

DESCRIPTION

Title of Invention

ADHESIVE SHEET FOR SEMICONDUCTOR PROCESSING

Technical Field

[0001]

The present invention relates to a semiconductor processing pressure sensitive adhesive sheet. In particular, the present invention relates to a semiconductor processing pressure sensitive adhesive sheet, which is suitable for a use application for protecting the surface of a semiconductor wafer with bumps.

Background Art

[0002]

Along with a rapid process of thinning, downsizing, and multi-functionalizing of an information terminal instrument, thinning and densification of a semiconductor device mounted thereon are also required. For thinning of a device, thinning of a semiconductor wafer in which a semiconductor is integrated is demanded. In order to cope with the demand, thinning is performed by grinding the back surface of the semiconductor wafer.

[0003]

In recent years, there is a case where bumps (electrodes) made of solder or the like having a height of approximately 30 μm to 100 μm are formed on the semiconductor wafer surface. In the case of grinding the back surface of such a semiconductor wafer with bumps, in order to protect the surface on which a bump portion is included, a back grind sheet (hereinafter also referred to as "BG sheet") is attached.

However, in a generally used BG sheet, on the surface after attaching, a difference in height is generated between portions where bumps exist and portions where bumps do not exist, so that the surface hardly becomes planar. There would be a case where a pressure difference to be caused due to the difference in height directly influences the back surface of the wafer, whereby at the time of grinding the back surface of the wafer, dimples (e.g., fragments or depressions) or cracks (breakage) are generated, resulting in breakage of the semiconductor wafer after grinding.

[0004]

In order to solve such problems, for example, PTL 1 discloses a sheet for semiconductor wafer surface protection including a resin layer (A) prepared so as to allow a storage elastic modulus at each of 25°C and 60°C to fall within a specified range. The foregoing sheet for semiconductor wafer surface protection includes the resin layer (A) in which a difference is present between the storage elastic modulus at room temperature (25°C) and the storage elastic modulus at a high temperature (60°C). By taking such a configuration, it is contemplated to soften the resin layer (A) by attaching on the wafer surface including an uneven portion at a high temperature to absorb the uneven portion of the wafer surface, thereby making the difference in level on the wafer surface small.

In addition, PTL 2 discloses a pressure sensitive adhesive tape for semiconductor wafer surface protection including a specified pressure sensitive adhesive layer on a substrate film. In the foregoing pressure sensitive adhesive tape for semiconductor wafer surface protection, the pressure sensitive adhesive layer is a pressure sensitive type pressure sensitive adhesive which does not contain isocyanate-based and epoxy-based crosslinking agents; a thickness, a contact angle against diiodomethane, and an adhesive strength to the SUS280 polished surface of the pressure sensitive adhesive have specified values at 23°C; and the adhesive strength to the SUS280 polished surface at the time of releasing upon heating at 50°C is 50% or less as compared with the adhesive strength at the time of releasing at 23°C. By taking such a configuration, it is contemplated to realize a pressure sensitive adhesive tape for semiconductor wafer surface protection capable of preventing infiltration of dusts and water at the time of wafer polishing and allowing to be easily released without damaging the wafer.

Citation List

Patent Literature

[0005]

PTL 1: JP-B 4603578

PTL 2: JP-B 5138102

Summary of Invention

Technical Problem

[0006]

However, in the case of merely decreasing the storage elastic modulus of the resin layer at a high temperature as in PTL 1, the absorption property of the bump portion was not satisfactory. In particular, an effect for inhibiting an air void to be generated between the bump portion and the BG sheet was insufficient, so that there was a concern that water which is used at the time of grinding the wafer infiltrates into the wafer surface. In addition, PTL 1 does not describe a relation of the resin layer (A) with other resin layers.

