be formed of a double-face pressure sensitive adhesive double coated 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 40 is arranged on surface (α) 21 of the resin film-forming film 20, but the composite sheet of one aspect of the present invention may also include such a configuration that the jig-adhering layer 40 is arranged on the surface of the supporting sheet 10 of the composite sheet 1b shown in Fig. 1(b).

[0018]

As well, for example, the exposed surface (α) 21 of the resin film-forming film 20 that the composite sheet 1a shown in Fig. 1(a) has is a sticking surface to an adherend, silicon wafer.

Consequently, for protecting the surface (α) 21 from adhesion of foreign substances thereto or from being scratched, a carrier sheet 50 capable of being released in sticking to a silicon wafer may be further laminated on the surface (α) 21 of the resin film-forming film 20 to give a composite sheet 1d, as shown in Fig. 1(d).

[0019]

The composite sheet 1d shown in Fig. 1(d) has such a configuration that the carrier sheet 50 is arranged on the surface (α) 21 of the resin film-forming film 20 that the composite sheet 1a shown in Fig. 1(a) has. The carrier sheet 50 is provided for the purpose of preventing the surface (α) 21 of the resin film-forming film 20 from being contaminated during storage, and is removed when the composite sheet 1d is stuck to a silicon wafer.

The carrier sheet 50 that the composite sheet 1d shown in Fig. 1(d) has includes those formed of a carrier sheet substrate such as a resin film or the like, and is preferably such that the surface of the carrier sheet substrate such as a resin film or the like is treated for releasing.

Like in the configuration of the composite sheet 1d, such a carrier sheet may be further arranged to cover the surface (α) 21 and the surface of the supporting sheet 10 in the composite sheet 1b in Fig. 1(b), and in the composite sheet 1c shown in Fig. 1(c), the carrier sheet may be arranged to cover the surface

(α) 21 and the surface of the jig-adhering layer 40.

[0020]

Here, the supporting sheet that the composite sheet of one aspect of the present invention has may be a sheet formed of a substrate alone, or may be a pressure sensitive adhesive sheet having a pressure sensitive adhesive layer on a substrate.

In the case where a pressure sensitive adhesive sheet is used as the supporting sheet, the pressure sensitive adhesive layer of the pressure sensitive adhesive sheet is so configured as to be directly laminated on a surface (β) 22 of the resin film-forming film 20.

[0021]

The supporting sheet to be used in one aspect of the present invention may be a sheet formed of a substrate having a surface treated for releasing. The composite sheet using, as the supporting sheet, a sheet formed of a substrate having a surface treated for releasing is to be so configured that the release-treated surface of the substrate is directly laminated on the surface (β) 22 of the resin film-forming film 20.

[0022]

[Release Force (α 1), (β 1), (β 2) of Resin Film-Forming Composite Sheet]

The resin film-forming composite sheet of the present invention must satisfy the following requirements (I) and (II).

Requirement (I): A release force (α 1) required for releasing the resin film-forming film from a silicon wafer, as measured in an environment at 23°C and under releasing conditions (x) of a pulling rate of 300 mm/min and a pulling angle of 180° after a surface (α) of the resin film-forming film on the side thereof to be stuck to the silicon wafer has been stuck to a silicon wafer, is 0.05 to 10.0 N/25 mm.

Requirement (II): A release force (β 1) required for releasing the supporting sheet from a surface (β) of the resin film-forming film on the side thereof directly laminated on the supporting sheet, as measured under the above-mentioned releasing conditions (x), is a value equal to or greater than the release force (α 1).

In this description, the "release force (α 1)" and the "release force (β 1)" defined in the above-mentioned requirements (I) and (II) mean the values measured under the condition and according to the method described in the section of Examples.

[0023]

Fig. 2 is a cross-sectional view showing a configuration where a resin film-forming composite sheet of one aspect of the present invention has been stuck onto a silicon wafer.

The "release force ($\alpha 1$)" defined in the requirement (I) is a release force at an interface $\alpha 1$ between a silicon wafer 100 and the surface (α) 21 of the resin film-forming film 20 on the side thereof to be stuck to the silicon wafer, as shown in Fig. 2.

[0024]

In the present invention, the release force ($\alpha 1$) must be 0.05 to 10.0 N/25 mm.

For example, many conventional resin film-forming films such as those disclosed in PTLs 1 and 2 are for improving adhesiveness to silicon wafer and retentiveness thereof, and the materials are so planned as to increase the value of the release force ($\alpha 1$).

However, when the release force ($\alpha 1$) exceeds 10.0 N/25 mm, it is substantially difficult to rework the resin film-forming film that has been once stuck to a silicon wafer. In other words, in such a case, where the resin film-forming film that has been stuck to a silicon wafer is forcibly released, it is considered that a part of the resin film-forming film may remain on the silicon wafer or the silicon wafer may be broken, and the silicon wafer could no more be reused.

Therefore, in the composite sheet of the present invention, the releasing force ($\alpha 1$) is controlled to be 10.0 N/25 mm or less, for the purpose of obtaining a composite sheet excellent in reworkability and capable of being released even after stuck to a silicon wafer.

On the other hand, when the release force ($\alpha 1$) is less than 0.05 N/25 mm, especially the edges of the composite sheet may often lift or peel after stuck to a silicon wafer.

[0025]

From the above-mentioned viewpoints, in one aspect of the present invention, the release force ($\alpha 1$) is preferably 0.06 to 9.5 N/25 mm, more preferably 0.07 to 9.2 N/25 mm, even more preferably 0.1 to 9.0 N/25 mm, further more preferably 0.2 to 8.0 N/25 mm, still more preferably 0.5 to 6.0 N/25 mm, even further more preferably 0.5 to 4.0 N/25 mm, and especially more preferably 0.5 to

3.0 N/25 mm.

[0026]

In one aspect of the present invention, as an example of the method for controlling the release force ($\alpha 1$), there is mentioned a method of suitably selecting the kind and the content of a polymer component, a curable component, an inorganic filler and an additive to be contained in the resin film-forming film for controlling the value. Regarding the concrete method for controlling the release force ($\alpha 1$), the matters described in the item of each component to be mentioned hereinunder may be suitably taken into consideration for controlling the value.

[0027]

The "release force ($\beta 1$)" in the requirement (II) is, for example, one to define the release force at an interface $\beta 1$ between the surface (β) 22 of the resin film-forming film 20 on the side thereof directly laminated with the supporting sheet 10, and the supporting sheet 10, as shown in Fig. 2.

In the case where a pressure sensitive adhesive sheet is used as the supporting sheet, the "release force (β)" is one to define the release force at the interface between the surface (β) of the resin film-forming film and the pressure sensitive adhesive layer of the pressure sensitive adhesive sheet used as the supporting sheet.

[0028]

In the present invention, the release force ($\beta 1$) must be larger than the value of the above-mentioned release force ($\alpha 1$).

When the release force ($\beta 1$) is a value less than the release force ($\alpha 1$), all or a part of the resin film-forming film may remain on the silicon wafer in reworking the composite sheet stuck to a silicon wafer, and therefore the silicon wafer could no more be reused.

[0029]

From the viewpoint of more improving the reworkability of the composite sheet, the difference between the release force ($\beta 1$) and the release force ($\alpha 1$) [$(\beta 1) - (\alpha 1)$] is preferably 0.01 N/25 mm or more, more preferably 0.1 N/25 mm or more, even more preferably 0.15 N/25 mm or more, still more preferably 0.2 N/25 mm or more, further more preferably 0.5 N/25 mm or more, especially more preferably 1.0 N/25 mm or more.

Also the difference between the release force ($\beta 1$) and the release force

$(\alpha 1) [(\beta 1) - (\alpha 1)]$ is preferably 20 N/25 mm or less, more preferably 12 N/25 mm or less, but from the viewpoint of improving the picking up capability in picking up diced silicon wafers, the difference is even more preferably 8.0 N/25 mm or less, further more preferably 6.0 N/25 mm or less, still further more preferably 4.0 N/25 mm or less, and especially more preferably 2.5 N/25 mm or less.

[0030]

In one aspect of the present invention, the release force ($\beta 1$) is preferably 0.05 to 20.0 N/25 mm, more preferably 0.2 to 18.0 N/25 mm, even more preferably 0.5 to 16.0 N/25 mm, still more preferably 1.0 to 14.0 N/25 mm.

When the release force ($\beta 1$) is 0.05 N/25 mm or more, a phenomenon of separating the resin film-forming film from the supporting sheet at the interface $\beta 1$ in reworking the composite sheet stuck to a silicon wafer can be prevented.

