

[DESCRIPTION]

[TITLE OF INVENTION]

FILM FOR FORMING PROTECTIVE COATING AND COMPOSITE SHEET FOR
FORMING PROTECTIVE COATING

5 [Technical Field]

[0001]

The present invention relates to a film for a protective coating that can form a
protective coating on a workpiece such as a semiconductor wafer or an artifact (for
example, a semiconductor chip) obtained by processing the workpiece, a sheet for
10 forming a protective coating, and a composite sheet for forming a protective coating.

Priority is claimed on Japanese Patent Application No. 2014-220295, filed
October 29, 2014, the content of which is incorporated herein by reference.

[Background Art]

[0002]

15 In recent years, semiconductor devices have been manufactured by a mounting
method called a face-down method. In this method, when a semiconductor chip having
a circuit surface in which an electrode such as a bump is formed is mounted, a circuit
surface side of the semiconductor chip is bonded to a chip-mounting portion such as a
lead frame. Therefore, a structure is provided in which a rear surface side of the
20 semiconductor chip in which no circuit is formed is exposed.

[0003]

Therefore, on the rear surface side of the semiconductor chip, in order to protect
the semiconductor chip, a protective coating made of a hard organic material is often
formed. This protective coating is formed using, for example, a film for a

semiconductor rear surface or a film for protecting a rear surface of a dicing tape integrated wafer as shown in Patent Literature 1 or 2.

[0004]

Here, the protective coating is generally formed of a thermosetting resin such as an epoxy resin. However, there are obstacles to improving efficiency of production since a curing temperature of the thermosetting resin exceeds 130 °C and a time of about 2 hours is required for curing. Therefore, a protective coating including a curing mechanism through which it is possible to reduce a processing time is desirable.

[0005]

On the other hand, in Patent Literature 3, an energy ray-curable chip protective coating including an energy ray-curable protective coating forming layer that contains (A) a polymer component including an acrylic copolymer having no double bond, (B) an energy ray-curable component, (C) a dye and/or a pigment, (D) an inorganic filler, and (E) a photopolymerization initiator that absorbs light in a long wavelength range of 350 nm or more is disclosed. Since such an energy ray-curable chip protective coating is generally cured by ultraviolet irradiation in a short time, the protective coating can be easily formed, thereby contributing to improving efficiency of production.

[Citation List]

[Patent Literature]

[0006]

[Patent Literature 1]

Japanese Unexamined Patent Application, First Publication No. 2012-28396

[Patent Literature 2]

Japanese Unexamined Patent Application, First Publication No. 2012-235168

[Patent Literature 3]

[Summary of Invention]

[Technical Problem]

[0007]

5 However, the component (C) used in an example in Patent Literature 3 is a black pigment. A chip protective coating containing such a black pigment has a low ultraviolet transmittance. Therefore, when ultraviolet rays are irradiated to cure the chip protective coating, the ultraviolet rays do not sufficiently reach the inside of the film or a surface opposite to an ultraviolet irradiation surface and the chip protective coating may
10 be insufficiently cured. When the chip protective coating is insufficiently cured in this manner, the obtained protective coating has functional problems as a protective coating. For example, it may be easily peeled off due to heat or the like.

[0008]

 On the other hand, a grinding mark due to back grind processing performed on
15 the semiconductor wafer generally remains on a rear surface of a semiconductor chip. In consideration of the appearance of the semiconductor chip, it is desirable for such a grinding mark not to be visually observable but to be concealed by the protective coating.

[0009]

 The present invention has been made in view of the above circumstances and
20 provides a film for forming a protective coating, a sheet for forming a protective coating, and a composite sheet for forming a protective coating which are capable of forming a protective coating that has excellent ultraviolet curability so that a grinding mark present in a workpiece or an artifact is not visually observable.

[Solution to Problem]

25 [0010]

In order to achieve the above object, as a first aspect, the present invention provides a film for forming a protective coating that includes an ultraviolet-curable component and in which a light transmittance at a wavelength of 375 nm is 8% or more and a light transmittance at a wavelength of 550 nm is 12% or less (invention 1).

5 [0011]

The film for forming a protective coating according to the invention (invention 1) can form a protective coating that is sufficiently cured by ultraviolet rays so that a grinding mark present in a workpiece or an artifact is not visually observable after the ultraviolet curing.

10 [0012]

The invention (invention 1) may further include a coloring agent (invention 2).

[0013]

In the invention (invention 2), the coloring agent may be a red coloring agent (invention 3).

15 [0014]

In the invention (invention 2 or 3), the coloring agent may be an organic coloring agent (invention 4).

[0015]

In the invention (any one of inventions 2 to 4), a value W/T obtained by dividing
20 a content W (mass%) of the coloring agent in the film for forming a protective coating by a thickness T (μm) of the film for forming a protective coating may be 0.01 to 0.5 (invention 5).

[0016]

In the invention (any one of inventions 1 to 5), when ultraviolet rays with a
25 illuminance of 215 mW/cm^2 and a light intensity of 187 mJ/cm^2 are irradiated to the film

for forming a protective coating from one surface side three times, a ratio $P2/P1$ of a peak value $P2$ of a probe tack on a surface opposite to an ultraviolet irradiation surface with respect to a peak value $P1$ of a probe tack of the ultraviolet irradiation surface may be 0.1 to 7 (invention 6).

5 [0017]

In the invention (any one of inventions 1 to 6), a light transmittance at a wavelength of 1,600 nm may be 25% or more (invention 7).

[0018]

According to a second aspect, the present invention provides a sheet for forming
10 a protective coating that includes the film for forming a protective coating (any one of inventions 1 to 7) and a release sheet that is laminated on one surface or both surfaces of the film for forming a protective coating (invention 8). Also, the “sheet” in this specification includes the concept of a tape.

[0019]

15 According to a third aspect, the present invention provides a composite sheet for forming a protective coating that includes a support sheet and the film for forming a protective coating (any one of inventions 1 to 7) that is laminated on one surface side of the support sheet (invention 9).

[0020]

20 In the invention (invention 9), the support sheet may include a substrate and an adhesive layer that is laminated on the film for forming a protective coating side of the substrate or include a substrate (invention 10).

[Advantageous Effects of Invention]

[0021]

25 According to the film for forming a protective coating, the sheet for forming a

protective coating, and the composite sheet for forming a protective coating in the present invention, it is possible to form a protective coating that is sufficiently cured by ultraviolet rays so that a grinding mark present in a workpiece or an artifact is not visually observable.

5 [Brief Description of Drawings]

[0022]

Fig. 1 is a cross-sectional view of a sheet for forming a protective coating according to an embodiment of the present invention.

Fig. 2 is a cross-sectional view of a composite sheet for forming a protective
10 coating according to an embodiment of the present invention.

Fig. 3 is a cross-sectional view of a composite sheet for forming a protective coating according to another embodiment of the present invention.

Fig. 4 is a cross-sectional view of an application example of a composite sheet for forming a protective coating according to an embodiment of the present invention.

15 Fig. 5 is a graph showing measurement results of light transmittances in Test Example 1.

[Description of Embodiments]

[0023]

Embodiments of the present invention will be described below.

20 (Film for a protective coating)

A film for forming a protective coating according to the present embodiment is used to form a protective coating on a workpiece or an artifact obtained by processing the workpiece. As the workpiece, for example, a semiconductor wafer may be exemplified. As the artifact obtained by processing the workpiece, for example, a semiconductor chip
25 may be exemplified, however the present invention is not limited thereto. Also, when

the workpiece is a semiconductor wafer, the protective coating is formed on a rear surface side (a side on which an electrode such as a bump is not formed) of the semiconductor wafer.

[0024]

5 1. Physical properties

The film for forming a protective coating according to the present embodiment has a light transmittance at a wavelength of 375 nm that is 8% or more and a light transmittance at a wavelength of 550 nm that is 12% or less. Note that the light transmittance in this specification is a value that is measured using an integrating sphere and a spectrophotometer is used as a measuring instrument.

[0025]

As will be described below, the film for forming a protective coating according to the present embodiment includes an ultraviolet-curable component. As described above, when the light transmittance at a wavelength of 375 nm is 8% or more, ultraviolet rays easily pass through the film for forming a protective coating and the ultraviolet-curable component in the film for forming a protective coating is accordingly easily cured. Therefore, even if ultraviolet rays are irradiated to the film for forming a protective coating from one surface side, the entire film for forming a protective coating is sufficiently cured, and it is possible to effectively prevent the inside of the film for forming a protective coating and a surface opposite to the ultraviolet irradiation surface from being insufficiently cured.

[0026]

In consideration of curability of the film for forming a protective coating, the light transmittance at a wavelength of 375 nm of the film for forming a protective coating is preferably 10% or more, more preferably 13% or more, still more preferably 15% or

more, yet more preferably 17% or more, and most preferably 20% or more. Here, an upper limit of the light transmittance at a wavelength of 375 nm is not particularly limited, but is naturally determined when the light transmittance at a wavelength of 550 nm is set to 12% or less. Specifically, the light transmittance at a wavelength of 375 nm of the film for forming a protective coating is preferably 35% or less.

[0027]

On the other hand, for example, a grinding mark due to back grind processing performed on the semiconductor wafer generally remains on a rear surface of the semiconductor chip. As described above, when the light transmittance at a wavelength of 550 nm is 12% or less, visible rays do not easily pass through the film for forming a protective coating. Accordingly, the grinding mark is concealed by the film for forming a protective coating (a protective coating) and is almost invisible in visual observation. Therefore, an artifact such as a semiconductor chip has an excellent appearance.

[0028]

In consideration of the grinding mark concealment, the light transmittance at a wavelength of 550 nm of the film for forming a protective coating is preferably 11% or less, more preferably 8% or less, and most preferably 5% or less. Here, a lower limit of the light transmittance at a wavelength of 550 nm is not particularly limited, but is naturally determined when the light transmittance at a wavelength of 375 nm is set to 8% or more. Specifically, the light transmittance at a wavelength of 375 nm of the film for forming a protective coating is preferably 0% or more.

[0029]

In addition, a light transmittance at a wavelength of 1,600 nm of the film for forming a protective coating according to the present embodiment is preferably 25% or more, more preferably 40% or more, still more preferably 45% or more, and most

preferably 50% or more. In a semiconductor chip obtained by dicing a semiconductor wafer, cracks may occur due to stress generated during processing. As described above, when the light transmittance at a wavelength of 1,600 nm is 25% or more, an infrared light transmittance is favorable, and an infrared inspection in which infrared rays are acquired from a side of the film for forming a protective coating (or a protective coating formed of the film for forming a protective coating) can be performed. Accordingly, it is possible to find cracks in an artifact such as a semiconductor chip through the film for forming a protective coating (the protective coating), thereby improving a product yield.

[0030]

Here, an upper limit of the light transmittance at a wavelength of 1,600 nm is not particularly limited, but is naturally determined when the light transmittance at a wavelength of 550 nm is set to 12% or less. In addition, when an artifact (such as a semiconductor chip) having a protective coating formed thereon is used, if the light transmittance at a wavelength of 1,600 nm of the film for forming a protective coating is set to 90% or less, it is possible to prevent a malfunction of the artifact that is likely to be influenced by infrared rays from the outside.