In PTL 2, evaluation by a wafer having a scribe line made of a polyimide film formed on the wafer surface is made. However, PTL 2 does not describe evaluation by a wafer with bumps per se. In addition, PTL 2 is concerned with the protection of a semiconductor wafer surface with a difference in level by a single pressure sensitive adhesive layer but does not describe a relation with other layers than the pressure sensitive adhesive layer.

[0007]

In view of the foregoing problems, the present invention has been made, and an object thereof is to provide a semiconductor processing pressure sensitive adhesive sheet with an excellent absorption property of bumps included in a semiconductor wafer.

Solution to Problem

[0008]

The present inventors made extensive and intensive investigations. As a result, it has been found that the aforementioned object can be achieved by a semiconductor processing pressure sensitive adhesive sheet including a substrate having thereon an intermediate layer having a loss tangent at 50°C as measured at a frequency of 1 Hz and a pressure sensitive adhesive layer in this order, wherein a ratio $[A/I]$ of a storage elastic modulus A of the pressure sensitive adhesive layer and a storage elastic modulus I of the intermediate layer at 50°C as measured at a frequency of 1 Hz is in a specified range, leading to accomplishment of the present invention.

Specifically, the present invention provides the following [1] to [10].

[1] A semiconductor processing pressure sensitive adhesive sheet including a substrate having thereon an intermediate layer and a pressure sensitive adhesive layer in this order, the semiconductor processing pressure sensitive adhesive sheet satisfying the following (a) and (b):

(a) a loss tangent of the intermediate layer at 50°C as measured at a frequency of 1 Hz is 1.0 or more, and

(b) a ratio $[A/I]$ of a storage elastic modulus A of the pressure sensitive adhesive layer and a storage elastic modulus I of the intermediate layer at 50°C as measured at a frequency of 1 Hz is 1.8 or less.

[2] The semiconductor processing pressure sensitive adhesive sheet as set forth above in [1], wherein the ratio $[A/I]$ of the storage elastic modulus A of the pressure sensitive adhesive layer and the storage elastic modulus I of the intermediate layer at 50°C as measured at a frequency of 1 Hz is 1.0 or less.

[3] The semiconductor processing pressure sensitive adhesive sheet as set forth above in [1] or [2], wherein the intermediate layer is formed of a resin composition including urethane (meth)acrylate and a thiol group-containing compound.

[4] The semiconductor processing pressure sensitive adhesive sheet as set forth above in any of [1] to [3], wherein the storage elastic modulus I of the intermediate layer at 50°C as measured at a frequency of 1 Hz is 1.0×10^6 Pa or less.

[5] The semiconductor processing pressure sensitive adhesive sheet as set forth above in any of [1] to [4], wherein a thickness of the intermediate layer is 50 to 400 μm .

[6] The semiconductor processing pressure sensitive adhesive sheet as set forth above in any of [1] to [5], wherein the pressure sensitive adhesive layer is formed of an acrylic pressure sensitive adhesive, a rubber-based pressure sensitive adhesive, or a urethane-based pressure sensitive adhesive.

[7] The semiconductor processing pressure sensitive adhesive sheet as set forth above in [6], wherein the acrylic pressure sensitive adhesive, the rubber-based pressure sensitive adhesive, or the urethane-based pressure sensitive adhesive is an energy ray curable pressure sensitive adhesive.

[8] The semiconductor processing pressure sensitive adhesive sheet as set forth above in [6] or [7], wherein the acrylic pressure sensitive adhesive includes an acrylic copolymer containing, as copolymer component, an alkyl (meth)acrylate having an alkyl group having 4 or more carbon atoms in an amount 50 to 98 mass% relative to the whole amount of the copolymer components.

[9] The semiconductor processing pressure sensitive adhesive sheet as set forth above in [6] or [7], wherein the acrylic pressure sensitive adhesive includes a resin having an energy ray polymerizable functional group introduced into an acrylic copolymer and having a weight average molecule weight of 800,000 or more.

[10] A method of protecting a surface of a semiconductor wafer, including attaching the semiconductor processing pressure sensitive adhesive sheet as set forth above in any of [1] to [9] to a surface of a semiconductor wafer.