On the other hand, when the release force ($\beta 1$) is 20.0 N/25 mm or less, the picking up capability in picking up diced silicon wafers can be bettered.

[0031]

In one aspect of the present invention, an example of the method for controlling the release force ($\beta 1$) is a method of suitably selecting the kind and the content of the above-mentioned components to be contained in the resin film-forming film, and the kind of the supporting sheet to be used (including the kind of the resin film to be the substrate, the kind and the blending amount of the resin and the additive to constitute the releasing layer, and the kind and the blending amount of the resin and the additive to constitute the pressure sensitive adhesive layer) for controlling the value.

Regarding the concrete method for controlling the release force ($\beta 1$), the matters described in the item of each component to be mentioned hereinunder may be suitably taken into consideration for controlling the value.

[0032]

Further, the composite sheet of one aspect of the present invention preferably satisfies the following requirement (III).

Requirement (III): When a resin film is formed of the resin film-forming film, a release force ($\beta 2$) required for releasing the supporting sheet from a surface (β') of the resin film on the side thereof directly laminated with the supporting sheet, as measured under the above-mentioned releasing conditions (x), is 0.02 to 5.0 N/25 mm.

In this description, the "release force ($\beta 2$)" defined in the above-mentioned

requirement (III) means a value measured under the condition and according to the method described in the section of Examples.

[0033]

Fig. 3 is a cross-sectional view showing a configuration in forming a resin film on a silicon wafer using the resin film-forming composite sheet of one aspect of the present invention.

The "release force ($\beta 2$)" defined in the requirement (III) is, for example, as shown in Fig. 3, to define the release force at the interface $\beta 2$ between the surface (β') 32 of the resin film 30 formed of the resin film-forming film and the supporting sheet 10.

In the case where a pressure sensitive adhesive sheet is used as the supporting sheet, the "release force ($\beta 2$)" is to define the release force at the interface between the surface (β') of the resin film and the pressure sensitive adhesive layer of the pressure sensitive adhesive sheet used as the supporting sheet.

[0034]

When the release force ($\beta 2$) is 0.02 N/25 mm or more, in obtaining chips by picking up diced silicon wafers, the chips could have a retention force in some degree, and therefore just before picking up them, a phenomenon that the chips would scatter discretely can be prevented.

On the other hand, when the release force ($\beta 2$) is 5.0 N/25 mm or less, in picking up diced silicon wafers, the picking up performance can be bettered.

In one aspect of the present invention, the release force ($\beta 2$) is, from the above-mentioned viewpoints, preferably 0.03 to 4.0 N/25 mm, more preferably 0.05 to 2.5 N/25 mm, even more preferably 0.10 to 2.0 N/25 mm, further more preferably 0.15 to 1.5 N/25 mm.

[0035]

On the other hand, a release force ($\alpha 2$) at an interface $\alpha 2$ between a silicon wafer 100 and a surface (α') 31 of the resin film 30 formed of a resin film-forming film on the side thereof laminated with the silicon wafer is not specifically limited, but is preferably a value at least larger than the above mentioned release force ($\alpha 1$) and the release force ($\beta 2$).

[0036]

In one aspect of the present invention, the method for controlling the release force ($\beta 2$) is not specifically limited, and may be the same method as that

for controlling the above-mentioned release force ($\beta 1$).

In the case where a pressure sensitive adhesive sheet is used as the supporting sheet, it is preferable to use a pressure sensitive adhesive sheet having a pressure sensitive adhesive layer formed of a pressure sensitive adhesive composition containing an energy ray-curable resin. By irradiation with energy rays, the adhesion of the pressure sensitive adhesive layer can be lowered and the release force ($\beta 2$) can be readily controlled to fall within the above-mentioned range.

[0037]

[Individual Layers Constituting Resin Film-Forming Composite Sheet]

Individual layers constituting the resin film-forming composite sheet of one aspect of the present invention are described below.

[0038]

<Resin Film-Forming Film>

The resin film-forming film that the composite sheet of one aspect of the present invention has may be any one having the release force ($\alpha 1$) and ($\beta 1$) each falling within the above-mentioned range, but is preferably a resin film-forming film that contains a polymer component (A) and a curable component (B).

The resin film-forming film may further contain one or more kinds selected from an inorganic filler (C), a colorant (D), a coupling agent (E) and a wide-use additive (F), in addition to the components (A) and (B), within a range not detracting from the advantageous effects of the present invention.

The components (A) to (F) to be contained in the resin film-forming film are described below.

The values of the release force ($\alpha 1$), ($\beta 1$) and ($\beta 2$) can be controlled by suitably combining the preferred matters of the constituent components mentioned below and by taking them into consideration.

[0039]

[Polymer Component (A)]

In this description, the "polymer component" means a compound having a mass-average molecular weight (Mw) of 20,000 or more and having at least one kind of repeating units.

The resin film-forming film for use in one aspect of the present invention contains a polymer component (A) and therefore can be given flexibility and film formability and can better sheet property retentiveness.

The mass-average molecular weight (Mw) of the polymer component (A) is, from the above-mentioned viewpoints, preferably 20,000 or more, more preferably 20,000 to 3,000,000, even more preferably 50,000 to 2,000,000, still more preferably 100,000 to 1,500,000.

[0040]

In this description, the value of the mass-average molecular weight (Mw) of the polymer component and others is a standard polystyrene-equivalent value measured through gel permeation chromatography (GPC), and specifically, it is a value measured according to the method described in the section of Examples.

[0041]

The content of the polymer component (A) is preferably 5 to 50% by mass relative to the total mass (100% by mass) of the resin film-forming film, more preferably 8 to 40% by mass, even more preferably 10 to 35% by mass, still more preferably 15 to 30% by mass.

[0042]

In this description, for example, the "content of the component (A) relative to the total mass (100% by mass) of the resin film-forming film" has the same meaning as that of the "content of the component (A) relative to the total mass (100% by mass) of the active ingredient in the composition that is a forming material for the resin film-forming film", and the same shall apply to the content of the other components to be described hereinunder.

In other words, regarding the definition of the content of each component, the wording "relative to the total mass (100% by mass) of the resin film-forming film" may be replaced by the wording "relative to the total mass (100% by mass) of the active ingredient in the composition that is a forming material for the resin film-forming film".

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 contained in the composition.

[0043]

The polymer component (A) preferably contains an acrylic polymer (A1), but may contain a non-acrylic polymer (A2) except an acrylic polymer (A1), such as polyester, phenoxy resin, polycarbonate, polyether, polyurethane, polysiloxane,

rubber-type polymer, etc.

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

[0044]

The content of the acrylic polymer (A1) relative to the total mass (100% by mass) of the polymer component (A) contained in the resin film-forming film for use in 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.

[0045]

(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 film, 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.

[0046]

The glass transition temperature (Tg) of the acrylic polymer (A1) is, from the viewpoint of controlling the release force (α 1), (β 1) and (β 2) to fall each within the above-mentioned range, preferably -40°C or higher, more preferably -20 to 50°C, even more preferably -10 to 30°C, still more preferably 0 to 20°C.

[0047]

In this description, the value of the glass transition temperature (Tg) of the acrylic polymer or the like is a value as determined by converting the glass transition temperature (Tg_K) 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 W₁, W₂, W₃, W₄ ... each indicate the mass fraction (% by mass) of each monomer component constituting the resin component, and Tg₁, Tg₂, Tg₃, Tg₄ ... each indicate the glass transition temperature (unit: K) of the homopolymer of each monomer component constituting the resin component.

[0048]

The acrylic polymer (A1) includes a polymer containing an alkyl (meth)acrylate as the main component, and specifically, an acrylic polymer having a structural unit (a1) derived from an alkyl (meth)acrylate with an alkyl group having 1 to 18 carbon atoms is preferred. From the viewpoint of controlling the release force ($\alpha 1$), ($\beta 1$) and ($\beta 2$) to fall each within the above-mentioned range, an acrylic copolymer having the structural unit (a1) and any other structural unit (a2) than the structural unit (a1) is more preferred.

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.

[0049]

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 film, preferably 1 to 18, more preferably 1 to 12, even more preferably 1 to 8.

[0050]

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.

[0051]

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 a structural unit (a1-1) 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 98% by mass relative to the total structural units (100% by mass) of the acrylic polymer (A1), more preferably 10 to 95% by mass, even more preferably 20 to 90% by mass.