[0031]

The film for forming a protective coating according to the present embodiment may include a single layer or a plurality of layers. In consideration of ease of control of a light transmittance and manufacturing costs, a film including a single layer is preferable. When the film for forming a protective coating includes a plurality of layers, in consideration of ease of control of a light transmittance, it is preferable for all of the plurality of layers to satisfy the above light transmittance.

[0032]

In addition, in the film for forming a protective coating according to the present embodiment, when ultraviolet rays are irradiated to the film for forming a protective coating from one surface side, a ratio $P2/P1$ of a peak value $P2$ of a probe tack on a surface opposite to an ultraviolet irradiation surface (hereinafter referred to as an “ultraviolet irradiation opposite surface” in some cases) to a peak value $P1$ of a probe tack of the ultraviolet irradiation surface is preferably 0.1 to 7, more preferably 0.5 to 4, and most preferably 1 to 2. Here, for example, when the film for forming a protective coating includes a plurality of layers, more of an ultraviolet-curable component (A) to be described below is blended into a layer that forms the ultraviolet irradiation opposite surface than a layer that forms the ultraviolet irradiation surface, and $P2/P1$ may be a value smaller than 1. A measurement method of the probe tack is performed according to JIS Z1023 1999. Details will be described in test examples to be shown below.

[0033]

When $P2/P1$ is within the above range, in the film for forming a protective coating (the protective coating), not only the ultraviolet irradiation surface side but also the ultraviolet irradiation opposite surface side is cured. That is, the entire film for forming a protective coating can be sufficiently cured in a thickness direction.

[0034]

Here, when the probe tack is represented by an energy value, a ratio $E2/E1$ of an energy value $E2$ of a probe tack of the ultraviolet irradiation opposite surface to an energy value $E1$ of a probe tack of the ultraviolet irradiation surface is preferably 0.1 to 10, more preferably 0.5 to 5, and most preferably 1 to 2.5. Here, for example, when the film for forming a protective coating includes a plurality of layers and more of an ultraviolet-curable component (A) to be described below is blended into a layer that

forms the ultraviolet irradiation opposite surface than a layer that forms the ultraviolet irradiation surface, $E2/E1$ may be a value smaller than 1.

[0035]

Here, the peak value $P1$ of the probe tack of the ultraviolet irradiation surface
5 itself is preferably 0.05 to 1.5, more preferably 0.1 to 1, and most preferably 0.15 to 0.75.
In addition, the energy value $E1$ of the probe tack of the ultraviolet irradiation surface
itself is preferably 0.005 to 0.3, more preferably 0.008 to 0.15, and most preferably 0.01
to 0.1. When the peak value $P1$ and/or the energy value $E1$ of the probe tack of the
ultraviolet irradiation surface is within the above range, at least the ultraviolet irradiation
10 surface side of the film for forming a protective coating (a protective coating) can be
cured to a high extent.

[0036]

2. Material

The film for forming a protective coating according to the present embodiment
15 includes the ultraviolet-curable component (A). The ultraviolet-curable component (A)
is preferably an uncured ultraviolet-curable component and more preferably an uncured
ultraviolet-curable component having tackiness.

[0037]

For the film for forming a protective coating, it is possible to form a protective
20 coating having durability on a chip and the like by overlapping a film for forming a
protective coating and a workpiece such as a semiconductor wafer and then curing the
film for forming a protective coating by ultraviolet irradiation. Since the film for
forming a protective coating is cured in a short time, efficiency of production is excellent.
In addition, if the film for forming a protective coating has tackiness, when a workpiece
25 such as a semiconductor wafer overlaps the film for forming a protective coating as

described above, they can be stuck together. Thereby, positioning can be reliably performed before the film for forming a protective coating is cured. Also, the film for forming a protective coating may have tackiness at a normal temperature or may exhibit tackiness due to heat.

5 [0038]

Here, a light transmittance of the film for forming a protective coating hardly differs before curing and after curing. Accordingly, when the film for forming a protective coating before curing has a light transmittance at a wavelength of 375 nm that is 8% or more and a light transmittance at a wavelength of 550 nm that is 12% or less,
10 the film for forming a protective coating (a protective coating) after curing also has a light transmittance at a wavelength of 375 nm that is 13% or more and a light transmittance at a wavelength of 550 nm that is 12% or less.

[0039]

The film for forming a protective coating according to the present embodiment
15 preferably includes a coloring agent (B) in addition to the ultraviolet-curable component (A). When the film for forming a protective coating includes the coloring agent (B), it is easy to control light transmittances at a wavelength of 375 nm and a wavelength of 550 nm (as well as a wavelength of 1,600 nm) to be within the above-described ranges.

[0040]

20 In addition, the film for forming a protective coating according to the present embodiment preferably includes a filler (C) together with the coloring agent (B). Thereby, it is easier to control light transmittances at a wavelength of 375 nm and a wavelength of 550 nm (as well as a wavelength of 1,600 nm) to be within the above-described ranges. In addition, when the film for forming a protective coating
25 includes a filler, it is possible to maintain hardness of the cured protective coating at a

high value and improve moisture resistance. Furthermore, it is possible for a coefficient of thermal expansion of the cured protective coating to be close to a coefficient of thermal expansion of the semiconductor wafer. As a result, it is possible to reduce warping of the semiconductor wafer during processing.

5 [0041]

Preferably, the film for forming a protective coating according to the present embodiment further includes a thermosetting component (D). When the film for forming a protective coating that further includes the thermosetting component (D) is heated, it is possible to improve an adhesive strength of the film for forming a protective
10 coating with respect to a workpiece and a strength of the cured protective coating.

Also, when the film for forming a protective coating includes the ultraviolet-curable component (A) and the coloring agent (B), a proportion of the ultraviolet-curable component (A) and a proportion of the coloring agent (B) are set so that a sum of the proportion of the ultraviolet-curable component (A) and the proportion
15 of the coloring agent (B) is 100 mass%. Similarly, when the film for forming a protective coating includes the ultraviolet-curable component (A), the coloring agent (B) and the filler (C), proportions of the ultraviolet-curable component (A), the coloring agent (B) and the filler (C) are set so that a sum of the proportion of the ultraviolet-curable component (A), the proportion of the coloring agent (B), and the
20 proportion of the filler (C) is 100 mass%. When the film for forming a protective coating includes the ultraviolet-curable component (A), the coloring agent (B), the filler (C) and the thermosetting component (D), proportions of the ultraviolet-curable component (A), the coloring agent (B), the filler (C) and the thermosetting component (D) are set so that a sum of the proportion of the ultraviolet-curable component (A), the

proportion of the coloring agent (B), the proportion of the filler (C), and the thermosetting component (D) is 100 mass%.

[0042]

(1) Ultraviolet-curable component (A)

5 The ultraviolet-curable component (A) may be a polymer (A1) into which an ultraviolet-curable group is introduced or may include an ultraviolet-curable compound (A3) other than the polymer (A1) into which an ultraviolet-curable group is introduced. When the ultraviolet-curable component (A) in the present embodiment includes the ultraviolet-curable compound (A3), a polymer such as a polymer (A2) not having
10 ultraviolet curability is preferably included. Here, the “polymer” herein includes the concept of “copolymer.”

[0043]

(1-1) Polymer (A1) into which an ultraviolet-curable group is introduced

 When the ultraviolet-curable component (A) in the present embodiment includes
15 the polymer (A1) into which an ultraviolet-curable group is introduced, the polymer (A1) may be included in the film for forming a protective coating without change or the polymer (A1) in the form of a crosslinked product, of which at least a part is crosslinked using a crosslinking agent, may be included therein.

[0044]

20 As the polymer (A1) into which an ultraviolet-curable group is introduced, for example, an acrylic polymer that is a reaction product of a functional group-containing acrylic polymer (A1-1) including a functional group-containing monomer that contains a functional group as a structural component and a curable group-containing compound (A1-2) that includes a substituent that reacts with the functional group and an
25 ultraviolet-curable carbon-carbon double bond.

[0045]

The functional group-containing acrylic polymer (A1-1) is preferably a copolymerization reaction product of an acrylic monomer containing a functional group and an acrylic monomer not containing functional group, and a monomer other than an acrylic monomer if necessary. That is, the functional group-containing monomer is preferably an acrylic monomer containing a functional group.

In this specification, the term “polymer” or “resin” used for a substance obtained by polymerizing monomers refers to a “polymer” or a “resin” that includes a structural unit (also referred to as a repeating unit) derived from the monomer.

10 [0046]

As a functional group of an acrylic monomer containing a functional group (a functional group of a functional group-containing monomer), a functional group that can react with the substituent included in the curable group-containing compound (A1-2) is selected. As such a functional group, for example, a hydroxy group, a carboxy group, an amino group, a substituted amino group, and an epoxy group may be exemplified. Among these, a hydroxy group is preferable. Also, when the ultraviolet-curable component (A) in the present embodiment includes a crosslinking agent, the functional group-containing acrylic polymer (A1-1) preferably includes a functional group-containing monomer that contains a functional group which reacts with the crosslinking agent as a structural component. The functional group-containing monomer may also serve as a functional group-containing monomer that includes a functional group which can react with the substituent included in the curable group-containing compound.

20

[0047]

As an acrylic monomer that includes a hydroxy group (a hydroxy group-containing monomer), for example, (meth)acrylic acid hydroxyalkyl esters such as 2-hydroxyethyl (meth)acrylate, 2-hydroxypropyl (meth)acrylate, 3-hydroxypropyl (meth)acrylate, 2-hydroxybutyl (meth)acrylate, 3-hydroxybutyl (meth)acrylate, and 4-hydroxybutyl (meth)acrylate may be exemplified. Among these, in consideration of reactivity with the curable group-containing compound (A1-2), 2-hydroxyethyl (meth)acrylate is preferable. Among these, one type may be used alone and two or more types may be used in a combination.

[0048]

The acrylic monomer not containing functional group preferably includes a (meth)acrylic acid alkyl ester monomer. As the (meth)acrylic acid alkyl ester monomer, for example, methyl (meth)acrylate, ethyl (meth)acrylate, propyl (meth)acrylate, n-butyl (meth)acrylate, n-pentyl (meth)acrylate, n-hexyl (meth)acrylate, 2-ethylhexyl (meth)acrylate, isooctyl (meth)acrylate, n-decyl (meth)acrylate, lauryl (meth)acrylate, myristyl (meth)acrylate, palmityl (meth)acrylate, and stearyl(meth)acrylate may be exemplified. Among (meth)acrylic acid alkyl ester monomers, a monomer including an alkyl group having 1 to 18 carbon atoms is preferable and a monomer including an alkyl group having 1 to 4 carbon atoms is more preferable. Among these, one type may be used alone or two or more types may be used in a combination.