Advantageous Effects of Invention

[0009]

In accordance with the present invention, it is possible to provide a semiconductor processing pressure sensitive adhesive sheet with an excellent absorption property of bumps included in a semiconductor wafer.

Brief Description of Drawing

[0010]

Fig. 1 is a cross-sectional view showing an example of a configuration of a semiconductor processing pressure sensitive adhesive sheet of the present invention.

Description of Embodiments

[0011]

In the description of the present specification, the "weight average molecular weight (Mw)", "number average molecular weight (Mn)", and "molecular weight distribution (Mw/Mn)" are values as expressed in terms of standard polystyrene as measured by a gel permeation chromatography (GPC) method, and specifically, are values measured based on the method described in the Examples.

In addition, in the description of the present specification, for example, the "(meth)acrylate" is a word meaning both "acrylate" and "methacrylate", and the same is also applied to other similar terms.

In addition, in the description of the present specification, for example, the "energy rays" are words meaning known energy rays, such as γ -rays, electron beams, ultraviolet rays, visible light, etc.

In addition, a thickness of each of a substrate, an intermediate layer, a pressure sensitive adhesive layer, and a release material to be optionally provided, each of which configures a semiconductor processing pressure sensitive adhesive sheet as mentioned later, is a value measured by a constant pressure thickness gauge.

[0012]

[Semiconductor Processing Pressure Sensitive Adhesive Sheet]

In order to protect a semiconductor wafer, particularly a surface of a semiconductor wafer with bumps, on which a bump portion is included (hereinafter also referred to simply as "surface of the wafer with bumps"), the semiconductor processing pressure sensitive adhesive sheet of the present invention is attached thereon and used for protecting the surface. As shown in Fig. 1, a semiconductor processing pressure sensitive adhesive sheet 10 of the present invention is a semiconductor processing pressure sensitive adhesive sheet including a substrate 3 having thereon an intermediate layer 2 and a pressure sensitive adhesive layer 1 in this order, the semiconductor processing pressure sensitive adhesive sheet 10 satisfying the following (a) and (b):

(a) a loss tangent of the intermediate layer at 50°C as measured at a frequency of 1 Hz is 1.0 or more, and

(b) a ratio $[A/I]$ of a storage elastic modulus A of the pressure sensitive adhesive layer and a storage elastic modulus I of the intermediate layer at 50°C as measured at a frequency of 1 Hz is 1.8 or less.

[0013]

The semiconductor processing pressure sensitive adhesive sheet of the present invention includes an intermediate layer in which a loss tangent ($\tan \delta$) (hereinafter also referred to simply as "loss tangent of intermediate layer") at 50°C as measured at a frequency of 1 Hz is 1.0 or more. When the loss tangent of the intermediate layer is less than 1.0, on attaching the semiconductor processing pressure sensitive adhesive sheet of the present invention on the surface of the wafer with bumps, the intermediate layer does not thoroughly transform, so that it cannot follow the bumps. From the viewpoint that the intermediate layer thoroughly absorbs the bumps to obtain an excellent attaching state to the surface of the wafer with bumps, the loss tangent of the intermediate layer is preferably 1.5 or more, more preferably 1.8 or more, still more preferably 2.0 or more, and yet still more preferably 3.0 or more.

From the viewpoint of adjusting flowability of the intermediate layer at the time of heating to an appropriate range, the loss tangent of the intermediate layer is preferably 5.0 or less, and more preferably 4.0 or less.

More specifically, the loss tangent of the intermediate layer is a value measured based on the method described in the Examples as mentioned later.

[0014]

The semiconductor processing pressure sensitive adhesive sheet of the present invention includes a pressure sensitive adhesive layer and an intermediate layer, wherein a ratio $[A/I]$ of a storage elastic modulus A of the pressure sensitive adhesive layer at 50°C as measured at a frequency of 1 Hz and a storage elastic modulus I of the intermediate layer at 50°C as measured at a frequency of 1 Hz (the ratio will be hereinafter also referred to simply as "storage elastic modulus ratio $[A/I]$ ") is 1.8 or less.