[0052]

From the viewpoint of controlling the release force ($\alpha 1$), ($\beta 1$) and ($\beta 2$) to

fall each within the above-mentioned range, the acrylic polymer (A1) for use in one aspect of the present invention is preferably a copolymer having both the structural unit (a1-1) derived from an alkyl (meth)acrylate with an alkyl group having 1 to 3 carbon atoms and a structural unit (a1-2) derived from an alkyl (meth)acrylate with an alkyl group having 4 to 18 (preferably 4 to 12, more preferably 4 to 8) carbon atoms.

The content ratio of the structural unit (a1-1) to the structural unit (a1-2) [(a1-1)/(a1-2)] is preferably 1/99 to 99/1, more preferably 10/90 to 90/10, even more preferably 15/85 to 85/15.

[0053]

The content of the structural unit (a1) in the acrylic polymer (A1) is preferably 50 to 100% by mass relative to the total structural units (100% by mass) of the acrylic polymer (A1), more preferably 60 to 99% by mass, even more preferably 70 to 95% by mass.

[0054]

The acrylic polymer (A1) may contain a structural unit (a2) derived from any other monomer than the above-mentioned structural unit (a1) within a range not detracting from the advantageous effects of the present invention.

Examples of the monomer that constitutes 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.

[0055]

Examples of the hydroxy-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.

[0056]

The carboxy group-containing monomer includes (meth)acrylic acid,

maleic acid, fumaric acid, itaconic acid, etc.

[0057]

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 has a heat-curable property but is not a curable component (B), that is, the polymer is included in the concept of the polymer component (A).

[0058]

From the viewpoint of controlling the release force ($\alpha 1$), ($\beta 1$) and ($\beta 2$) to fall each within the above-mentioned range, the acrylic polymer (A1) that is used in one aspect of the present invention is preferably a copolymer having a structural unit (a2-1) derived from a hydroxy group-containing monomer, along with the structural unit (a1).

The content of the structural unit (a2-1) derived from the 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 2 to 30% by mass, even more preferably 5 to 25% by mass.

[0059]

Also, especially from the viewpoint of controlling the release force ($\alpha 1$) to fall within the above-mentioned range, the acrylic polymer (A1) that is used in one aspect of the present invention is preferably a copolymer having a structural unit (a2-2) derived from a nitrile monomer, along with the structural unit (a1).

The content of the structural unit (a2-2) derived from the nitrile 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 2 to 35% by mass, even more preferably 5 to 30% by mass.

[0060]

When the content of the structural unit derived from an epoxy group-containing monomer in the acrylic polymer (A1) increases, the adhesiveness between the resultant resin film-forming film and a silicon wafer may increase and the value of the release force ($\alpha 1$) may tend to increase.

Consequently, in one aspect of the present invention, the content of the structural unit derived from an epoxy group-containing monomer in the acrylic polymer (A1) is preferably smaller.

The content of the structural unit derived from an epoxy group-containing monomer in the acrylic polymer (A1) is preferably 0 to 4% by mass relative to the total structural units (100% by mass) of the acrylic polymer (A1), more preferably 0 to 3% by mass, even more preferably 0 to 2% by mass, still more preferably 0% by mass.

[0061]

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 constituent 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.

[0062]

The content of the structural unit (a2) 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 2 to 35% by mass, even more preferably 5 to 30% by mass.

[0063]

(Non-acrylic Polymer (A2))

As needed, the resin film-forming film for use in the present invention may contain a non-acrylic polymer (A2) as the other polymer component having Mw of 20,000 or more 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.

A phenoxy resin having an epoxy group and having Mw of 20,000 or more

has a heat-curable property, but this is not the curable component (B) and is included in the non-acrylic polymer (A2).

[0064]

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.

[0065]

[Curable Component (B)]

The curable component (B) plays a role of curing the resin film-forming film to form a hard resin film.

The resin film-forming film 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 preventing the resin film to be formed of the resin film-forming film from being colored, 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, more preferably contains an epoxy group-having compound (B11).

The energy ray-curable component (B2) preferably contains a compound (B21) having a polymerizable functional group that reacts 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.

[0066]

(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-having component (B11) and a heat-curing agent (B12).

The epoxy group-having component (B11) and the heat-curing agent (B12) are compounds having a mass-average molecular weight (Mw) of less than 20,000, and are differentiated from the above-mentioned polymer component (A).

An epoxy group-having compound and a hardener having a mass-average

molecular weight (Mw) of 20,000 or more are included in the polymer component (A).

[0067]

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 an ortho-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.

The mass-average molecular weight (Mw) of the epoxy compound (B11) is less than 20,000, but from the viewpoint of preventing the viscosity of the composition to form the resin film-forming film from increasing to thereby improve the handleability of the composition by using in combination with the component (A), it is preferably 10,000 or less, more preferably 100 to 10,000.

[0068]

Especially from the viewpoint of controlling the release force ($\alpha 1$) to fall within the above-mentioned range, the composition that is a forming material for the resin film-forming film preferably contains, as the epoxy compound (B11), both an epoxy compound liquid at 25°C and an epoxy compound solid at 25°C.

The content ratio of the liquid epoxy compound to the solid epoxy compound contained in the composition [liquid epoxy compound/solid epoxy compound] is, from the viewpoint of controlling the release force ($\alpha 1$) to fall within the above-mentioned range, preferably 5/95 to 95/5, more preferably 10/90 to 90/10, even more preferably 20/80 to 80/20, further more preferably 30/70 to 70/30.

When the proportion of the liquid epoxy compound increases more, the value of the release force ($\alpha 1$) becomes larger, but when the proportion of the solid epoxy compound increases more, the value of the release force ($\alpha 1$) tends to be smaller.

[0069]

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 10 to 150 parts by mass, still more preferably

20 to 120 parts by mass.

[0070]

(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.

[0071]

Examples of the phenolic heat-curing agent having a phenol group include a polyfunctional phenol resin, a biphenol resin, 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 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.

[0072]

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 1 to 200 parts by mass.

[0073]

(Curing Accelerator (B13))

For controlling the heat-curing rate of the resin film-forming film, a curing accelerator (B13) may be used. Preferably, the curing accelerator (B13) is used along with an epoxy compound (B11) as the heat-curable component (B1).

[0074]

Examples of the curing accelerator (B13) include tertiary amines such as triethylenediamine, benzyl dimethylamine, 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.

[0075]

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 film, and for improving the reliability of the resin film-having chip to be produced using the composite 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.

[0076]

(Energy Ray-Curable Component (B2))

As the energy ray-curable component (B2), a compound (B21) having a polymerizing 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).

[0077]

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

The compound (B21) having a polymerizing functional group that reacts through irradiation with energy rays (hereinafter also referred to as "energy ray-reactive compound (B21)") may be any compound having a polymerizing functional group such as a (meth)acryloyl group, a vinyl group or the like, and examples thereof 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 energy ray-reactive compound (B21) is a compound having a mass-average molecular weight (Mw) of less than 20,000, and is differentiated from the above-mentioned polymer component (A).

An energy ray-reactive compound having a mass-average molecular weight (Mw) of 20,000 or more is contained in the polymer component (A).

The mass-average molecular weight (Mw) of the energy ray-reactive compound (B21) is less than 20,000, and is preferably 100 to 15,000, more preferably 300 to 10,000.

[0078]

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.

[0079]

(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 film even though the photoirradiation dose is small.

[0080]

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.

[0081]

The content of the photopolymerization initiator (B22) is, from the viewpoint of sufficiently prosecuting the curing reaction of the resin film-forming film 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 1 to 5 parts by mass.

[0082]

The content of the curable component (B) is preferably 5 to 50% by mass relative to the total mass (100% by mass) of the resin film-forming film, 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) is a total content of the heat-curable component (B1) including the above-mentioned epoxy compound (B11), the heat-curing agent (B12), 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).

[0083]

[Inorganic Filler (C)]

Preferably, the resin film-forming film for use in one aspect of the present invention further contains an inorganic filler (C).

Containing an inorganic filler (C), the thermal expansion coefficient of the resin film to be formed of the resin film-forming film can be controlled 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 film can be reduced.

[0084]

Examples of the inorganic filler (C) include powders of silica, alumina, talc, calcium carbonate, titanium oxide, iron oxide, silicon carbide, boron nitride, etc., as well as beads produced by shaping them into spherical forms, and single crystal fibers, glass fibers, etc.

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

Among these, silica and alumina are preferred.

[0085]

The mean particle size of the inorganic filler (C) is preferably 0.01 to 50 μm , more preferably 0.05 to 30 μm , even more preferably 0.1 to 10 μm .

In the present invention, the mean particle size of the inorganic filler (C) is a value measured using a laser diffraction scattering particle sizer, and means a

volume medium particle diameter (D_{50}).