[0049]

In addition to the above (meth)acrylic acid alkyl ester monomer, the acrylic monomer not containing functional group may include, for example, alkoxy alkyl group-containing (meth)acrylic acid esters such as methoxymethyl (meth)acrylate, methoxyethyl (meth)acrylate, ethoxymethyl (meth)acrylate, and ethoxyethyl (meth)acrylate, aromatic ring-containing (meth)acrylic acid esters such as phenyl

(meth)acrylate, non-crosslinking acrylamides such as acrylamide and methacrylamide, and (meth)acrylic acid esters including a non-crosslinking tertiary amino group such as N,N-dimethylaminoethyl (meth)acrylate and N,N-dimethylaminopropyl (meth)acrylate.

[0050]

5 As a monomer other than the acrylic monomer, for example, olefins such as ethylene and norbornene, vinyl acetate, and styrene may be exemplified.

[0051]

 In the functional group-containing acrylic polymer (A1-1), a proportion of a mass of a structural part derived from a functional group-containing monomer with
10 respect to the total mass of the functional group-containing acrylic polymer (A1-1) is preferably 0.1 to 50 mass%, more preferably 1 to 40 mass%, and most preferably 3 to 30 mass%. Accordingly, an amount of a curable group introduced by the curable group-containing compound (A1-2) (and an amount that reacts with a crosslinking agent) is adjusted to a desired amount and a degree of curing (a degree of crosslinking) of the
15 obtained protective coating can be controlled to be within a preferable range.

[0052]

 The functional group-containing acrylic polymer (A1-1) is obtained by copolymerizing the above monomers according to a general method. A polymerization mode of the functional group-containing acrylic polymer (A1-1) may be a random
20 copolymer or a block copolymer.

[0053]

 The curable group-containing compound (A1-2) includes a substituent that reacts with a functional group included in the functional group-containing acrylic polymer (A1-1) and an ultraviolet-curable carbon-carbon double bond. As the
25 substituent that reacts with a functional group included in the functional

group-containing acrylic polymer (A1-1), for example, an isocyanate group, an epoxy group, and a carboxy group may be exemplified. Among these, an isocyanate group having high reactivity with a hydroxy group is preferable.

[0054]

5 The curable group-containing compound (A1-2) preferably includes 1 to 5 ultraviolet-curable carbon-carbon double bonds for each molecule of the curable group-containing compound (A1-2) and more preferably includes 1 to 2 ultraviolet-curable carbon-carbon double bonds for each molecule of the curable group-containing compound (A1-2).

10 [0055]

As the curable group-containing compound (A1-2), for example, 2-methacryloyloxyethyl isocyanate, meta-isopropenyl- α,α -dimethylbenzyl isocyanate, methacryloyl isocyanate, allyl isocyanate, 1,1-bis(acryloyloxymethyl)ethyl isocyanate; an acryloyl monoisocyanate compound obtained by reacting a diisocyanate compound or
15 a polyisocyanate compound with hydroxyethyl(meth)acrylate; and an acryloyl monoisocyanate compound obtained by reacting a diisocyanate compound or a polyisocyanate compound and a polyol compound with hydroxyethyl(meth)acrylate may be exemplified. Among these, 2-methacryloyloxyethyl isocyanate is particularly preferable. As the curable group-containing compound (A1-2), one type can be used
20 alone or two or more types can be used in a combination.

[0056]

The polymer (A1) into which an ultraviolet-curable group is introduced preferably includes a curable group derived from the curable group-containing compound (A1-2) at 20 to 120 mol%, more preferably at 35 to 100 mol%, and most preferably at 50
25 to 100 mol% with respect to a functional group (a functional group that reacts with a

substituent of the curable group-containing compound (A1-2)) included in the polymer (A1). Also, when the curable group-containing compound (A1-2) is monofunctional, an upper limit is 100 mol%. When the curable group-containing compound (A1-2) is multifunctional, the upper limit may exceed 100 mol%. When a ratio of the curable group to above functional group is within the above range, the adhesive strength of the ultraviolet cured protective coating can be very excellent.

[0057]

A weight average molecular weight (Mw) of the polymer (A1) into which an ultraviolet-curable group is introduced is preferably 100,000 to 2 million and more preferably 300,000 to 1.5 million. Note that the weight average molecular weight herein is a standard polystyrene corresponding value measured by a gel permeation chromatography (GPC) method.

[0058]

(1-2) Polymer (A2) not having ultraviolet curability

When the ultraviolet-curable component (A) in the present embodiment includes the polymer (A2) not having ultraviolet curability, the polymer (A2) may be included in the film for forming a protective coating without change or the polymer (A2) in the form of a crosslinked product, of which at least a part is crosslinked using a crosslinking agent, may be included therein. As the polymer (A2), a phenoxy resin, an acrylic polymer (A2-1), a urethane resin, a polyester resin, a rubber-based resin, an acrylic urethane resin, and the like may be exemplified. Among these, a case in which the acrylic polymer (A2-1) is used will be described in detail.

[0059]

As the acrylic polymer (A2-1), acrylic polymers known in the related art can be used. The acrylic polymer (A2-1) may be a homopolymer formed of one type of acrylic

monomer, a copolymer formed of multiple types of acrylic monomers, or a copolymer formed of one type or multiple types of acrylic monomers and a monomer other than the acrylic monomers. A specific type of a compound serving as an acrylic monomer is not particularly limited, and (meth)acrylic acid, (meth)acrylic acid ester, and derivatives thereof (such as acrylonitrile and itaconic acid) may be exemplified as specific examples. As further specific examples of the (meth)acrylic acid ester, (meth)acrylates including a chain skeleton such as methyl (meth)acrylate, ethyl (meth)acrylate, propyl (meth)acrylate, butyl (meth)acrylate, or 2-ethylhexyl (meth)acrylate; (meth)acrylates including a cyclic skeleton such as cyclohexyl (meth)acrylate, benzyl (meth)acrylate, isobornyl (meth)acrylate, dicyclopentanyl (meth)acrylate, tetrahydrofurfuryl (meth)acrylate, or imide acrylate; (meth)acrylates including a hydroxy group such as 2-hydroxyethyl (meth)acrylate or 2-hydroxy propyl (meth)acrylate; and (meth)acrylates including a reactive functional group other than a hydroxy group such as glycidyl (meth)acrylate or N-methylaminoethyl (meth)acrylate may be exemplified. In addition, as a monomer other than the acrylic monomer, olefins such as ethylene and norbornene, vinyl acetate, and styrene may be exemplified. Also, when the acrylic monomer is an alkyl (meth)acrylate, an alkyl group thereof preferably has from 1 to 18 carbon atoms.

[0060]

When the ultraviolet-curable component (A) in the present embodiment includes a crosslinking agent, the acrylic polymer (A2-1) preferably includes a reactive functional group that reacts with the crosslinking agent. A type of the reactive functional group is not particularly limited and may be appropriately determined based on a type of the crosslinking agent and the like.

[0061]

For example, when the crosslinking agent is a polyisocyanate compound, a hydroxy group, a carboxy group, and an amino group may be exemplified as a reactive functional group included in the acrylic polymer (A2-1). Among these, a hydroxy group having high reactivity with an isocyanate group is preferable. In addition, when the crosslinking agent is an epoxy compound, a carboxy group, an amino group, and an amide group may be exemplified as a reactive functional group included in the acrylic polymer (A2-1). Among these, a carboxy group having high reactivity with an epoxy group is preferable. The carboxy group is preferably included at 12 wt% or less with respect to the entire reactive functional group included in the acrylic polymer (A2-1).

10 [0062]

A method of introducing a reactive functional group into the acrylic polymer (A2-1) is not particularly limited. As an example, a method in which the acrylic polymer (A2-1) is formed using a monomer including a reactive functional group and a structural unit based on the monomer including the reactive functional group is included in a skeleton of a polymer may be exemplified. For example, when a hydroxy group is introduced into the acrylic polymer (A2-1), the acrylic polymer (A2-1) may be formed using a monomer including a hydroxy group such as 2-hydroxyethyl acrylate.

[0063]

When the acrylic polymer (A2-1) includes a reactive functional group, in order for a degree of crosslinking to be within an appropriate range, a proportion of a mass of a structural part derived from the monomer including the reactive functional group with respect to the total mass of the acrylic polymer (A2-1) is preferably about 1 to 20 mass% and more preferably 2 to 10 mass%.

20 [0064]

In consideration of film formability during coating, a weight average molecular weight (Mw) of the acrylic polymer (A2-1) is preferably 10,000 to 2 million and more preferably 100,000 to 1.5 million.

[0065]

5 (1-3) Ultraviolet-curable compound (A3)

The ultraviolet-curable component (A) may include the ultraviolet-curable compound (A3) other than the polymer (A1) into which an ultraviolet-curable group is introduced. In this case, it is preferable to also include the above-described polymer (A2) not having ultraviolet curability. In addition, instead of or together with the
10 polymer (A2) not having ultraviolet curability, the polymer (A1) into which an ultraviolet-curable group is introduced may be included. The ultraviolet-curable compound (A3) is a compound that includes an ultraviolet-curable group and is polymerized when irradiated with ultraviolet rays.

[0066]

15 The ultraviolet-curable group included in the ultraviolet-curable compound (A3) is, for example, a group containing an ultraviolet-curable carbon-carbon double bond. Specifically, a (meth)acryloyl group and a vinyl group may be exemplified.

[0067]

Examples of the ultraviolet-curable compound (A3) are not particularly limited
20 as long as the above ultraviolet-curable group is included. However, in consideration of general versatility, low molecular weight compounds (monofunctional or multifunctional monomers and oligomers) are preferable. As a specific example of the low molecular weight ultraviolet-curable compound (A3), trimethylolpropane triacrylate, tetramethylol methane tetraacrylate, pentaerythritol triacrylate, dipentaerythritol
25 monohydroxypentaacrylate, dipentaerythritol hexaacrylate, or cyclic aliphatic

skeleton-containing acrylates such as 1,4-butylene glycol diacrylate, 1,6-hexanediol diacrylate, dicyclopentadiene dimethoxydiacrylate, and isobornyl acrylate, and acrylate compounds such as polyethylene glycol diacrylate, oligoester acrylate, urethane acrylate oligomer, epoxy modified acrylate, polyether acrylate, and itaconic acid oligomer may be exemplified.

[0068]

In addition, as examples of the ultraviolet-curable compound (A3), an epoxy resin including an ultraviolet-curable group and a phenolic resin including an ultraviolet-curable group may be exemplified. As such a resin, for example, a resin described in Japanese Unexamined Patent Application, First Publication No. 2013-194102 can be used. Such a resin corresponds to the resin forming the thermosetting component (C) to be described below, and also contributes to ultraviolet curing. Therefore, this resin is treated as an ultraviolet-curable compound (A) in the present invention.

[0069]

The ultraviolet-curable compound (A3) has a molecular weight that is generally 100 to 30,000, and is preferably about 300 to 10,000. In general, with respect to a total amount (100 parts by mass) of the polymer (A1) and the polymer (A2), the ultraviolet-curable compound (A3) is used at a proportion that is 10 to 400 parts by mass, and preferably about 30 to 350 parts by mass.

[0070]

The film for forming a protective coating according to the present embodiment includes the ultraviolet-curable component (A) that is preferably 5 to 89 mass%, more preferably 10 to 80 mass%, and most preferably 20 to 70 mass% with respect to the mass of the film for forming a protective coating. When a content of the ultraviolet-curable

component (A) is within the above range, the film for forming a protective coating can be sufficiently cured by ultraviolet irradiation.