When the storage elastic modulus ratio $[A/I]$ is more than 1.8, transformation of the pressure sensitive adhesive layer to an extent that it is able to follow the bumps does not take place, so that the bump absorption property of the semiconductor processing pressure sensitive adhesive sheet is poor. That is, even in the case where the semiconductor processing pressure sensitive adhesive sheet merely includes a flexible intermediate layer, when the pressure sensitive adhesive layer as an outermost layer is more rigid than the intermediate layer, the semiconductor processing pressure sensitive adhesive sheet cannot give rise to thorough bump followability. From the viewpoint that it is possible to thoroughly absorb the bumps and to undergo attaching, so that the surface of the semiconductor processing pressure sensitive adhesive sheet after attaching can be made smooth, the storage elastic modulus ratio $[A/I]$ is preferably 1.5 or less, more preferably 1.0 or less, and still more preferably 0.5 or less. In particular, when the storage elastic modulus ratio $[A/I]$ is 1.0 or less, the surface of the semiconductor processing pressure sensitive adhesive sheet after being attached on the surface of the wafer with bumps can be kept more smooth.

From the viewpoint that it is easy to maintain flexibility of the intermediate layer to a higher degree or to maintain cohesiveness of the pressure sensitive adhesive layer, the storage elastic modulus ratio $[A/I]$ is preferably 0.05 or more, more preferably 0.1 or more, and still more preferably 0.15 or more.

More specifically, the storage elastic modulus A of the pressure sensitive adhesive layer at 50°C as measured at a frequency of 1 Hz and the storage elastic modulus I of the intermediate layer at 50°C as measured at a frequency of 1 Hz are values measured based on the method described in the Examples as mentioned later.

Each of the members of the semiconductor processing pressure sensitive adhesive sheet is hereunder described.

[0015]

<Substrate>

Though the substrate used in the present invention is not particularly limited, the substrate is preferably a resin film from the viewpoints that it is suitable for a processing member of an electronic part because it produces a less amount of dust as compared with papers and nonwoven fabrics and that it is easily available. By providing the substrate in the semiconductor processing pressure sensitive adhesive sheet, shape stability of the semiconductor processing pressure sensitive adhesive sheet can be improved, and nerve can be given to the semiconductor processing pressure sensitive adhesive sheet. In addition, when the semiconductor processing pressure sensitive adhesive sheet is attached on the adhesive surface on which bumps exist, an opposite surface to the attaching surface of the semiconductor processing pressure sensitive adhesive sheet is easily kept smooth.

The substrate used in the present invention may be a substrate composed of a single-layer film composed of a single resin film, or may be a substrate composed of multilayer films obtained by laminating plural resin films.

From the viewpoint of giving appropriate elasticity to the semiconductor processing pressure sensitive adhesive sheet and also from the viewpoint of handling properties at the time of winding up the semiconductor processing pressure sensitive adhesive sheet, a thickness of the substrate is preferably 5 to 250 μm , more preferably 10 to 200 μm , and still more preferably 25 to 150 μm .

[0016]

Examples of the resin film used as the substrate of the present invention include a polyolefin-based film, a vinyl halide polymer-based film, an acrylic resin-based film, a rubber-based film, a cellulose-based film, a polyester-based film, a polycarbonate-based film, a polystyrene-based film, a polyphenylene sulfide-based film, a cycloolefin polymer-based film, a film composed of a cured material of an energy ray curable composition including a urethane resin, and the like.

Among them, from the viewpoint that even when a work, such as a wafer, etc., is ground ultrathin, the work can be stably kept, a film with high thickness precision is preferred. Specifically, a polyester-based film, a polycarbonate-based film, a polystyrene-based film, a polyphenylene sulfide-based film, a cycloolefin polymer-based film, a film composed of a cured material of an energy ray curable composition including a urethane resin, and the like are preferred, with a

polyester-based film being more preferred.