[0086]

The content of the inorganic filler (C) is preferably 15 to 80% by mass relative to the total mass (100% by mass) of the resin film-forming film, more preferably 20 to 75% by mass, even more preferably 30 to 70% by mass, still more preferably 40 to 65% by mass, especially more preferably 45 to 60% by mass.

When the content of the inorganic filler in the resin film-forming film increases more, the values of the release force ($\alpha 1$) and ($\beta 1$) (especially the value of the release force ($\beta 1$)) tend to be smaller.

[0087]

[Colorant (D)]

Preferably, the resin film-forming film for use in one aspect of the present invention further contains a colorant (D).

When the resin film-forming film contains a colorant (D) and when a semiconductor chip having a resin film formed of the resin film-forming film of the type is incorporated in a device, the device can be shielded from IR rays and others to be generated by other surrounding devices and can be thereby protected from malfunction of the semiconductor chip.

[0088]

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.

Among these, black pigment is preferred as exhibiting good shielding performance from electromagnetic waves and IR rays and from the viewpoint of more improving the distinguishability according to a laser marking method.

Examples of the black pigment include carbon black, iron oxide, manganese dioxide, aniline black, activated carbon, etc. From the viewpoint of increasing the reliability of semiconductor chips, carbon black is preferred.

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

[0089]

The content of the colorant (D) is preferably 0.01 to 30% by mass relative to the total mass (100% by mass) of the resin film-forming film, more preferably

0.05 to 25% by mass, even more preferably 0.1 to 15% by mass, still more preferably 0.15 to 5% by mass.

[0090]

[Coupling Agent (E)]

Preferably, the resin film-forming film for use in one aspect of the present invention further contains a coupling agent (E).

Containing a coupling agent (E), the resin film formed of the resultant resin film-forming film can have improved waterproofness without interfering with heat resistance.

[0091]

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 -glycidoxypropyltrimethoxysilane, γ -glycidoxypropylmethyldiethoxysilane, β -(3,4-epoxycyclohexyl)ethyltrimethoxysilane, γ -(methacryloxypropyl)trimethoxysilane, γ -aminopropyltrimethoxysilane, N-6-(aminoethyl)- γ -aminopropyltrimethoxysilane, N-6-(aminoethyl)- γ -aminopropylmethyldiethoxysilane, N-phenyl- γ -aminopropyltrimethoxysilane, γ -ureidopropyltriethoxysilane, γ -mercaptopropyltrimethoxysilane, γ -mercaptopropylmethyldimethoxysilane, 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.

[0092]

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 15,000, more preferably 150 to 10,000, even more preferably 200 to 5,000, still more preferably 250 to 3,000, further more preferably 350 to 2,000.

[0093]

Containing a coupling agent (E), it is considered that the polymer component (A) in the resin film-forming film may be bonded to the surface of an

adherend, silicon wafer or to the surface of the inorganic filler (C) that is optionally contained in the resin film-forming sheet, thereby improving the adhesiveness and the aggregability to increase the value of the release force ($\alpha 1$).

Consequently, the content of the coupling agent (E) is preferably smaller, from the viewpoint of controlling the release force ($\alpha 1$), ($\beta 1$) and ($\beta 2$) to fall each within the above-mentioned range and especially from the viewpoint of controlling the release force ($\alpha 1$).

From the above-mentioned viewpoint, the content of the coupling agent (E) is preferably 0.01 to 4% by mass relative to the total mass (100% by mass) of the resin film-forming film, more preferably 0.05 to 2% by mass, even more preferably 0.10 to 1.5% by mass, still more preferably 0.15 to 1% by mass.

[0094]

[Wide-Use Additive (F)]

Within a range not detracting from the advantageous effects of the present invention, the resin film-forming film 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 leveling agent, a plasticizer, an antistatic agent, an antioxidant, an ion scavenger, a gettering agent, a chain transfer agent, etc.

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

[0095]

<Method for Producing Resin Film-Forming Film>

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

For example, a resin film-forming composition containing the above-mentioned components 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 a resin film-forming composition is applied onto a supporting sheet 10 as in Fig. 1, according to a known coating method to form a coating film, and the coating film is dried to form a resin film-forming film.

[0096]

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.

[0097]

The resin film-forming film may be a single layer or may have a multilayer structure of two or more layers.

For producing the resin film-forming film having a two or more multilayer structure, for example, solutions of individual resin film-forming compositions are separately applied onto two or more supporting sheets to form a coating film thereon, and the formed coating films are layered to give a layered coating film and dried to produce the intended resin film-forming film having a multilayer structure.

[0098]

The thickness of the resin film-forming film that the composite sheet of one aspect of the present invention has may be suitably defined depending on the use thereof, but is preferably 3 to 300 μm , more preferably 5 to 250 μm , even more preferably 7 to 200 μm . Also in the case where the resin film-forming film has a multilayer structure, the total thickness of the film is preferably within the above-mentioned range.

[0099]

<Supporting Sheet>

The supporting sheet for use in one aspect of the present invention includes a sheet formed of a substrate alone, or a pressure sensitive adhesive sheet having a pressure sensitive adhesive layer on a substrate.

The supporting sheet 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 dicing sheet or the like for protecting the surface of the resin film-forming sheet in the

dicing step or the like.

[0100]

The thickness of the supporting sheet is suitably selected depending on the use thereof, but is, from the viewpoint of imparting sufficient flexibility to the composite sheet and bettering the sticking performance to silicon wafers, preferably 10 to 500 μm , more preferably 20 to 350 μm , even more preferably 30 to 200 μm .

The thickness of the supporting sheet includes not only the thickness of the substrate to constitute the supporting sheet but also, in the case of having a pressure sensitive adhesive layer, the thickness of the layer and the film thereof.

[0101]

(Substrate)

As the substrate to constitute the supporting sheet, a resin film is preferred.

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.

Also in one aspect of the present invention, a sheet produced by surface-treating the surface of the substrate of the above-mentioned resin film or the like may be used as the supporting sheet.

[0102]

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 by predetermined means, and the sheet may be used.

[0103]

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 containing a polypropylene film, it may have a single-layer structure of a polypropylene film alone, or a multilayer structure formed of a polypropylene film and any other resin film.

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

[0104]

In the case where a sheet formed of a substrate alone is used as the supporting sheet, the surface tension of the surface of the substrate that is to be in contact with the surface (β) of the resin film-forming film is, from the viewpoint of controlling the release force (β_1) to fall within the above-mentioned range, preferably 20 to 50 mN/m, more preferably 23 to 45 mN/m, even more preferably 25 to 40 mN/m.

[0105]

The thickness of the substrate to constitute the supporting sheet is preferably 10 to 500 μm , more preferably 15 to 300 μm , even more preferably 20 to 200 μm .

[0106]

(Pressure Sensitive Adhesive Sheet)

The pressure sensitive adhesive sheet that may be used as the supporting sheet in one aspect of the present invention includes a sheet having a pressure sensitive adhesive layer formed of a pressure sensitive adhesive, on a substrate such as the above-mentioned resin film or the like.

The pressure sensitive adhesive that is a forming material for the pressure sensitive adhesive layer includes a pressure sensitive adhesive composition containing a pressure sensitive adhesive resin, and the pressure

sensitive adhesive composition may contain wide-use additives such as the above-mentioned crosslinking agent, a tackifier, etc.

Examples of the pressure sensitive adhesive resin include, when the structure of the resin is specifically noted, acrylic resin, urethane resin, rubber resin, silicone resin, vinyl ether resin, etc., but include, when the function of the resin is specifically noted, energy ray-curable pressure sensitive adhesive, etc.

In one aspect of the present invention, from the viewpoint of controlling the release force ($\beta 2$) to fall within the above-mentioned range, and from the viewpoint of bettering the pickup aptitude, a pressure sensitive adhesive sheet having a pressure sensitive adhesive layer formed of a pressure sensitive adhesive composition containing an energy ray-curable resin is preferred.

The energy ray-curable resin may be any resin having a polymerizable group such as a (meth)acryloyl group, a vinyl group or the like, but is preferably a pressure sensitive adhesive resin having a polymerizable group.

[0107]

From the viewpoint of controlling the release force ($\beta 1$) and ($\beta 2$) to fall each within the above-mentioned range, a pressure sensitive adhesive containing an acrylic resin is preferred.

As the acrylic resin, an acrylic polymer having a structural unit (x1) derived from an alkyl (meth)acrylate is preferred, and an acrylic copolymer having the structural unit (x1) and a structural unit (x2) derived from a functional group-containing monomer is more preferred.