[0071]

(2) Coloring agent (B)

5 As the coloring agent (B), for example, known coloring agents such as an inorganic pigment, an organic pigment, and an organic dye can be used. In order to increase controllability of a light transmittance, the coloring agent (B) is preferably an organic coloring agent. As described above, properties of the film for forming a protective coating according to the present embodiment or preferred properties of the

10 film for forming a protective coating according to the present embodiment are properties in which a lower light transmittance is shown in a certain wavelength band than in a lower wavelength band, such as light transmittance of 8% or more at a wavelength of 375 nm, and light transmittance of 12% or less at a wavelength of 550 nm. Here, when only an inorganic coloring agent is used, a light transmittance tends to linearly increase as a

15 wavelength of a light beam increases (refer to results of Test Example 1 to be described below and Fig. 5). Therefore, when the film for forming a protective coating according to the present embodiment includes only an inorganic coloring agent, it is not necessarily easy to impart the above properties to the film for forming a protective coating according to the present embodiment. On the other hand, when the film for forming a protective

20 coating according to the present embodiment includes an organic coloring agent, it is easy for the film for forming a protective coating according to the present embodiment to satisfy the above properties. In addition, in order to increase chemical stability (specifically, stability against elution and color transfer, and little change over time may be exemplified) of a coloring agent, the coloring agent (B) preferably includes a pigment.

25 Therefore, the coloring agent (B) included in the film for forming a protective coating

according to the present embodiment preferably includes an organic pigment. Also, the coloring agent (B) included in the film for forming a protective coating according to the present embodiment may be made of a plurality of types of materials.

[0072]

5 As organic pigments and organic dyes serving as organic coloring agents, for example, aminium dyes, cyanine dyes, merocyanine dyes, croconium dyes, squalium dyes, azulenium dyes, polymethine dyes, naphthoquinone dyes, pyrylium dyes, phthalocyanine dyes, naphthalocyanine dyes, naphtholactam dyes, azo dyes, azo lake dyes, condensed azo dyes, indigo dyes, perinone dyes, perylene dyes, dioxazine dyes, 10 quinacridone dyes, isoindolinone dyes, quinophthalone dyes, pyrrole dyes, thioindigo dyes, metal complex dyes (metal complex salt dyes), dithiol metal complex dyes, indole phenol dyes, triaryl methane dyes, anthraquinone dyes, dioxazine dyes, naphthol dyes, azomethine dyes, benzimidazolone dyes, pyranthrone dyes and threne dyes may be exemplified.

15 [0073]

As the inorganic pigment, for example, carbon black, cobalt dyes, iron dyes, chromium dyes, titanium dyes, vanadium dyes, zirconium dyes, molybdenum dyes, ruthenium dyes, platinum dyes, indium tin oxide (ITO) dyes, and antimony tin oxide (ATO) dyes may be exemplified.

20 [0074]

The coloring agent (B) in the film for forming a protective coating according to the present embodiment may include an organic coloring agent and an inorganic coloring agent.

[0075]

In addition, the film for forming a protective coating according to the present embodiment preferably includes a red coloring agent. When the film for forming a protective coating includes a red coloring agent, it is easier to control light transmittances at a wavelength of 375 nm and a wavelength of 550 nm (as well as a wavelength of 1,600 nm) to be within the above-described ranges. The red coloring agent may be a pigment or a dye. As the red coloring agent, for example, monoazo type, disazo type, azo lake type, benzimidazolone type, perylene type, diketopyrrolopyrrole type, condensed azo type, anthraquinone type, and quinacridone type coloring agents may be exemplified. Among these, one type can be used alone, or two or more types can be used in a mixture.

10 [0076]

Among these, a diketopyrrolopyrrole type red coloring agent is preferable. According to this red coloring agent, it is easy to control light transmittances at a wavelength of 375 nm and a wavelength of 550 nm to be within the above-described ranges.

15 [0077]

A content of the coloring agent (B) in the film for forming a protective coating is preferably determined according to a thickness of the film for forming a protective coating such that a light transmittance is within the above-described range. Specifically, a value W/T obtained by dividing a content W (a mass% with respect to the total mass of the film for forming a protective coating) of the coloring agent (B) in the film for forming a protective coating by a thickness T (μm) of the film for forming a protective coating is preferably 0.01 to 0.5, more preferably 0.03 to 0.3, and most preferably 0.05 to 0.25. When W/T is 0.5 or more, it is easy to control the light transmittance at a wavelength of 550 nm to 12% or less. When W/T is 0.01 or less, it is easy to control the light transmittance at a wavelength of 375 nm to 13% or more.

20

25

[0078]

(3) Filler (C)

As the filler (C), silicas such as a crystalline silica, a fused silica, and a synthetic silica and inorganic fillers such as alumina and a glass balloon may be exemplified.

- 5 Among these, silica is preferable, synthetic silica is more preferable, and particularly, a synthetic silica type in which a source of α rays that cause a malfunction in a semiconductor device is removed as much as possible is optimal. As a shape of the filler (C), a spherical shape, a needle shape, and an amorphous shape may be exemplified. The spherical shape is preferable, and a true spherical shape is more preferable. When
- 10 the filler has a spherical shape or a true spherical shape, light beams are unlikely to be irregularly reflected and the above-described infrared inspection can be performed satisfactorily. Here, the amorphous shape means a shape whose surface is irregular. An amorphous surface may have multiple faces or one curved face. When a surface has multiple faces, each of the faces may be a flat surface, a curved surface, or a mixture
- 15 thereof. In addition, when a surface has multiple faces, areas of the faces may be different. The surfaces may have protruding shapes or concave shapes.

[0079]

- In addition to the above inorganic filler, a functional filler may also be blended into the film for forming a protective coating. As the functional filler, for example,
- 20 conductive fillers covered with gold, silver, copper, nickel, aluminum, stainless steel, carbon, ceramic or nickel, aluminum, or the like using silver for imparting conductivity after die bonding and thermally conductive fillers such as metal materials, for example, gold, silver, copper, nickel, aluminum, magnesium, stainless steel, silicon, and germanium and alloys and oxides, nitrides, hydroxides thereof and boron nitrides for
- 25 imparting thermal conductivity may be exemplified.

[0080]

An average particle size of the filler (C) (particularly a silica filler) is preferably 0.01 to 10 μm , more preferably 0.01 to 3 μm , still more preferably 0.03 to 2 μm and most preferably 0.05 to 1 μm . When the average particle size of the filler (C) is 0.01 μm or
5 more, it is easy to control the light transmittance at a wavelength of 550 nm to 13% or less to prevent a grinding mark in a semiconductor chip and the like from being visually observed. On the other hand, when the average particle size of the filler (C) is 10 μm or less, it is possible to maintain a favorable surface state of the film for forming a protective coating. In addition, when the average particle size of the filler (C) is 3 μm
10 or less, it is possible to prevent irregular reflection of infrared rays and perform an infrared inspection satisfactorily.

[0081]

Here, in this specification, an average particle size of less than 1 μm of the filler (C) is a value that is measured using a particle size distribution-measuring device (Nano
15 track Wave-UT151 commercially available from Nikkiso Co., Ltd.) according to a dynamic light scattering method. In addition, an average particle size of 1 μm or more of the filler (C) is a value that is measured using a particle size distribution-measuring device (MicroTrack MT3000II commercially available from Nikkiso Co., Ltd.) according to a laser diffraction and scattering method.

20 [0082]

A content of the filler (C) (particularly a silica filler) in the film for forming a protective coating is preferably 10 to 80 mass%, more preferably 20 to 70 mass%, and most preferably 30 to 65 mass% with respect to the mass of the film for forming a protective coating. When a blending amount of the filler is 10 mass% or more, it is
25 easy to control the light transmittance at a wavelength of 550 nm to 13% or less to

prevent a grinding mark in a semiconductor chip and the like from being visually observed. On the other hand, when a blending amount of the filler (C) is 80 mass% or less, the film for forming a protective coating can be sufficiently cured by ultraviolet irradiation.

5 [0083]

(4) Thermosetting component (D)

As the thermosetting component (D), for example, an epoxy resin, a phenolic resin, a melamine resin, a urea resin, a polyester resin, a urethane resin, an acrylic resin, a polyimide resin, and a benzoxazine resin and mixtures thereof may be exemplified.

10 Among these, an epoxy resin, a phenolic resin and a mixture thereof are preferably used.
[0084]

An epoxy resin has a property of forming a strong film when three dimensionally reticulated while heat is applied. As such an epoxy resin, various epoxy resins known in the related art are used. In general, an epoxy resin having a molecular weight of about 300 to 2,000 is preferable, and an epoxy resin having a molecular weight of 300 to 500 is more preferable. Further, a blended form of an epoxy resin that is liquid in a normal state and has a molecular weight of 330 to 400 and an epoxy resin that is solid at a normal temperature and has a molecular weight of 400 to 2500, and particularly 500 to 2,000 is preferable. In addition, an epoxy equivalent weight of an epoxy resin is preferably 50 to 5,000 g/eq.

15
20

[0085]

As such an epoxy resin, a so-called alicyclic epoxide in which a carbon-carbon double bond in a molecule is, for example, oxidized to introduce epoxy, specifically, glycidyl ethers of phenols such as bisphenol A, bisphenol F, resorcinol, phenyl novolac, and cresol novolac; glycidyl ethers of alcohols such as butanediol, polyethylene glycol,

25

and polypropylene glycol; glycidyl ethers of carboxylic acids such as phthalic acid, isophthalic acid, and tetrahydrophthalic acid; glycidyl type or alkylglycidyl type epoxy resins in which an active hydrogen atom bonded to a nitrogen atom is substituted with a glycidyl group such as aniline isocyanurate; and vinyl cyclohexane diepoxide,

- 5 3,4-epoxycyclohexylmethyl-3,4-dicyclohexane carboxylate, and
2-(3,4-epoxy)cyclohexyl-5,5-spiro(3,4-epoxy)cyclohexane-m-dioxane may be exemplified. In addition, an epoxy resin having a biphenyl skeleton, a dicyclohexadiene skeleton, or a naphthalene skeleton can be used.

[0086]

- 10 Among these, a bisphenol-based glycidyl type epoxy resin, an o-cresol novolac type epoxy resin and a phenol novolac type epoxy resin are preferably used. As the epoxy resin, one type can be used alone or two or more types can be used in a combination.

[0087]

- 15 When an epoxy resin is used, a curing agent of a thermally activated latent epoxy resin is preferably used as an auxiliary agent. The curing agent of the thermally activated latent epoxy resin is a curing agent type that does not react with an epoxy resin at room temperature, but is activated when heated to a certain temperature or higher and reacts with an epoxy resin. A method of activating the curing agent of the thermally
20 activated latent epoxy resin includes a method in which active species (anions and cations) are generated during a chemical reaction due to heat; a method in which a curing agent is reliably dispersed in an epoxy resin at around room temperature and is mixed with or dissolved in an epoxy resin at high temperatures to initiate a curing reaction; a method in which elution is performed using a molecular sieve enclosed type curing agent
25 at high temperatures to initiate a curing reaction; and a method using a microcapsule.