[0017]

Examples of a polyester that constitutes the polyester-based film include a polyester obtained through polycondensation of an aromatic dibasic acid or an ester derivative thereof with a diol or an ester derivative thereof.

Specifically, examples of the polyester-based film include a film composed of a polyester, such as polyethylene terephthalate, polyethylene isophthalate, polybutylene terephthalate, polyethylene-2,6-naphthalene dicarboxylate, etc.

The polyester-based film used in the present invention may be a film composed of a copolymer of a polyester, or may be a resin mixed film composed of a mixture of the aforementioned polyester with a relatively small amount of other resin.

Among these polyester-based films, a polyethylene terephthalate film is preferred from the viewpoints that it is easily available and that it is high in thickness precision.

[0018]

From the viewpoint of improving adhesive properties of the substrate to the intermediate layer, a substrate obtained by further laminating a primer layer or a pressure sensitive adhesive layer on the surface of the resin film may be used.

Furthermore, the substrate used in the present invention may contain a filler, a colorant, an antistatic agent, an antioxidant, an organic lubricant, a catalyst, or the like within a range where the effects of the present invention are not impaired.

The substrate may be either transparent or opaque, and it may be colored or vapor-deposited, if desired.

In the case where the semiconductor processing pressure sensitive adhesive sheet includes a pressure sensitive adhesive layer as mentioned later, when a pressure sensitive adhesive that constitutes the pressure sensitive adhesive layer is an energy ray curable pressure sensitive adhesive, the substrate is preferably one which transmits energy rays to a degree sufficient for curing of the pressure sensitive adhesive.

[0019]

<Intermediate Layer>

The intermediate layer used in the present invention is not particularly limited so long as it is an intermediate layer satisfying the aforementioned

requirements (a) and (b); however, from the viewpoints that the foregoing requirements are readily satisfied and that a more excellent bump absorption property is obtained, it is preferred that the intermediate layer is formed of a resin composition including urethane (meth)acrylate and a thiol group-containing compound.

As for the intermediate layer, from the viewpoint of obtaining a more excellent attaching state to the wafer with bumps, a storage elastic modulus I of the intermediate layer at 50°C as measured at a frequency of 1 Hz is preferably 1.0×10^6 Pa or less, more preferably 5.0×10^5 Pa or less, and still more preferably 2.0×10^5 Pa or less.

From the viewpoint of giving an appropriate bump absorption property, the storage elastic modulus I of the intermediate layer is preferably 1.0×10^4 Pa or more, more preferably 5.0×10^4 Pa or more, and still more preferably 7.0×10^4 Pa or more.

A thickness of the intermediate layer can be properly adjusted according to a bump height of the surface of the semiconductor as a subject of protection; however, from the viewpoint that it becomes possible to absorb even bumps having a relatively tall height, the thickness of the intermediate layer is preferably 50 to 400 μm , more preferably 70 to 300 μm , and still more preferably 80 to 250 μm .

Details of each of the components included in the foregoing resin composition (hereinafter also referred to simply as "resin composition for intermediate layer") are hereunder described.

[0020]

(Urethane (Meth)acrylate)

The urethane (meth)acrylate is a compound having at least a (meth)acryloyl group and a urethane bond and has such properties that it is polymerized upon irradiation with energy rays.

The (meth)acryloyl group number in the urethane (meth)acrylate may be monofunctional, bifunctional, or trifunctional or higher functional; however, from the viewpoint of forming an intermediate layer satisfying the aforementioned requirement (a), it is preferred that the a monofunctional urethane (meth)acrylate is included.

When a monofunctional urethane (meth)acrylate is included in a film forming composition, the monofunctional urethane (meth)acrylate does not participate in formation of a three-dimensional network structure in the

polymerization structure, and therefore, the three-dimensional network structure is hardly formed, and in particular, the intermediate layer satisfying the aforementioned requirement (a) is readily formed.