[0108]

The carbon number of the alkyl group that the alkyl (meth)acrylate has is preferably 1 to 18, more preferably 1 to 12, even more preferably 1 to 8.

The alkyl (meth)acrylate includes the same ones as those of the above-mentioned alkyl (meth)acrylate constituting the structural unit (a1).

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

The content of the structural unit (x1) is generally 50 to 100% by mass relative to the total structural units (100% by mass) of the acrylic polymer, preferably 50 to 99.9% by mass, more preferably 60 to 99% by mass, even more preferably 70 to 95% by mass.

[0109]

Examples of the functional group-containing monomer include a hydroxy

group-containing monomer, a carboxy group-containing monomer, an epoxy group-containing monomer, etc. Specific examples of those monomers are the same as those exemplified hereinabove for the monomer to constitute the structural unit (a2).

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

The content of the structural unit (x2) is generally 0 to 40% by mass relative to the total structural units (100% by mass) of the acrylic polymer, preferably 0.1 to 40% by mass, more preferably 1 to 30% by mass, even more preferably 5 to 20% by mass.

[0110]

The acrylic resin for use in one aspect of the present invention may be an energy ray-curable acrylic resin that is obtained by further reacting the acrylic copolymer having the structural units (x1) and (x2) with a compound having an energy ray-polymerizable group.

The compound having an energy ray-polymerizable group may be a compound having a polymerizable group such as a (meth)acryloyl group, a vinyl group, etc.

[0111]

In the case where a pressure sensitive adhesive containing an acrylic resin is used, a crosslinking agent is preferably contained along with the acrylic resin, from the viewpoint of controlling the release force ($\beta 1$) and ($\beta 2$) to fall each within the above-mentioned range.

Examples of the crosslinking agent include an isocyanate-type crosslinking agent, an imine-type crosslinking agent, an epoxy-type crosslinking agent, an oxazoline-type crosslinking agent, a carbodiimide-type crosslinking agent, etc. From the viewpoint of controlling the release force ($\beta 1$) and ($\beta 2$) to fall each within the above-mentioned range, an isocyanate-type crosslinking agent is preferred.

The content of the crosslinking agent is preferably 0.01 to 20 parts by mass relative to the total mass (100 parts by mass) of the acrylic resin contained in the pressure sensitive adhesive, more preferably 0.1 to 15 parts by mass, even more preferably 0.5 to 10 parts by mass, still more preferably 1 to 8 parts by mass.

[0112]

A supporting sheet formed of a substrate that has been treated for

releasing can be obtained by applying a pressure sensitive adhesive onto the above-mentioned resin film serving as a substrate, according to a known coating method, and drying the formed coating film to form a release film.

A diluting solvent may be added to the pressure sensitive adhesive to give a solution or an emulsion of the pressure sensitive adhesive.

[0113]

For enhancing the adhesion between the resin film serving as a substrate and the pressure sensitive adhesive layer, if desired, the surface of the resin film on which the pressure sensitive adhesive layer is to be formed may be processed for surface roughening by sand blasting, solvent treatment or the like, or may be processed for oxidation by corona discharge treatment, electron ray irradiation, plasma treatment, ozone treatment, UV irradiation treatment, flame treatment, chromate treatment, hot air treatment or the like, or may be processed for primer treatment, etc.

[0114]

The surface tension of the pressure sensitive adhesive layer of the pressure sensitive adhesive sheet is, from the viewpoint of controlling the release force ($\beta 1$) to fall within the above-mentioned range, preferably 20 to 50 mN/m, more preferably 23 to 45 mN/m, even more preferably 25 to 40 mN/m.

[0115]

The thickness of the pressure sensitive adhesive layer is preferably 1 to 100 μm , more preferably 2 to 80 μm , even more preferably 3 to 50 μm .

[0116]

<Jig-Adhering Layer>

The jig-adhering layer may be formed of a pressure sensitive adhesive double coated sheet having a substrate (core material) or of 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 or a polyvinyl chloride film.

The pressure sensitive adhesive includes the same ones as those of the forming material for the pressure sensitive adhesive layer of the above-mentioned pressure sensitive adhesive sheet.

The thickness of the jig-adhering layer is preferably 1 to 200 μm , more preferably 5 to 100 μm , even more preferably 10 to 70 μm .

[0117]

<Carrier Sheet>

The carrier sheet is not specifically limited so far as it is releasable in use, and includes a resin film that is usable as the above-mentioned substrate, a sheet produced by release-treating the surface of the resin film, etc.

The thickness of the carrier sheet is not specifically limited, and is preferably 1 to 200 μm , more preferably 5 to 150 μm , even more preferably 10 to 100 μm .

[0118]

[Use of Resin Film-Forming Composite Sheet]

The composite sheet of one aspect of the present invention may be stuck to the back surface of a workpiece such as a semiconductor wafer for chips or a semiconductor chip or the like of a face-down method 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.

[0119]

The resin film formed of the resin film-forming film of the composite sheet of one aspect of the present invention can be given a function as a pressure sensitive adhesive film. Regarding the use thereof, the pressure sensitive adhesive film is generally stuck to the back surface of a semiconductor wafer or the like, and after cut into individual chips in a dicing step, the chips are mounted (die-bonded) in a predetermined adhering site in a substrate or the like, and then the semiconductor chips are adhered and fixed in a heat-curing step.

[0120]

The composite sheet of one aspect of the present invention may also be used as a sheet for fixing workpieces such as semiconductor wafers or the like in blade dicing or laser dicing, and in dicing, it is unnecessary to stick any additional dicing sheet, and the semiconductor device production process can be thereby simplified.

In addition, the composite sheet of the present invention is also usable in a pre-dicing process (where a groove deeper than the thickness of the chip to be obtained is formed on the circuit surface side of a semiconductor wafer, and the

semiconductor wafer is thinned from the back surface side to reach at least the depth of the groove thereby providing a group of chips), and the sheet may be stuck to the group of diced chips.

[0121]

[Method for Producing Resin Film-Having Chip]

An example of a method for producing a resin film-having chip using the composite sheet of one aspect of the present invention is described below.

For example, as a production method for a resin film-having chip of one aspect of the present invention, there is mentioned a blade dicing method having the following steps (1) to (4).

step (1): a step of sticking a resin film-forming composite sheet of one aspect of the present invention to the back surface of a workpiece.

step (2): a step of dicing the workpiece.

step (3): a step of forming a resin film of the resin film-forming film.

step (4): a step of picking up the diced workpieces obtained via the step (2) to give chips.

In the production method for a resin film-having chip of one aspect of the present invention, the order of the steps (2) to (4) after the step (1) is not defined. For example, it may be an order of "steps (1), (2), (3), (4)", or an order of "steps (1), (3), (2), (4)", or an order of "steps (1), (2), (4), (3)".

[0122]

<Step (1)>

The step (1) is a step of sticking the resin film-forming film of a composite sheet of one aspect of the present invention to the back surface of a workpiece such as a silicon wafer or the like.

The workpiece to be used in this step may be a silicon wafer or may also be a compound semiconductor wafer of gallium, arsenic or the like. The semiconductor wafer may have a circuit formed on the surface thereof, or may be optionally cut on the back surface thereof to have a thickness of 50 to 500 μm or so.

[0123]

Here, the composite sheet of the present invention is excellent in reworkability, and therefore in this step, when the sticking of a workpiece to the composite sheet is not good, the two may be reworked for resticking. In other words, even when the resin film-forming film of the composite sheet has been once

stuck to the back surface of a workpiece, the composite sheet can be cleanly released off from the workpiece. A residue of the resin film-forming film could hardly remain on the surface of the workpiece from which the composite sheet has been released away, and therefore the workpiece can be reused.

[0124]

<Step (2)>

The step (2) is a step of dicing the workpiece for every circuit formed on the surface thereof, thereby working it into chips.

The workpiece that is an object to be diced in this step may be a resin film-forming film-attached workpiece obtained via the step (1), or may also be a resin film-attached workpiece obtained via the step (3) in first.

The workpiece dicing may be carried out according to a known method.

[0125]

Here, in the case where this step is carried out after the step (1), diced resin film-forming film-having workpieces can be obtained, and when a resin film is formed from the resin film-forming film in the next step (3), diced resin film-having workpieces can be obtained.

On the other hand, in the case where the step (3) is carried out after the step (1), a resin film-having workpieces is diced in this step to give diced resin film-having workpieces.

[0126]

<Step (3)>

The step (3) is a step of forming a resin film from the resin film-forming film of the composite sheet stuck to a workpiece.