[0088]

As specific examples of the curing agent of the thermally activated latent epoxy resin, high melting point active hydrogen compounds such as various onium salts, dibasic acid dihydrazide compounds, dicyandiamides, amine adduct curing agents, and imidazole compounds can be exemplified. As the curing agent of the thermally activated latent epoxy resin, one type can be used alone or two or more types can be used in a combination. The curing agent of the thermally activated latent epoxy resin described above is used at a proportion that is preferably 0.1 to 20 parts by weight, more preferably 0.2 to 10 parts by weight, and most preferably 0.3 to 5 parts by weight with respect to 100 parts by weight of the epoxy resin.

[0089]

As the phenolic resin, condensates of phenols such as alkyl phenols, polyhydric phenols and naphthol, and aldehydes are used without specific limitations. Specifically, phenol novolac resins, o-cresol novolac resins, p-cresol novolac resins, t-butyl phenol novolac resins, dicyclopentadiene cresol resins, polyparabinylnol phenolic resins, bisphenol type A novolac resins, or modified products thereof are used.

[0090]

A phenolic hydroxyl group included in these phenolic resins easily undergoes an addition reaction with an epoxy group of the above epoxy resin due to heating to form a high impact resistance cured product. Therefore, an epoxy resin and a phenolic resin may be used in a combination.

[0091]

A content of the thermosetting component (D) in the film for forming a protective coating is preferably 1 to 85 mass%, more preferably 2 to 75 mass%, and most preferably 5 to 70 mass% with respect to the mass of the film for forming a protective

coating. When the content of the thermosetting component (D) is within the above range, it is possible to effectively increase an adhesive strength of the film for forming a protective coating with respect to a workpiece due to thermosetting or a strength of a cured protective coating without interfering with ultraviolet curability.

5 [0092]

(5) Other components

The film for forming a protective coating according to the present embodiment may include a photopolymerization initiator. When the photopolymerization initiator is included, it is possible to decrease a curing time of the ultraviolet-curable component (A) and a light irradiation amount. The photopolymerization initiator is included preferably
10 at 0.1 to 15 mass% with respect to a mass of the ultraviolet-curable component (A).

[0093]

As the photopolymerization initiator, specifically, benzophenone, acetophenone, benzoin, benzoin methyl ether, benzoin ethyl ether, benzoin isopropyl ether, benzoin
15 isobutyl ether, benzoin benzoic acid, methyl benzoin benzoate, benzoin dimethyl ketal, 2,4-diethylthioxanthone, 1-hydroxycyclohexyl phenyl ketone, benzyl diphenyl sulfide, tetramethyl thiuram monosulfide, azobisisobutyronitrile, benzyl, dibenzyl, diacetyl, β -chloro anthraquinone, (2,4,6-trimethylbenzyl)diphenyl)phosphine oxide, 2-benzothiazole-N,N-diethyl dithiocarbamate,
20 oligo{2-hydroxy-2-methyl-1-[4-(1-propenyl)phenyl]propanone}, and 2,2-dimethoxy-1,2-diphenylethan-1-one may be exemplified. Among these, one type may be used alone or two or more types may be used in a combination.

[0094]

In addition, the film for forming a protective coating according to the present
25 embodiment may include a chain transfer agent. When the chain transfer agent is

included, an effect that ultraviolet curing becomes easier in the film for forming a protective coating in the thickness direction is expected. As the chain transfer agent, for example, a chain transfer agent described in Japanese Unexamined Patent Application, First Publication No. 2012-207179 can be used.

5 [0095]

In addition, the film for forming a protective coating according to the present embodiment may include a coupling agent. When the coupling agent is included, after the film for forming a protective coating is cured, it is possible to increase tackiness or adhesion between the protective coating and the workpiece and increase water resistance
 10 (moisture and heat resistance) without impairing heat resistance of the protective coating. As the coupling agent, a silane coupling agent is preferable in consideration of general versatility thereof and cost benefit.

[0096]

As the silane coupling agent, for example, γ -glycidoxypropyltrimethoxysilane,
 15 γ -glycidoxypropylmethyldiethoxysilane, β -(3,4-epoxy cyclohexyl)ethyltrimethoxysilane, γ -(methacryloxypropyl)trimethoxysilane, γ -aminopropyltrimethoxysilane, N-6-(aminoethyl)- γ -aminopropyltrimethoxysilane, N-6-(aminoethyl)- γ -aminopropylmethyldiethoxysilane, N-phenyl- γ -aminopropyltrimethoxysilane, γ -ureidopropyltriethoxysilane,
 20 γ -mercaptopropyltrimethoxysilane, γ -mercaptopropylmethyldimethoxysilane, bis(3-triethoxysilylpropyl)tetrasulfane, methyltrimethoxysilane, methyltriethoxysilane, vinyltrimethoxysilane, vinyl triacetoxysilane, and imidazole silane may be exemplified. Among these, one type can be used alone or two or more types can be used in a mixture.

[0097]

The film for forming a protective coating according to the present embodiment may include a crosslinking agent such as an organic multivalent isocyanate compound, an organic multivalent imine compound, and an organic metal chelate compound in order to adjust a cohesive force before curing. In addition, the film for forming a protective coating may include an antistatic agent for preventing static electricity and improving reliability of a chip. Further, the film for forming a protective coating may include a flame retardant such as a phosphate compound, a bromine compound, and a phosphorus compound in order to increase flame retardance of the protective coating and improve reliability of a package.

[0098]

3. Thickness

In order to effectively exhibit a function as a protective coating, the thickness of the film for forming a protective coating is preferably 3 to 300 μm , more preferably 5 to 200 μm , and most preferably 7 to 100 μm . Here, the thickness of the film for forming a protective coating is an average value of thicknesses that are measured at any five positions of the film for forming a protective coating using a contact type thickness meter. Also, when the thickness of the film for forming a protective coating is measured, if it is difficult to directly apply the contact type thickness meter while it is overlapped by another film such as a substrate film or a release material to be described below, the total thickness is measured in the same manner as above and a difference from a thickness (measured in the same manner as above) of the other overlapping film may be obtained for calculation.

[0099]

(Sheet for forming a protective coating)

Fig. 1 is a cross-sectional view of a sheet for forming a protective coating according to an embodiment of the present invention. As shown in Fig. 1, a sheet for forming a protective coating 2 according to the present embodiment includes a film for forming a protective coating 1 and a release sheet 21 that is laminated on one surface (the lower surface in Fig. 1) of the film for forming a protective coating 1. However, the release sheet 21 is released when the sheet for forming a protective coating 2 is used.

[0100]

The release sheet 21 protects the film for forming a protective coating 1 before the sheet for forming a protective coating 2 is used and is not necessarily required. A configuration of the release sheet 21 is arbitrary. A plastic film in which the film itself has detachability with respect to the film for forming a protective coating 1 and a sheet obtained by releasing a plastic film using a release agent may be exemplified. As a specific example of the plastic film, polyester films such as those of polyethylene terephthalate, polybutylene terephthalate, and polyethylene naphthalate and polyolefin films such as those of polypropylene and polyethylene may be exemplified. As the release agent, silicone-based, fluorine-based, long chain alkyl group-based agents can be used. Among these, a silicone-based is preferable because it is inexpensive and exhibits reliable performance. The thickness of the release sheet 21 is not particularly limited, and is generally about 20 to 250 μm .

[0101]

The above release sheet 21 may be laminated on the other surface (the upper surface in Fig. 1) of the film for forming a protective coating 1. That is, the film for forming a protective coating 1 may be interposed between a first release sheet 21 and a second release sheet 21. In this case, preferably, a release force of one release sheet 21

is increased to form a tight release type release sheet and a release force of the other release sheet 21 is decreased to form an easy release type release sheet.

[0102]

When the sheet for forming a protective coating 2 according to the present
5 embodiment is manufactured, the film for forming a protective coating 1 is formed on a release surface of the release sheet 21 (a surface having detachability; generally a surface subjected to a release treatment, but the surface is not limited thereto). Specifically, a curable adhesive agent of the film for forming a protective coating 1 and additionally, a coating agent for the film for forming a protective coating including a solvent if
10 necessary are prepared and applied to a release surface of the release sheet 21 using a coating machine such as a roll coater, a knife coater, a roll knife coater, an air knife coater, a die coater, a bar coater, a gravure coater, and a curtain coater and dried to form the film for forming a protective coating 1.

[0103]

15 Using the sheet for forming a protective coating 2 according to the present embodiment, as an example, a method of manufacturing a chip having a protective coating from a semiconductor wafer as a workpiece will be described below. At first, on a rear surface of a semiconductor wafer that has a surface in which a circuit is formed and on which back grind processing is performed, the film for forming a protective
20 coating 1 of the sheet for forming a protective coating 2 is attached. In this case, if necessary, the film for forming a protective coating 1 may be heated to exhibit tackiness.

[0104]

Next, the release sheet 21 is released from the film for forming a protective coating 1. Then, ultraviolet rays are irradiated to the film for forming a protective
25 coating 1, the film for forming a protective coating 1 is cured to form a protective coating,

and a semiconductor wafer having a protective coating is obtained. Before or after ultraviolet irradiation, the film for forming a protective coating 1 may be heated if necessary. Also, the film for forming a protective coating 1 may be cured after a dicing process.

5 [0105]

Since ultraviolet curability is excellent when the light transmittance at a wavelength of 375 nm is 8% or more, the film for forming a protective coating 1 according to the present embodiment is sufficiently entirely cured by the above ultraviolet irradiation. An amount of ultraviolet rays irradiated to the film for forming a
10 protective coating 1 is preferably a light intensity of 50 to 1,000 mJ/cm² and more preferably 100 to 500 mJ/cm².

[0106]

When the semiconductor wafer having a protective coating is obtained as described above, laser beams are emitted to the protective coating if necessary to perform
15 laser printing. Also, this laser printing may be performed before the film for forming a protective coating 1 is cured.

[0107]

Next, a desired dicing sheet is used, the semiconductor wafer having a protective coating is diced according to a general method, and a chip including a protective coating
20 (a chip having a protective coating) is obtained. Then, if necessary, the dicing sheet expands in a planar direction, and the chip having a protective coating is picked up from the dicing sheet.

[0108]

Since the light transmittance at a wavelength of 550 nm of the film for forming a
25 protective coating 1 (a protective coating) is 12% or less, the chip having a protective

coating obtained as described above has an excellent appearance because a grinding mark due to back grind processing is concealed by the protective coating and is not visually observable.

[0109]

5 In addition, when the light transmittance at a wavelength of 1,600 nm of the film for forming a protective coating 1 is 25% or more, an infrared light transmittance is favorable in the film for forming a protective coating 1 (a protective coating). An infrared inspection can be performed on the above chip having a protective coating and semiconductor wafer having a protective coating through the protective coating.

10 Accordingly, cracks and the like can be found through the infrared inspection and it is possible to improve a product yield.