The urethane (meth)acrylate used in the resin composition for intermediate layer can be, for example, obtained through a reaction of an isocyanate-terminal urethane prepolymer obtained by allowing a polyol compound to react with a polyvalent isocyanate compound, with a (meth)acrylate having a hydroxy group.

The urethane (meth)acrylate may be used either alone or in combination of two or more thereof.

[0021]

[Polyol Compound]

The polyol compound is not particularly limited so long as it is a compound having two or more hydroxy groups.

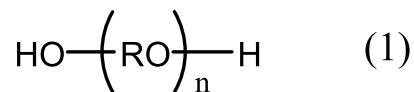
Specifically, examples of the polyol compound include an alkylene diol, a polyether type polyol, a polyester type polyol, a polycarbonate type polyol, and the like.

Among them, a polyether type polyol is preferred.

The polyol compound may be any of a bifunctional diol, a trifunctional triol, and a tetrafunctional or higher functional polyol; however, from the viewpoints of easy availability, multiplicity, reactivity, and the like, a bifunctional diol is preferred, and a polyether type diol is more preferred.

[0022]

The polyether type diol is preferably a compound represented by the following formula (1).



[0023]

In the formula (1), R is a divalent hydrocarbon group, preferably an alkylene group, and more preferably an alkylene group having 1 to 6 carbon atoms. Among the alkylene groups having 1 to 6 carbon atoms, an ethylene group, a propylene group, and a tetramethylene group are preferred, with a propylene group and a tetramethylene group being preferred.

In addition, n is a repeating unit number of the alkylene oxide, preferably 10 to 250, more preferably 25 to 205, and still more preferably 40 to 185. When n

falls within the aforementioned range, a urethane bond concentration of the obtained urethane (meth)acrylate is made appropriate, whereby it becomes easy to prepare the intermediate layer so as to satisfy the aforementioned requirement (a).

Among the compounds represented by the formula (1), polyethylene glycol, polypropylene glycol, and polytetramethylene glycol are preferred, with polypropylene glycol and polytetramethylene glycol being more preferred.

An isocyanate-terminal prepolymer to which an ether bonding part $[-(R-O)_n-]$ is introduced is formed through a reaction of a polyether type diol with a polyvalent isocyanate compound. By using such a polyether type diol, the urethane (meth)acrylate contains a structural unit derived from the polyether type diol.

[0024]

As a polybasic acid component used for production of the polyether type polyol, a compound generally known as a polybasic acid component of a polyester can be used.

Specifically, examples of the polybasic acid component include dibasic acids, such as adipic acid, maleic acid, succinic acid, oxalic acid, fumaric acid, malonic acid, glutaric acid, pimelic acid, azelaic acid, sebacic acid, suberic acid, etc.; aromatic polybasic acids, such as dibasic acids, e.g., phthalic acid, isophthalic acid, terephthalic acid, 2,6-naphthalenedicarboxylic acid, etc.; polybasic acids, e.g., trimellitic acid, pyromellitic acid, etc., etc.; anhydrides or derivatives thereof and dimer acids corresponding thereto; hydrogenated dimer acids; and the like.

Among them, from the viewpoint of forming a coating film having an appropriate hardness, aromatic polybasic acids are preferred.

For the esterification reaction for producing the polyester type polyol, various known catalysts may be used as the need arises.

Examples of the catalyst include a tin compound, such as dibutyltin oxide, stannous octylate, etc.; an alkoxy titanium, such as tetrabutyl titanate, tetrapropyl titanate, etc.; and the like.

The polycarbonate type polyol is not particularly limited, and examples thereof include a reaction product of the aforementioned glycol with an alkylene carbonate, and the like.