In general, a resin film is formed by curing a resin film-forming film, but when a resin film-forming film itself has a function of a protective film or an adhesive film, an uncured resin film-forming film may be used as a resin film directly as it is.

The resin film to be formed may be a completely cured one, or may be a partially cured one, but is preferably a completely cured one.

[0127]

Curing the resin film-forming film may be carried out by any of heat-curing or curing through irradiation with energy rays, depending on the kind of the curing component contained in the resin film-forming film.

Regarding the condition for heat-curing, the curing temperature is

preferably 100 to 150°C, and the curing time is preferably 1 to 3 hours.

The condition for curing through irradiation with energy rays may be suitably set depending on the kind of the energy rays to be used. For example, when UV rays are used, the lighting intensity is preferably 170 to 250 mW/cm², and the light quantity is 600 to 1,000 mJ/cm².

[0128]

<Step (4)>

The step (4) is a step of picking up the diced workpieces obtained via the step (2) by a wide-use means such as a collet or the like to give chips. Via this step, diced chips can be obtained.

In the case where a resin film is formed by curing the resin film-forming film in the step (3) and when the value of the release force (β 2) necessary for releasing the supporting sheet from the surface (β ') of the resin film falls within the above-mentioned range, the pickup aptitude is good and the productivity of resin film-having chips can be improved.

[0129]

Preferably, the value of the release force necessary for releasing the supporting sheet from the surface of an uncured resin film-forming film is also within the same range as that of the above-mentioned release force (β 2).

In the case where a composite sheet having an uncured resin film-forming film laminated on a pressure sensitive adhesive sheet serving as a supporting sheet is used, the pressure sensitive adhesive sheet preferably has a pressure sensitive adhesive layer formed of a pressure sensitive adhesive composition containing an energy ray-curable resin.

Regarding the pressure sensitive adhesive sheet having such a pressure sensitive adhesive layer, the adhesion of the pressure sensitive adhesive layer can be lowered by irradiation with energy rays before the picking up operation in this step, and therefore the pickup aptitude can be thereby bettered. It is considered that, through such energy ray irradiation, the value of the release force necessary for releasing the pressure sensitive adhesive sheet from the surface of the uncured resin film-forming film can be readily controlled to fall within the same range as that of the above-mentioned release force (β 2).

[0130]

The resin film-having chips thus obtained through the above-mentioned steps can be mounted on a substrate or the like in a face-down method to produce

a semiconductor device. Alternatively, the resin film having chips in which the resin film has a function as an adhesive film can be stuck onto other members such as die pad parts or other semiconductor chips or the like (onto chip-mounted parts) to produce a semiconductor device.

Examples

[0131]

In the following description, the mass-average molecular weight (Mw) and the glass transition temperature (Tg) of each component are values measured or calculated according to the methods mentioned below.

[0132]

<Mass-Average Molecular Weight (Mw)>

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 was used.

(Measurement Condition)

Column: "TSK Guard Column HXL-H", "TSK Gel GMHXL ($\times 2$)", "TSK Gel G2000HXL" (all manufactured by Tosoh Corporation).

Column temperature: 40°C

Developing solvent: tetrahydrofuran

Flow rate: 1.0 mL/min

[0133]

<Glass Transition Temperature (Tg)>

A value calculated according to the above-mentioned formula (1) was used.

[0134]

Examples 1 to 9, Comparative Example 1

The components of the kind and the blending amount (active ingredient ratio) shown in Table 1 were blended, and diluted with methyl ethyl ketone to prepare a solution of a resin film-forming composition for a resin film-forming film having a solid concentration of 61% by mass.

With that, on a release-treated surface of a carrier sheet formed of a resin film having the release-treated surface (trade name "SP-PET3811" manufactured by Lintec Corporation, thickness: 38 μm), the solution of a resin film-forming composition was applied, and dried at 120°C for 2 minutes. Thus, a resin

film-forming film having a thickness of 25 μm was formed on the carrier sheet to produce a laminate (1) formed of the carrier sheet and the resin film-forming film.

On the resin film-forming film of the laminate (1), any of supporting sheets (I) to (VII) having a kind shown in Table 1 was stuck, thereby producing a laminate (2) with the supporting sheet, the resin film-forming film and the carrier sheet laminated in that order.

In the case where the supporting sheets (I), (II) and (IV) to (VII) were used, the resin film-forming film was stuck to the supporting sheet in such a manner that the pressure sensitive adhesive layer of the supporting sheet could be directly laminated on the film, thereby producing the laminate (2).

[0135]

The details of the components described in Table 1, used in preparing the resin film-forming compositions of Examples and Comparative Example, are as follows.

<Polymer Component>

(A-1): Acrylic copolymer of ethyl acrylate (EA), n-butyl acrylate (BA) and acrylonitrile (AN) ($M_w = 850,000$, $T_g = 12^\circ\text{C}$).

(A-2): Acrylic copolymer of methyl acrylate (MA) and 2-hydroxyethyl acrylate (HEA) (MA/HEA = 85/15 (% by mass), $M_w = 370,000$, $T_g = 6^\circ\text{C}$).

(A-3): Acrylic copolymer of methyl acrylate (MA), n-butyl acrylate (BA), 2-hydroxyethyl acrylate (HEA) and glycidyl methacrylate (GMA) (MA/BA/HEA/GMA = 70/10/15/5 (% by mass), $M_w = 800,000$, $T_g = -1^\circ\text{C}$).

<Curable Component>

(B-1): Bisphenol A-type epoxy resin (trade name "jER828" manufactured by Mitsubishi Chemical Corporation, liquid at 25°C , compound corresponding to the epoxy compound (B1)).

(B-2): Bisphenol A-type epoxy resin (trade name "jER1055" manufactured by Mitsubishi Chemical Corporation, solid at 25°C , compound corresponding to the epoxy compound (B1)).

(B-3): Dicyclopentadiene-type epoxy resin (trade name "Epiclon HP-7200HH" manufactured by DIC Corporation, solid at 25°C , compound corresponding to the epoxy compound (B1)).

(B-4): Amine-type curing agent (trade name "Adeka Hardener 3636AS" manufactured by ADEKA Corporation, compound corresponding to the heat-curing agent (B12)).

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

<Inorganic Filler>

(C-1): Silica filler (trade name "SC2050MA" manufactured by Admatechs Company Limited).

<Colorant>

(D-1): Carbon black (trade name "#MA650" manufactured by Mitsubishi Chemical Corporation).

<Silane Coupling Agent>

(E-1): Silane coupling agent (trade name "A-1110" manufactured by Nippon Unicar Co.,Ltd).

[0136]

The details of the supporting sheet described in Table 1, used in Examples and Comparative Example, are as follows.

[0137]

Supporting Sheet (I):

A pressure sensitive adhesive sheet having, on one surface of a polypropylene film (manufactured by Mitsubishi Plastics, Inc.) having a thickness of 80 μm , a pressure sensitive adhesive layer having a thickness of 90 μm formed of a pressure sensitive adhesive (i) (surface tension of the surface of the pressure sensitive adhesive layer = 30 mN/m).

The pressure sensitive adhesive (i) contains 100 parts by mass (solid content) of an acrylic resin of 2-ethylhexyl acrylate (2EHA), methyl methacrylate (MMA) and 2-hydroxyethyl acrylate (HEA) (2EHA/MMA/HEA = 60/30/10 (% by mass), Mw = 500,000) and 10 parts by mass (solid content) of a trifunctional xylylene diisocyanate-type crosslinking agent (trade name "Takenate D110N" manufactured by Mitsui Takeda Chemicals, Inc.).

[0138]

Supporting Sheet (II):

A pressure sensitive adhesive sheet having, on one surface of a polypropylene film (manufactured by Mitsubishi Plastics, Inc.) having a thickness of 80 μm , a pressure sensitive adhesive layer having a thickness of 90 μm formed of a pressure sensitive adhesive (ii) (surface tension of the surface of the pressure sensitive adhesive layer = 33 mN/m).

The pressure sensitive adhesive (ii) contains 100 parts by mass (solid content) of an acrylic resin of 2-ethylhexyl acrylate (2EHA), methyl methacrylate (MMA) and 2-hydroxyethyl acrylate (HEA) (2EHA/MMA/HEA = 60/30/10 (% by mass), Mw = 500,000) and 5 parts by mass (solid content ratio) of a trifunctional xylylene diisocyanate-type crosslinking agent (trade name "Takenate D110N" manufactured by Mitsui Takeda Chemicals, Inc.).