[0110]

 Also, the infrared inspection is an inspection that is performed using infrared rays and can be performed by acquiring infrared rays from a workpiece having a
15 protective coating such as a semiconductor wafer having a protective coating or an artifact such as a chip having a protective coating through the protective coating. A wavelength of the acquired infrared rays is generally 800 to 2,800 nm, and preferably 1,100 to 2,100 nm. As an infrared inspection device, known devices including, for example, an infrared camera or an infrared microscope can be used.

20 [0111]

(Composite sheet for forming a protective coating)

 Fig. 2 is a cross-sectional view of a composite sheet for forming a protective coating according to an embodiment of the present invention. As shown in Fig. 2, a composite sheet for forming a protective coating 3 according to the present embodiment
25 includes a support sheet 4 in which an adhesive layer 42 is laminated on one surface of a

substrate 41, the film for forming a protective coating 1 laminated on the adhesive layer 42 side of the support sheet 4 and an adhesive layer for jig 5 that is laminated on a peripheral portion on a side opposite to the support sheet 4 in the film for forming a protective coating 1. In other words, the composite sheet for forming a protective coating 3 includes the substrate 41, the adhesive layer 42 on the substrate 41, the film for forming a protective coating 1 on the adhesive layer 42, and the adhesive layer for jig 5 on the film for forming a protective coating 1. The adhesive layer for jig 5 is positioned on a peripheral portion of the film for forming a protective coating 1 when viewed in a normal direction of a surface of the film for forming a protective coating 1. The adhesive layer for jig 5 is a layer for adhering the composite sheet for forming a protective coating 3 to a jig such as a ring frame.

[0112]

When a workpiece is processed, the composite sheet for forming a protective coating 3 according to the present embodiment is attached to the workpiece, supports the workpiece, and is used to form a protective coating on the workpiece or an artifact obtained by processing the workpiece. This protective coating is made of the film for forming a protective coating 1, and preferably a cured film for forming a protective coating 1.

[0113]

As an example, the composite sheet for forming a protective coating 3 according to the present embodiment is used to support a semiconductor wafer when the semiconductor wafer serving as a workpiece is diced and to form a protective coating on a semiconductor chip obtained by dicing. However, the present invention is not limited thereto. The support sheet 4 of the composite sheet for forming a protective coating 3 in this case is generally referred to as a dicing sheet.

[0114]

1. Support sheet

The support sheet 4 of the composite sheet for forming a protective coating 3 according to the present embodiment may include the substrate 41 and the adhesive layer 42 that is laminated on one surface of the substrate 41. However, the support sheet 4 preferably includes only the substrate 41. In this case, when the film for forming a protective coating 1 of the present embodiment is cured by ultraviolet irradiation, in an exemplary method of applying a composite sheet for forming a protective coating to be described below, there is an advantage that a chip having a protective coating can be easily picked up from the support sheet 4. Also, when the support sheet 4 includes only the substrate 41, a primer layer, an antistatic layer, a heat resistant layer, a stress relaxation layer and the like may be provided on the substrate 41.

[0115]

1-1. Substrate

The substrate 41 of the support sheet 4 has a constituent material that is not particularly limited as long as the material is suitable for processing of a workpiece, for example, dicing and expanding a semiconductor wafer, and generally, is made of a film including a resin material as a main material (hereinafter referred to as a “resin film”).

[0116]

As specific examples of the resin film, polyethylene films such as a low density polyethylene (LDPE) film, a linear low density polyethylene (LLDPE) film, and a high density polyethylene (HDPE) film, and polyolefin films such as a polypropylene film, a polybutene film, a polybutadiene film, a polymethylpentene film, an ethylene-norbornene copolymer film, and a norbornene resin film; ethylene-based copolymer films such as an ethylene-vinyl acetate copolymer film, an ethylene-(meth)acrylic acid copolymer film,

and an ethylene-(meth)acrylic acid ester copolymer film; polyvinyl chloride-based films such as a polyvinyl chloride film and a vinyl chloride copolymer film; polyester-based films such as a polyethylene terephthalate film and a polybutylene terephthalate film; a polyurethane film; a polyimide film; a polystyrene film; a polycarbonate film; and a
5 fluorine resin film may be exemplified. In addition, modified films such as crosslinked films thereof and ionomer films are used. The above substrate 41 may be a film made of one type thereof or may be a laminate film made of a combination of two or more types thereof. Note that “(meth)acrylic acid” herein refers to both acrylic acid and methacrylic acid. This applies similarly to other similar terms. Among these, a
10 polyolefin film is preferable in consideration of environmental safety, costs, and the like.
[0117]

In order to improve adhesion with the adhesive layer 42 that is laminated on a surface of the above resin film, a surface treatment or a primer treatment can be performed on one surface or both surfaces of the above resin film if necessary using an
15 oxidation method or a roughening method. As the oxidation method, for example, a corona discharge treatment, a plasma discharge treatment, a chromium oxidation treatment (a wet type), a flame treatment, a hot air treatment, ozone, and an ultraviolet irradiation treatment may be exemplified. In addition, as the roughening method, for example, a sand blasting method and a thermal spraying method may be exemplified.
20 [0118]

The substrate 41 may include various additives such as a coloring agent, a flame retardant, a plasticizer, an antistatic agent, a lubricant, and a filler in the above resin film.
[0119]

A thickness of the substrate 41 is not particularly limited as long as the substrate
25 41 can appropriately function in processes in which the composite sheet for forming a

protective coating 3 is used. The thickness is preferably in the range of 20 to 450 μm , more preferably 25 to 400 μm , and most preferably 50 to 350 μm . Here, the thickness of the substrate 41 is an average value of thicknesses that are measured at any five positions of the substrate 41 using a contact type thickness meter.

5 [0120]

A fracture elongation of the substrate 41 of the support sheet 4 in the present embodiment is preferably 100% or more and more preferably 200 to 1,000% as a value measured at 23 °C and a relative humidity of 50%. Here, the fracture elongation is an elongation percentage of a length of a test piece at the time of breaking with respect to
10 the original length in a tensile test according to JIS K7161:1994 (ISO 527-1 1993). The substrate 41 having a fracture elongation of 100% or more is not easily broken during an expanding process and easily separates a chip formed by cutting a workpiece.

[0121]

In addition, a tensile stress at 25% strain of the substrate 41 of the support sheet
15 4 in the present embodiment is preferably 5 to 15 N/10 mm, and the maximum tensile stress is preferably 15 to 50 MPa. Here, the tensile stress at 25% strain and the maximum tensile stress are measured by tests according to JIS K7161:1994. If the tensile stress at 25% strain is 5 N/10 mm or more and the maximum tensile stress is 15 MPa or more, when a workpiece is stuck to a dicing sheet 1 and then is fixed to a frame
20 such as a ring frame, it is possible to prevent the occurrence of looseness in a substrate 2 and the occurrence of a transport error. On the other hand, when the tensile stress at 25% strain is 15 N/10 mm or less and the maximum tensile stress is 50 MPa or less, the dicing sheet 1 itself is prevented from being peeled off from a ring frame during the expanding process. Note that the above fracture elongation, tensile stress at 25% strain,

and maximum tensile stress indicate values that are measured in a longitudinal direction of a raw material in the substrate 41.

[0122]

1-2. Adhesive layer

5 The adhesive layer 42 included in the support sheet 4 of the composite sheet for forming a protective coating 3 according to the present embodiment preferably includes an ultraviolet-non-curable type adhesive agent (an ultraviolet-non-curable adhesive agent) or an adhesive agent obtained by pre-curing an ultraviolet-curable type adhesive agent. If an adhesive agent type that is not pre-cured but is cured by ultraviolet rays (an
10 ultraviolet-curable adhesive agent) is used, when the film for forming a protective coating 1 is cured, if ultraviolet rays are irradiated to the composite sheet for forming a protective coating 3, there is a concern of an ultraviolet-curable group that is generally included in one or more components of the adhesive layer 42 reacting with an ultraviolet-curable group included in the ultraviolet-curable component (A) of the film
15 for forming a protective coating 1 and it is difficult to separate the groups between the adhesive layer 42 and the film for forming a protective coating 1.

[0123]

As the ultraviolet-non-curable adhesive agent, an agent having a desired adhesive force and re-detachability is preferable. For example, an acrylic adhesive
20 agent, a rubber-based adhesive agent, a silicone-based adhesive agent, a urethane-based adhesive agent, a polyester-based adhesive agent, and a polyvinyl ether-based adhesive agent can be used. Among these, an acrylic adhesive agent that has high adhesion with the film for forming a protective coating 1 and can effectively prevent detachment of a workpiece or an artifact during a dicing process or the like is preferable. In addition,
25 when the adhesive agent obtained by pre-curing an ultraviolet-curable type adhesive

agent is used, an uncured adhesive layer 42 is formed using a known ultraviolet-curable type adhesive agent and the adhesive agent may be cured by irradiating ultraviolet rays during manufacture thereof.

[0124]

5 A thickness of the adhesive layer 42 is not particularly limited as long as the adhesive layer 42 can appropriately function in processes in which the composite sheet for forming a protective coating 3 is used. Specifically, 1 to 50 μm is preferable, 2 to 30 μm is more preferable, and 3 to 20 μm is most preferable. Here, the thickness of the adhesive layer 42 is an average value of thicknesses that are measured at any five
10 positions of the adhesive layer 42 using a contact type thickness meter. Also, when the thickness of the adhesive layer 42 is measured, if it is difficult to directly apply a contact type thickness meter while it is overlapped by another film such as a substrate film or a release material to be described below, the total thickness is measured in the same manner as above and a difference from a thickness (measured in the same manner as
15 above) of the other overlapping film may be obtained for calculation.

[0125]

As an adhesive agent of the adhesive layer for jig 5, an agent having a desired adhesive force and re-detachability is preferable. For example, an acrylic adhesive agent, a rubber-based adhesive agent, a silicone-based adhesive agent, a urethane-based
20 adhesive agent, a polyester-based adhesive agent, and a polyvinyl ether-based adhesive agent can be used. Among these, an acrylic adhesive agent that has high adhesion with a jig such as a ring frame and can effectively prevent the composite sheet for forming a protective coating 3 from being peeled off from a ring frame and the like during a dicing process and the like is preferable. Also, a substrate as a core material may be interposed
25 in a thickness direction of the adhesive layer for jig 5 along the way.

[0126]

On the other hand, in consideration of tackiness to a jig such as a ring frame, a thickness of the adhesive layer for jig 5 is preferably 5 to 200 μm and more preferably 10 to 100 μm .

5 [0127]

As will be described below in a method of manufacturing a chip having a protective coating using the composite sheet for forming a protective coating 3, after the composite sheet for forming a protective coating 3 is attached to a semiconductor wafer, ultraviolet rays may be irradiated to the film for forming a protective coating 1 through
10 the support sheet 4. Therefore, in such a case, an ultraviolet transmittance of the support sheet 4 is preferably high so that curing of the film for forming a protective coating 1 easily proceeds.

[0128]

2. Method of producing a composite sheet for forming a protective coating

15 Preferably, the composite sheet for forming a protective coating 3 can be manufactured when a first laminate including the film for forming a protective coating 1 and a second laminate including the support sheet 4 are separately prepared, and then the first laminate and the second laminate are used to laminate the film for forming a protective coating 1 and the support sheet 4, but the present invention is not limited
20 thereto.