[0025]

A number average molecular weight of the polyol compound, calculated

from a hydroxyl value, is preferably 1,000 to 10,000, more preferably 2,000 to 9,000, and still more preferably 3,000 to 7,000. When the foregoing number average molecular weight is 1,000 or more, the situation that control of the viscoelasticity property of the intermediate layer becomes difficult because of formation of an excessive amount of a urethane bond is avoided, and hence, such is preferred. On the other hand, when the number average molecular weight is 10,000 or less, excessive softening of the obtained intermediate layer can be prevented from occurring, and hence, such is preferred.

The number average molecular weight of the polyol compound, calculated from a hydroxy group, is a value calculated from {[number of polyol functional group number] $\times$ 56.11 $\times$ 1,000/[hydroxyl value (unit: mgKOH/g)]}.

[0026]

[Polyvalent Isocyanate Compound]

Examples of the polyvalent isocyanate compound include aliphatic polyisocyanates, such as tetramethylene diisocyanate, hexamethylene diisocyanate, trimethylhexamethylene diisocyanate, etc.; alicyclic diisocyanates, such as isophorone diisocyanate, norbornane diisocyanate, dicyclohexylmethane-4,4'-diisocyanate, dicyclohexylmethane-2,4'-diisocyanate, ω,ω' -diisocyanate dimethylcyclohexane, etc.; aromatic diisocyanates, such as 4,4'-diphenylmethane diisocyanate, tolylene diisocyanate, xylylene diisocyanate, trizine diisocyanate, tetramethylene xylylene diisocyanate, naphthalene-1,5-diisocyanate, etc.; and the like.

Among them, from the viewpoint of handling properties, isophorone diisocyanate, hexamethylene diisocyanate, and xylylene diisocyanate are preferred.

[0027]

{(Meth)acrylate Having a Hydroxy Group}

The (meth)acrylate having a hydroxy group is not particularly limited so long as it is a compound having at least a hydroxy group and a (meth)acryloyl group in one molecule.

Specifically, examples of the (meth)acrylate having a hydroxy group include hydroxyalkyl (meth)acrylates, such as 2-hydroxyethyl (meth)acrylate, 2-hydroxypropyl (meth)acrylate, 4-hydroxybutyl (meth)acrylate, 4-hydroxycyclohexyl (meth)acrylate, 5-hydroxycyclooctyl (meth)acrylate, 2-hydroxy-3-phenyloxypropyl (meth)acrylate, pentaerythritol tri(meth)acrylate,

polyethylene glycol mono(meth)acrylate, polypropylene glycol mono(meth)acrylate, etc.; hydroxy group-containing (meth)acrylamides, such as N-methylol (meth)acrylamide, etc.; reaction products obtained through a reaction of a diglycidyl ester of vinyl alcohol, vinyl phenol, or bisphenol A with (meth)acrylic acid; and the like.

Among them, hydroxyalkyl (meth)acrylates are preferred, and 2-hydroxyethyl (meth)acrylate is more preferred.

As condition for allowing an isocyanate-terminal urethane prepolymer to react with a (meth)acrylate having a hydroxy group, conditions under which the reaction is performed at 60 to 100°C for 1 to 4 hours in the presence of a solvent and a catalyst, each of which is added as the need arises, are preferred.

[0028]

The thus obtained urethane (meth)acrylate for the resin composition for intermediate layer may be any of an oligomer, a polymer, and a mixture thereof; however, a urethane (meth)acrylate oligomer is preferred.

A weight average molecular weight of the urethane (meth)acrylate is 1,000 to 100,000, more preferably 3,000 to 80,000, and still more preferably 5,000 to 65,000. When the foregoing weight average molecular weight is 1,000 or more, in a polymer of the urethane (meth)acrylate with a polymerizable monomer as mentioned later, an appropriate hardness is imparted to the intermediate layer due to an intermolecular force between the structures derived from the urethane (meth)acrylate, and hence, such is preferred.