[0139]

Supporting Sheet (III):

A supporting sheet formed of only a polypropylene film (manufactured by Mitsubishi Plastics, Inc., surface tension: 35 mN/m) having a thickness of 80 μm .

[0140]

Supporting Sheet (IV):

A pressure sensitive adhesive sheet having, on one surface of a polypropylene film (manufactured by Mitsubishi Plastics, Inc.) having a thickness of 80 μm , a pressure sensitive adhesive layer having a thickness of 90 μm formed of an energy ray-curable pressure sensitive adhesive (iii).

The energy ray-curable pressure sensitive adhesive (iii) contains 100 parts by mass (solid content) of an energy ray-curable acrylic copolymer (mass-average molecular weight: 600,000), which had been obtained by further reacting a pre-copolymer formed through copolymerization of 40 parts by mass of 2-ethylhexyl acrylate (2EHA), 40 parts by mass of vinyl acetate (VAc) and 20 parts by mass of 2-hydroxyethyl acrylate (HEA) (2EHA/VAc/HEA = 40/40/20 (% by mass)) with 21.4 parts by mass of 2-isocyanatoethyl methacrylate (in such an amount that the isocyanato group of 2-isocyanatoethyl methacrylate could be 80 mol% relative to 100 mol% of the hydroxyl group of HEA), and 5 parts by mass (solid content) of a trifunctional xylylene diisocyanate-type crosslinking agent (trade name "Takenate D110N" manufactured by Mitsui Takeda Chemicals, Inc.).

[0141]

Supporting Sheet (V):

A pressure sensitive adhesive sheet having, on one surface of a polypropylene film (manufactured by Mitsubishi Plastics, Inc.) having a thickness of 80 μm , a pressure sensitive adhesive layer having a thickness of 10 μm formed of a pressure sensitive adhesive (iv) (surface tension of the surface of the pressure sensitive adhesive layer = 33 mN/m).

The pressure sensitive adhesive (iv) contains 100 parts by mass (solid

content) of an acrylic resin of butyl acrylate (BA), methyl acrylate (MA) and 2-hydroxyethyl acrylate (HEA) (BA/MA/HEA = 60/30/10 (% by mass), Mw = 800,000), and 1 part by mass (solid content) of a trifunctional xylylene diisocyanate-type crosslinking agent (trade name "Takenate D110N" manufactured by Mitsui Takeda Chemicals, Inc.).

[0142]

Supporting Sheet (VI):

A pressure sensitive adhesive sheet having, on one surface of a polypropylene film (manufactured by Mitsubishi Plastics, Inc.) having a thickness of 80 μm , a pressure sensitive adhesive layer having a thickness of 10 μm formed of a pressure sensitive adhesive (v) (surface tension of the surface of the pressure sensitive adhesive layer = 29 mN/m).

The pressure sensitive adhesive (v) contains 100 parts by mass (solid content) of an acrylic resin of 2-ethylhexyl acrylate (2EHA), methyl methacrylate (MMA) and 2-hydroxyethyl acrylate (HEA) (2EHA/MMA/HEA = 50/40/10 (% by mass), Mw = 800,000) and 10 parts by mass (solid content) of a trifunctional xylylene diisocyanate-type crosslinking agent (trade name "Takenate D110N" manufactured by Mitsui Takeda Chemicals, Inc.).

[0143]

Supporting Sheet (VII):

A pressure sensitive adhesive sheet having, on one surface of a polypropylene film (manufactured by Mitsubishi Plastics, Inc.) having a thickness of 80 μm , a pressure sensitive adhesive layer having a thickness of 10 μm formed of a pressure sensitive adhesive (vi) (surface tension of the surface of the pressure sensitive adhesive layer = 33 mN/m).

The pressure sensitive adhesive (vi) contains 100 parts by mass (solid content) of an acrylic resin of butyl acrylate (BA), methyl acrylate (MA) and 2-hydroxyethyl acrylate (HEA) (BA/MA/HEA = 60/30/10 (% by mass), Mw = 800,000) and 2 parts by mass (solid content) of a trifunctional xylylene diisocyanate-type crosslinking agent (trade name "Takenate D110N" manufactured by Mitsui Takeda Chemicals, Inc.).

[0144]

Using the laminates (1) and (2) produced in Examples and Comparative Example, the release force ($\alpha 1$), ($\beta 1$) and ($\beta 2$) was measured according to the method mentioned below. In addition, using the laminate (2), the reworkability

with a silicon wafer was evaluated according to the method mentioned below. The results are shown in Table 1.

[0145]

<Measurement of Release Force ($\alpha 1$)>

As a lining tape, a pressure sensitive adhesive tape (trade name "PET25PL Shin" manufactured by Lintec Corporation - a pressure sensitive adhesive sheet having a pressure sensitive adhesive layer having a thickness of 20 μm and containing an acrylic resin, on a PET film having a thickness of 25 μm) was stuck to the exposed surface of the resin film-forming film of the laminate (1), and cut into a size of 25 mm in width $\times$ 150 mm in length to prepare a test sample.

The carrier sheet was removed from the test sample, and the exposed surface of the resin film-forming film and a surface of a dry-polished silicon wafer (diameter: 6 inches, thickness: 500 μm) were stuck together using a laminator (trade name "LAMIPACKER LPD3214" manufactured by Fujipla Inc.) and left to stand as such for 30 minutes.

After left to stand, the sample was tested according to a tensile test using a precision universal tester (trade name "Autograph AG-IS" manufactured by Shimadzu Corporation), at a release angle of 180°, at a measurement temperature of 23°C and at a pulling rate of 300 mm/min, in which the lining tape and the test sample were released together from the silicon wafer to measure the releasing load.

The measurement length was 100 mm, and the first 10 mm and the last 10 mm in the measurement were removed from the effective value. The maximum value of the resultant measurement values was referred to as the release force ($\alpha 1$) and shown in Table 1.

[0146]

<Measurement of Release Force ($\beta 1$)>

The laminate (2) was cut into a size of 25 mm in width $\times$ 150 mm in length, and the carrier sheet was removed, and the resultant piece, in which the surface of the resin film-forming film was thus exposed out, was used as a test sample.

A supporting plate formed of a polymethyl methacrylate and the exposed surface of the resin film-forming film of the test sample were stuck together via a pressure sensitive adhesive double coated tape (the pressure sensitive adhesive double coated tape, on both surfaces of a substrate of polyethylene terephthalate having a thickness of 25 μm , a pressure sensitive adhesive layer of an acrylic

pressure sensitive adhesive having a thickness of 10 μm), and left to stand as such for 30 minutes.

The pressure sensitive adhesive double coated tape is one having an adhesion capable of fixing both the supporting plate and the resin film-forming film during a tensile test.

After left to stand, the sample was tested according to a tensile test using a precision universal tester (trade name "Autograph AG-IS" manufactured by Shimadzu Corporation), at a release angle of 180° , at a measurement temperature of 23°C and at a pulling rate of 300 mm/min, in which the load in releasing any of the supporting sheet (I) to (VII) from the surface (β) of the resin film-forming film was measured.

The measurement length was 100 mm, and the first 10 mm and the last 10 mm in the measurement were removed from the effective value. The minimum value of the resultant measurement values was referred to as the release force (β_1) and shown in Table 1.

[0147]

<Measurement of Release Force (β_2)>

The laminate (2) was cut into a size of 25 mm in width $\times$ 150 mm in length, and the carrier sheet was removed, and the resultant piece, in which the surface of the resin film-forming film was thus exposed out, was used as a test sample.

The exposed surface of the resin film-forming film and a surface of a dry-polished silicon wafer (diameter: 6 inches, thickness: 500 μm) were stuck together using a laminator (trade name "LAMIPACKER LPD3214" manufactured by Fujipla Inc.) and left to stand as such for 30 minutes.

After left to stand, this was heated at 130°C for 2 hours to cure the resin film-forming film to form a resin film, and in the same manner as that for the measurement of the release force (β_1), the load in releasing any of the supporting sheet (I) to (VII) from the surface (β') of the resin film was measured.

In Example 4, after the resin film was formed, this was irradiated with UV rays (lighting intensity: 220 mW/cm², quantity of light: 190 mJ/cm²) using a UV irradiation apparatus (trade name "PAD2000m/8" manufactured by Lintec Corporation), and then the above-mentioned measurement was carried out.

The measurement length was 100 mm, and the first 10 mm and the last 10 mm in the measurement were removed from the effective value. The minimum value of the resultant measurement values was referred to as the

release force (β_2) and shown in Table 1.