[0129]

When the first laminate is manufactured, the film for forming a protective coating 1 is formed on a release surface of a first release sheet. Specifically, a curable adhesive agent of the film for forming a protective coating 1 and additionally, a coating
25 agent for a film for forming a protective coating including a solvent if necessary are

prepared and applied to the release surface of the first release sheet using a coating machine such as a roll coater, a knife coater, a roll knife coater, an air knife coater, a die coater, a bar coater, a gravure coater, and a curtain coater and dried to form the film for forming a protective coating 1. Next, a release surface of the second release sheet is
5 repeatedly pressed against an exposed surface of the film for forming a protective coating 1 to obtain a laminate (a first laminate) in which the film for forming a protective coating 1 is interposed between two release sheets.

[0130]

In the first laminate, if necessary, a half cut may be performed and the film for
10 forming a protective coating 1 (and the second release sheet) may have a desired shape, for example, a circular shape. In this case, extra portions of the film for forming a protective coating 1 and the second release sheet, which are generated due to the half cut, may be appropriately removed.

[0131]

15 On the other hand, when the second laminate is manufactured, an adhesive agent of the adhesive layer 42 and, if necessary, a coating agent for an adhesive layer including a solvent are applied to a release surface of a third release sheet and dried to form the adhesive layer 42. Then, the substrate 41 is pressed against an exposed surface of the adhesive layer 42 to obtain a laminate (the second laminate) that includes the support
20 sheet 4 containing the substrate 41 and the adhesive layer 42, and the third release sheet. When the adhesive agent obtained by pre-curing an ultraviolet-curable type adhesive agent is used, preferably, the adhesive agent is cured by irradiating ultraviolet rays in a stage after the second laminate is obtained.

[0132]

When the first laminate and the second laminate are obtained as described above, the second release sheet in the first laminate is released, the third release sheet in the second laminate is released, and the film for forming a protective coating 1 exposed to the first laminate and the adhesive layer 42 of the support sheet 4 exposed to the second laminate are pressed in an overlapping manner. The support sheet 4 may be cut in half if necessary, and have a desired shape, for example, a circular shape with a diameter greater than that of the film for forming a protective coating 1. In this case, extra portions of the support sheet 4 generated due to the half cut may be appropriately removed. In this case, a sheet for forming a protective coating 3 in the form shown in Fig. 3 is obtained.

[0133]

In this manner, the composite sheet for forming a protective coating 3 including the support sheet 4 in which the adhesive layer 42 is laminated on the substrate 41, the film for forming a protective coating 1 that is laminated on the adhesive layer 42 side of the support sheet 4, and the first release sheet that is laminated on a side opposite to the support sheet 4 in the film for forming a protective coating 1 is obtained. Finally, after the first release sheet is released, in a peripheral portion on a side opposite to the support sheet 4 in the film for forming a protective coating 1, the adhesive layer for jig 5 is formed. The adhesive layer for jig 5 can also be formed by application using the same method as in the above adhesive layer 42.

[0134]

3. Method of using a composite sheet for forming a protective coating

An exemplary method of manufacturing a chip having a protective coating from a semiconductor wafer serving as a workpiece using the composite sheet for forming a protective coating 3 according to the present embodiment will be described below.

[0135]

As shown in Fig. 4, the film for forming a protective coating 1 is attached to a semiconductor wafer 6 and the adhesive layer for jig 5 is attached to a ring frame 7.

When the film for forming a protective coating 1 is attached to the semiconductor wafer 6, the film for forming a protective coating 1 may be heated to exhibit tackiness if necessary.

[0136]

Then, ultraviolet rays are irradiated to the film for forming a protective coating 1 through the support sheet 4 and the film for forming a protective coating 1 is cured to form a protective coating to obtain a semiconductor wafer having a protective coating 6. Before or after ultraviolet irradiation, the film for forming a protective coating 1 may be heated if necessary. Also, the film for forming a protective coating 1 may be cured after a dicing process or after a chip having a film for forming a protective coating is picked up from the support sheet 4.

15 [0137]

Since ultraviolet curability is excellent when the light transmittance at a wavelength of 375 nm is 8% or more, the film for forming a protective coating 1 according to the present embodiment is sufficiently entirely cured by the above ultraviolet irradiation. An amount of ultraviolet rays irradiated to the film for forming a protective coating 1 is preferably a light intensity of 50 to 1,000 mJ/cm² and more preferably 100 to 500 mJ/cm².

[0138]

When the semiconductor wafer having a protective coating 6 is obtained as described above, laser beams are emitted to the protective coating through the support

sheet 4 if necessary to perform laser printing. Also, this laser printing may be performed before the film for forming a protective coating 1 is cured.

[0139]

Next, the semiconductor wafer having a protective coating 6 is diced according to a general method, and a chip including a protective coating (a chip having a protective coating) is obtained. Then, if necessary, the support sheet 4 expands in a planar direction and the chip having a protective coating is picked up from the support sheet 4.

[0140]

When the light transmittance at a wavelength of 550 nm of the film for forming a protective coating 1 (a protective coating) is 12% or less, the chip having a protective coating obtained as described above has an excellent appearance because a grinding mark due to back grind processing is concealed by the protective coating and is not visually observable.

[0141]

In addition, when the light transmittance at a wavelength of 1,600 nm of the film for forming a protective coating 1 is 25% or more, an infrared light transmittance is favorable in the film for forming a protective coating 1 (a protective coating). An infrared inspection can be performed on the above chip having a protective coating and semiconductor wafer having a protective coating through the protective coating. Accordingly, cracks and the like can be found through the infrared inspection and it is possible to improve a product yield.

[0142]

4. Other embodiments of a composite sheet for forming a protective coating

Fig. 3 is a cross-sectional view of a composite sheet for forming a protective coating according to another embodiment of the present invention. As shown in Fig. 3,

a composite sheet for forming a protective coating 3A according to the present embodiment includes the support sheet 4 in which the adhesive layer 42 is laminated on one surface of the substrate 41 and the film for forming a protective coating 1 that is laminated on the adhesive layer 42 side of the support sheet 4. The film for forming a protective coating 1 in an embodiment is formed to be substantially the same as a workpiece in a plane direction or slightly larger than the workpiece and is formed to be smaller than the support sheet 4 in a plane direction. The adhesive layer 42 in a portion in which the film for forming a protective coating 1 is not laminated can be attached to a jig such as a ring frame.

10 [0143]

Materials and thicknesses of members of the composite sheet for forming a protective coating 3A according to the present embodiment are the same as materials and thicknesses of members of the composite sheet for forming a protective coating 3 described above.

15 [0144]

Also, in a peripheral portion on a side opposite to the substrate 41 in the adhesive layer 42 of the support sheet 4 of the composite sheet for forming a protective coating 3A, the same adhesive layer for jig as the adhesive layer for jig 5 of the composite sheet for forming a protective coating 3 described above may be separately provided. In other words, the composite sheet for forming a protective coating 3A may include the substrate 41, the adhesive layer 42 on the substrate 41, the film for forming a protective coating 1 on the adhesive layer 42, and the adhesive layer for jig 5 that is positioned above the adhesive layer 42 and on a peripheral portion of the film for forming a protective coating 1. In this case, the support sheet 4 may include only the substrate 41. That is, the composite sheet for forming a protective coating 3A may

20

25

include the substrate 41, the film for forming a protective coating 1 on the substrate 41, and the adhesive layer for jig 5 that is positioned above the substrate 41 and on a peripheral portion of the film for forming a protective coating 1.

[0145]

5 In addition, in the configuration of Fig. 3, when the adhesive agent obtained by pre-curing an ultraviolet-curable type adhesive agent is used for the adhesive layer 42, only an inner circumferential portion in a plan view of the adhesive layer 42 may be cured in advance. Therefore, high tackiness is maintained in an outer circumferential portion attached to a jig such as a ring frame and the support sheet 4 is easily fixed to the
10 jig.

[0146]

 Further, in Fig. 3, a release force adjusting layer may be provided between the adhesive layer 42 and the film for forming a protective coating 1. In other words, the composite sheet for forming a protective coating 3A may include the substrate 41, the
15 adhesive layer 42 on the substrate 41, the release force adjusting layer on the adhesive layer 42, and the film for forming a protective coating 1 on the release force adjusting layer. Accordingly, the release force adjusting layer and the film for forming a protective coating 1 can be easily released. In addition, strong tackiness is imparted to the adhesive layer 42 for which there is no need to consider an influence on a process of
20 picking up a chip having a protective coating (a film for forming a protective coating) and the support sheet 4 can be easily fixed to the jig. The release force adjusting layer can be formed of, for example, an adhesive agent having a weaker adhesive force than an adhesive agent used for the adhesive layer 42 or can be formed of a resin film (including films subjected to a release treatment).

25 [0147]

The above-described embodiment is described in order to facilitate understanding of the present invention and the present invention is not limited to the above description. Therefore, elements disclosed in the above embodiment include all design modifications and equivalents within the spirit and scope of the present invention.

5 [0148]

For example, a release sheet may be laminated on a side opposite to the support sheet 4 in the film for forming a protective coating 1 of the composite sheet for forming a protective coating 3 or 3A.

[Examples]

10 [0149]

Several aspects of the present invention will be described below in further detail with reference to examples and the like, but the scope of the present invention is not limited to the following examples and the like.

[0150]

15 (Example 1)

The following components were mixed according to blending ratios (mass ratios; in terms of a solid content) shown in Table 1 and were diluted with methyl ethyl ketone so that a concentration of the solid content was 54 mass% to prepare a coating agent for a film for forming a protective coating.

20 (a) An ultraviolet-curable component: an acrylic polymer (weight average molecular weight: 400,000, glass transition temperature: -10°C) that was obtained by reacting an amount of methacryloyloxyethyl isocyanate corresponding to 80 mol with respect to 100 mol of a hydroxyl group derived from 2-hydroxyethyl acrylate of an acrylic polymer obtained by copolymerizing 80 parts by mass of 2-ethylhexyl acrylate

and 20 parts by mass of 2-hydroxyethyl acrylate and had a side chain into which an ultraviolet-curable group was introduced.

(b1) A red coloring agent: a diketopyrrolopyrrole type red dye (Pigment Red264 commercially available from Sanyo Color Works, Ltd.)

5 (b2) A black coloring agent: carbon black (#MA600B commercially available from Mitsubishi Chemical Corporation, average particle size 28 nm)

(c) A filler: silica filler (SC2050MA commercially available from Admatechs, average particle size 0.5 μm)

(d) A thermosetting component: bisphenol type A epoxy resin (JER828
10 commercially available from Mitsubishi Chemical Corporation, epoxy equivalent weight 183 to 194 g/eq)

(e) A photopolymerization initiator: 1-hydroxy-cyclohexyl-phenyl-ketone (IRGACURE 184 commercially available from BASF)
[0151]

15 A first release sheet (SP-PET3811 commercially available from Lintec Corporation, thickness 38 μm) obtained by forming a silicone-based release agent layer on one surface of a polyethylene terephthalate (PET) film and a second release sheet (SP-PET381031 commercially available from Lintec Corporation, thickness 38 μm) obtained by forming a silicone-based release agent layer on one surface of a PET film
20 were prepared.

[0152]

The above-described coating agent for a film for forming a protective coating was applied onto a release surface of the first release sheet using a knife coater and was then dried in an oven at 120 °C for 2 minutes to form a film for forming a protective
25 coating. A thickness of the obtained film for forming a protective coating was 25 μm .

Next, a release surface of the second release sheet was superimposed on the film for forming a protective coating and the two were laminated together to obtain a sheet for forming a protective coating including the first release sheet (the release sheet 21 in Fig. 1), the film for forming a protective coating (the film for forming a protective coating 1 in Fig. 1) (thickness: 25 μm), and the second release sheet.

[0153]

(Examples 2 to 3 and Comparative Examples 1 to 2)

Sheets for forming a protective coating were prepared in the same manner as in Example 1 except that types and blending amounts of components of a film for forming a protective coating were changed as shown in Table 1.

Also, a value W/T calculated by dividing a content W (mass%) of a coloring agent in the examples by a thickness T (μm) of a film for forming a protective coating is shown in Table 1.

[0154]

(Test Example 1) <Measurement of light transmittance>

The second release sheets were released from the sheets for forming a protective coating obtained in the examples and comparative examples, and were laminated on glass plates under conditions of 70 °C and 1.2 m/min using a roller type laminator. Then, the first release sheets were released and used as measurement samples.

[0155]

Light transmittances of the measurement samples were measured using a spectrophotometer (UV-VIS-NIR SPECTROPHOTOMETER UV-3600 commercially available from SHIMADZU), and light transmittances (%) at a wavelength of 375 nm (ultraviolet light), 550 nm (visible light) and 1,600 nm (infrared light) were extracted.

A built-in integrating sphere was used for measurement. The results are shown in Table

1. In addition, the measurement results of the light transmittance are shown as graphs in Fig. 5. As shown in Table 1 and Fig. 5, in Comparative Example 1, an infrared light transmittance was high, but a visible light transmittance was high at 45.8%. In Comparative Example 2, a light transmittance at any wavelength was almost 0%. On the other hand, in Examples 1 to 3, the light transmittance at a wavelength of 375 nm was 8% or more, the light transmittance at a wavelength of 550 nm was 12% or less, and the light transmittance at a wavelength of 1,600 nm was 25% or more.

[0156]

(Test Example 2) <Evaluation of grinding mark concealment>

10 The second release sheets were released from the sheets for forming a protective coating obtained in the examples and comparative examples, and the films for forming a protective coating were exposed. The films for forming a protective coating were attached to polished surfaces of polished silicon wafers (# 2000) (with a diameter of 200 mm and a thickness of 350 μm) using a tape mounter (ADWILL RAD-3600 F/12 commercially available from Lintec Corporation) while heating at 70 °C.

[0157]

Next, an ultraviolet irradiation system (ADWILL RAD-2000 commercially available from Lintec Corporation) was used to irradiate ultraviolet rays to the films for forming a protective coating (irradiation three times under irradiation conditions: a luminance of 215 mW/cm^2 and a light intensity of 187 mJ/cm^2 without nitrogen purge), and the films for forming a protective coating were cured to form protective coatings. Then, the first release sheets were released to obtain silicon wafers having the protective coating.

[0158]

In the obtained silicon wafers having the protective coating, it was visually observed whether a grinding mark in the polished surface of the silicon wafer was visible through the protective coating. As a result, when a grinding mark was invisible, it was evaluated as favorable and when a grinding mark was visible, it was evaluated as defective. The results are shown in Table 1.

[0159]

(Test Example 3) <Measurement of probe tack>

An ultraviolet irradiation system (ADWILL RAD-2000 commercially available from Lintec Corporation) was used to irradiate ultraviolet rays to the sheets for forming a protective coating (irradiation three times under irradiation conditions: a luminance of 215 mW/cm² and a light intensity of 187 mJ/cm² without nitrogen purge) from the first release sheet side of the sheets for forming a protective coating obtained in the examples and comparative examples and the films for forming a protective coating were cured to form protective coatings.

[0160]

Next, a laminate including the above protective coating was cut into a square with four sides of 1 cm and the second release sheet was released. Under conditions of 70 °C and 1.2 m/min, a polyethylene terephthalate film (a thickness of 25 μm) serving as a substrate was bonded to the exposed protective coatings using a roller type laminator at a normal temperature. Then, the first release sheet on the ultraviolet irradiation surface side was released and used as a first sample (for ultraviolet irradiation surface measurement).

[0161]

Similarly, a laminate including the above protective coating was cut into a square with four sides of 1 cm and the first release sheet was released. Under

conditions of 70 °C and 1.2 m/min, a polyethylene terephthalate film (a thickness of 25 µm) serving as a substrate was bonded to the exposed protective coatings using a roller type laminator at a normal temperature. Then, the second release sheet on the ultraviolet irradiation opposite surface side was released and used as a second sample (for ultraviolet irradiation opposite surface measurement).

[0162]

A tacking tester (RHESCA PROBE TACK TESTER model RPT100 commercially available from Rhesca Co., Ltd.) was used, and a probe tack value (a peak value P1 and an energy value E1) of the exposed surface (the ultraviolet irradiation surface) of the protective coating in the above first sample and a probe tack value (a peak value P2 and an energy value E2) of the exposed surface (the ultraviolet irradiation opposite surface) of the protective coating in the above second sample were measured. The measurement conditions were as follows. In addition, based on the measurement results, a ratio P2/P1 of the peak value P2 to the peak value P1 and a ratio E2/E1 of the energy value E2 to the energy value E1 were calculated. The results are shown in Table 1.

<Measurement conditions of probe tack value>

- Speed: 600 mm/sec
- Pressing load: 0.98 N
- Pressing time: 1 second

[0163]

[Table 1]

		EXAMPLE 1	EXAMPLE 2	COMPARATIVE EXAMPLE 1	COMPARATIVE EXAMPLE 2	EXAMPLE 3
BLENDING RATIO (PARTS BY MASS)	a	145.5	145.5	145.5	145.5	145.5
	b1	11	19	0	0	27
	b2	0	0	0.7	7.4	0
	c	150	150	150	150	150
	d	60	60	60	60	60
	e	4.5	4.5	4.5	4.5	4.5
	SUM	371.0	379.0	360.7	367.4	387.0
	FILLER CONTENT (MASS%)	40.4	39.6	41.6	40.8	38.8
	CARBON BLACK CONTENT (MASS%)	0	0	0.19	2.0	0
	RED COLORING AGENT CONTENT (MASS%)	3.0	5.0	0	0	7.0
	W/T	0.12	0.20	0.0076	0.08	0.28
LIGHT TRANSMITTANCE (%)	ULTRAVIOLET LIGHT(375nm)	23.5	15.6	36.4	0.15	10.4
	VISIBLE LIGHT(550nm)	10.7	4.7	45.8	0.34	4.0
	INFRARED LIGHT(1600nm)	96.3	95.0	74.1	5.20	93.8
EVALUATION OF GRINDING MARK CONCEALMENT		FAVORABLE	FAVORABLE	DEFECTIVE	FAVORABLE	FAVORABLE
PROBE TACK VALUE	PEAK VALUE (N)	0.356	0.306	0.436	0.236	0.276
	ULTRAVIOLET IRRADIATION SURFACE	0.412	0.859	0.504	2.630	1.028
	P2/P1	1.16	2.81	1.16	11.2	3.72
	ULTRAVIOLET IRRADIATION SURFACE	0.039	0.034	0.094	0.021	0.031
	ULTRAVIOLET IRRADIATION OPPOSITE SURFACE	0.056	0.116	0.098	0.790	0.181
	E2/E1	1.44	3.45	1.04	37.6	5.84

[0164]

As can be clearly understood from Table 1, the probe tack value of the ultraviolet irradiation surface in the film for forming a protective coating (a protective coating) and the probe tack value on a surface opposite to the ultraviolet irradiation surface obtained in the examples are similar. Accordingly, it can be understood that the protective coatings of the examples were entirely cured in the thickness direction from the ultraviolet irradiation surface to the ultraviolet irradiation opposite surface. In addition, the protective coatings of the examples were excellent in grinding mark concealment.

10 [Industrial Applicability]

[0165]

A film for forming a protective coating, a sheet for forming a protective coating and a composite sheet for forming a protective coating according to the present invention can be suitably used for manufacturing a chip including a protective coating from a semiconductor wafer.

[Reference Signs List]

[0166]

- 1 Film for forming protective coating
- 2 Sheet for forming protective coating
- 20 21 Release sheet
- 3, 3A Composite sheet for forming protective coating
- 4 Support sheet
- 41 Substrate
- 42 Adhesive layer

5 Adhesive layer for jig

6 Semiconductor wafer

7 Ring frame

[CLAIMS]

[Claim 1]

A film for forming a protective coating, comprising
an ultraviolet-curable component,
5 wherein a light transmittance at a wavelength of 375 nm is 8% or more, and
a light transmittance at a wavelength of 550 nm is 12% or less.

[Claim 2]

The film for forming a protective coating according to Claim 1, further
comprising
10 a coloring agent.

[Claim 3]

The film for forming a protective coating according to Claim 2,
wherein the coloring agent is a red coloring agent.

[Claim 4]

15 The film for forming a protective coating according to Claim 2 or 3,
wherein the coloring agent is an organic coloring agent.

[Claim 5]

The film for forming a protective coating according to any one of Claims 2 to 4,
wherein a value W/T obtained by dividing a content W (mass%) of the coloring
20 agent in the film for forming a protective coating by a thickness T (μm) of the film for
forming a protective coating is 0.01 to 0.5.

[Claim 6]

The film for forming a protective coating according to any one of Claims 1 to 5,
wherein, when ultraviolet rays with a luminance of 215 mW/cm^2 and a light
25 intensity of 187 mJ/cm^2 are irradiated to the film for forming a protective coating from

one surface side three times, a ratio $P2/P1$ of a peak value $P2$ of a probe tack on a surface opposite to an ultraviolet irradiation surface with respect to a peak value $P1$ of a probe tack of the ultraviolet irradiation surface is 0.1 to 7.

[Claim 7]

- 5 The film for forming a protective coating according to any one of Claims 1 to 6,
 wherein a light transmittance at a wavelength of 1,600 nm is 25% or more.

[Claim 8]

- A sheet for forming a protective coating, comprising:
 the film for forming a protective coating according to any one of Claims 1 to 7;
10 and
 a release sheet that is laminated on one surface or both surfaces of the film for
forming a protective coating.

[Claim 9]

- A composite sheet for forming a protective coating, comprising:
15 a support sheet; and
 the film for forming a protective coating according to any one of Claims 1 to 7
that is laminated on one surface side of the support sheet.

[Claim 10]

- The composite sheet for forming a protective coating according to Claim 9,
20 wherein the support sheet includes a substrate and an adhesive layer that is
laminated on the film for forming a protective coating side of the substrate or includes a
substrate.