[0148]

<Evaluation of Reworkability with Silicon Wafer>

The laminate (2) was cut into a size of 25 mm in width $\times$ 150 mm in length, and the carrier sheet was removed, and the resultant piece, in which the surface (β) of the resin film-forming film was thus exposed out, was used as a test sample.

The exposed surface of the resin film-forming film and a surface of a dry-polished silicon wafer (diameter: 6 inches, thickness: 500 μ m) were stuck together using a laminator (trade name "LAMIPACKER LPD3214" manufactured by Fujipla Inc.) and left to stand as such for 30 minutes.

After left to stand, the test sample (the supporting sheet and the resin film-forming film) was released from the silicon wafer using a precision universal tester (trade name "Autograph AG-IS" manufactured by Shimadzu Corporation), at a release angle of 180°, at a measurement temperature of 23°C and at a pulling rate of 300 mm/min, in which the surface of the silicon wafer was visually checked as to whether or not a part of the resin film-forming film adhered to the surface of the silicon wafer. With that, the reworkability with silicon wafer was evaluated according to the following criteria.

"A+": No residue of the resin film-forming film remained on the surface of the silicon wafer.

"A": Any residue having a diameter of 5 mm or more of the resin film-forming film did not remain on the surface of the silicon wafer, and some slight residue having a diameter of less than 5 mm remained but could be fully removed with alcohol or the like.

"B": No residue having a diameter of 10 mm or more of the resin film-forming film remained on the surface of the silicon wafer, and some slight residue having a diameter of less than 10 mm remained but could be fully removed with alcohol or the like.

"C": Residue having a diameter of 10 mm or more of the resin film-forming film remained on the surface of the silicon wafer, which was difficult to remove with alcohol or the like.

[0149]
Table 1

Formulation of Resin Film-Forming Composition (part by mass)*1	Polymer Component	Example 1	Example 2	Example 3	Example 4	Example 5	Example 6	Example 7	Example 8	Example 9	Comparative Example 1
		A-1	-	150 (26.0)	150 (26.0)	150 (23.9)	150 (29.6)	150 (26.0)	150 (22.8)	150 (29.6)	-
	A-2	-	150 (26.0)	-	-	-	-	-	-	-	-
	A-3	-	-	-	-	-	-	-	-	-	150 (26.0)
	B-1	60 (10.4)	60 (10.4)	60 (10.4)	60 (10.4)	10 (1.7)	60 (10.4)	60 (10.4)	10 (1.7)	60 (10.4)	60 (10.4)
	B-2	10 (1.7)	10 (1.7)	10 (1.7)	10 (1.7)	60 (10.4)	10 (1.7)	10 (1.7)	60 (10.4)	10 (1.7)	10 (1.7)
	B-3	30 (5.2)	30 (5.2)	30 (5.2)	30 (5.2)	30 (5.2)	30 (5.2)	30 (5.2)	30 (5.2)	30 (5.2)	30 (5.2)
	B-4	2 (0.3)	2 (0.3)	2 (0.3)	2 (0.3)	2 (0.3)	2 (0.3)	2 (0.3)	2 (0.3)	2 (0.3)	2 (0.3)
	B-5	2 (0.3)	2 (0.3)	2 (0.3)	2 (0.3)	2 (0.3)	2 (0.3)	2 (0.3)	2 (0.3)	2 (0.3)	2 (0.3)
	C-1	320 (55.4)	320 (55.4)	320 (55.4)	320 (55.4)	370 (64.1)	260 (43.3)	320 (55.4)	400 (69.3)	250 (43.3)	320 (55.4)
	D-1	1.2 (0.2)	1.2 (0.2)	1.2 (0.2)	1.2 (0.2)	1.2 (0.2)	1.2 (0.2)	1.2 (0.2)	1.2 (0.2)	1.2 (0.2)	1.2 (0.2)
	E-1	2 (0.3)	2 (0.3)	2 (0.3)	2 (0.3)	2 (0.3)	2 (0.3)	2 (0.3)	2 (0.3)	2 (0.3)	2 (0.3)
Kind of Supporting Sheet		Supporting Sheet (I)	Supporting Sheet (II)	Supporting Sheet (III)	Supporting Sheet (IV)	Supporting Sheet (I)	Supporting Sheet (IV)	Supporting Sheet (V)	Supporting Sheet (VI)	Supporting Sheet (VII)	Supporting Sheet (I)
Evaluation	Release Force ($\alpha 1$)	0.7	1.2	0.7	0.7	0.07	9.0	0.7	0.06	9.0	11.0
	Release Force ($\beta 1$)	1.0	2.0	2.0	2.0	0.3	11.0	19.0	0.08	19.0	0.5
	Release Force ($\beta 2$)	0.4	1.0	1.5	1.5	0.2	3.0	4.0	0.03	4.5	0.4
	Reworkability with Silicon Wafer	B	A	A	A	A	B	A+	B	A	C

*1: The parenthesized values in the Table each indicate the compositional ratio (unit: % by mass) relative to the total amount (100% by mass) of the protective film-forming composition.

[0150]

From Table 1, it is known that the resin film-forming films formed in Examples 1 to 9 that are for one aspect of the present invention are excellent in reworkability as compared with the resin film-forming film of Comparative Example 1.

Industrial Applicability

[0151]

The resin film-forming composite 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 capable of adhering to a die pad part or to any other site.

Reference Signs List

[0152]

1a, 1b, 1c, 1d Resin Film-Forming Composite Sheet (composite sheet)

10 Supporting Sheet

20 Resin Film-Forming Film

21 Surface (α)

22 Surface (β)

30 Resin Film

31 Surface (α')

32 Surface (β')

40 Jig-Adhering Layer

50 Carrier Sheet

100 Silicon Wafer

CLAIMS

[Claim 1]

A resin film-forming composite sheet which is so configured that a resin film-forming film capable of forming a resin film is directly laminated on a supporting sheet and which satisfies the following requirements (I) and (II):

Requirement (I): a release force ($\alpha 1$) required for releasing the resin film-forming film from a silicon wafer, as measured in an environment at 23°C and under releasing conditions (x) of a pulling rate of 300 mm/min and a pulling angle of 180° after a surface (α) of the resin film-forming film on the side thereof to be stuck to the silicon wafer has been stuck to a silicon wafer, is 0.05 to 10.0 N/25 mm; and

Requirement (II): a release force ($\beta 1$) required for releasing the supporting sheet from a surface (β) of the resin film-forming film on the side thereof directly laminated on the supporting sheet, as measured under the above-mentioned releasing conditions(x), is a value equal to or greater than the release force ($\alpha 1$).

[Claim 2]

The resin film-forming composite sheet according to claim 1, further satisfying the following requirement (III):

Requirement (III): a release force ($\beta 2$) required for releasing the supporting sheet from a surface (β') of the resin film on the side on which the supporting sheet is directly laminated, as measured under the above-mentioned releasing conditions (x) after the resin film has been formed from the resin film-forming film, is 0.02 to 5.0 N/25 mm.

[Claim 3]

The resin film-forming composite sheet according to claim 1 or 2, wherein the release force ($\beta 1$) is 0.05 to 20.0 N/25 mm.

[Claim 4]

The resin film-forming composite sheet according to any one of claims 1 to 3, wherein the supporting sheet is a sheet formed of a substrate alone.

[Claim 5]

The resin film-forming composite sheet according to any one of claims 1 to 3, wherein the supporting sheet is a pressure sensitive adhesive sheet having a pressure sensitive adhesive layer on a substrate and is so configured that the pressure sensitive adhesive layer of the pressure sensitive adhesive sheet is

laminated directly on the surface (β) of the resin film-forming film.

[Claim 6]

The resin film-forming composite sheet according to claim 5, wherein the pressure sensitive adhesive layer is a layer formed of a pressure sensitive adhesive composition containing an energy ray-curable resin.

[Claim 7]

The resin film-forming composite sheet according to any one of claims 1 to 6, wherein the resin film-forming film contains a polymer component (A) and a curable component (B).

[Claim 8]

The resin film-forming composite sheet according to any one of claims 1 to 7, wherein the resin film-forming film is a forming material for a protective film or an adhesive film.

[Claim 9]

A method for producing a resin film-having chip, comprising the following steps (1) to (4):

step (1): a step of sticking the resin film-forming composite sheet of any one of claims 1 to 8, onto the back surface of a workpiece;

step (2): a step of dicing the workpiece;

step (3): a step of forming a resin film from the resin film-forming film;

and

step (4): a step of picking up the workpiece that has been diced via the step (2) to thereby obtain a chip.