A blending amount of the urethane (meth)acrylate in the resin composition for intermediate layer is preferably 20 to 70 mass%, more preferably 25 to 60 mass%, still more preferably 30 to 50 mass%, and yet still more preferably 33 to 47 mass%. When the blending amount of the urethane (meth)acrylate falls within the foregoing range, it becomes easier to form the intermediate layer satisfying the aforementioned requirement (a), or to adjust the storage elastic modulus I of the intermediate layer at 50°C as measured at a frequency of 1 Hz to the aforementioned range.

[0029]

(Thiol Group-Containing Compound)

The thiol group-containing compound is not particularly limited so long as it is a compound having at least one thiol group in a molecule thereof. However, from the viewpoint of readily forming the intermediate layer satisfying the

aforementioned requirement (a), a polyfunctional thiol group-containing compound is preferred, and a tetrafunctional thiol group-containing is more preferred.

Specifically, examples of the thiol group-containing compound include nonyl mercaptan, 1-dodecanethiol, 1,2-ethanedithiol, 1,3-propanedithiol, triazinethiol, triazinedithiol, triazinetrithiol, 1,2,3-propanetrithiol, tetraethylene glycol-bis(3-mercaptopropionate), trimethylolpropane tris(3-mercaptopropionate), pentaerythritol tetrakis(3-mercaptopropionate), pentaerythritol tetrakis(3-mercaptopropionate), dipentaerythritol hexakis(3-mercaptopropionate), tris[(3-mercaptopropionyloxy)-ethyl]-isocyanurate, 1,4-bis(3-mercaptopropionyloxy)butane, pentaerythritol tetrakis(3-mercaptopropionate), 1,3,5-tris(3-mercaptopropionyloxyethyl)-1,3,5-triazine-2,4,6-(1H,3H,5H)-trione, and the like.

These thiol group-containing compounds may be used either alone or in combination of two or more thereof.

[0030]

A molecular weight of the thiol group-containing compound is preferably 200 to 3,000, and more preferably 300 to 2,000. When the foregoing molecular weight falls within the aforementioned range, compatibility with the urethane (meth)acrylate becomes excellent, so that the film formability can be made excellent.

A blending amount of the thiol group-containing compound is preferably 1.0 to 4.9 parts by mass, and more preferably 1.5 to 4.8 parts by mass based on 100 parts by mass of a sum total of the urethane (meth)acrylate and a polymerizable monomer as mentioned later.

When the foregoing blending amount is 1.0 part by mass or more, the intermediate layer satisfying the aforementioned requirement (a) is readily formed, and the bump absorption property can be improved. On the other hand, when the blending amount is 4.9 parts by mass or less, oozing of the intermediate layer on winding up in a roll form can be inhibited.

[0031]

(Polymerizable Monomer)

From the viewpoint of improving the film formability, it is preferred that the resin composition for intermediate layer used in the present invention further includes a polymerizable monomer.

The polymerizable monomer is a polymerizable compound other than the aforementioned urethane (meth)acrylate and is a compound that is polymerizable with other components upon irradiation with energy rays. The polymerizable compound is preferably a compound excluding the resin component and having at least one (meth)acryloyl group.

In the present specification, the "resin component" refers to an oligomer or a polymer having a repeating structure in the structure and is a compound having a weight average molecular weight of 1,000 or more.

[0032]

Examples of the polymerizable monomer include (meth)acrylates having an alkyl group having 1 to 30 carbon atoms; (meth)acrylates having a functional group, such as a hydroxy group, an amide group, an amino group, an epoxy group, etc.; (meth)acrylates having an alicyclic structure; (meth)acrylates having an aromatic structure; (meth)acrylates having a heterocyclic structure; vinyl compounds, such as styrene, hydroxyethyl vinyl ether, hydroxybutyl vinyl ether, N-vinylformamide, N-vinylpyrrolidone, N-vinylcaprolactam, etc.; and the like.

[0033]

Examples of the (meth)acrylate having an alkyl group having 1 to 30 carbon atoms include methyl (meth)acrylate, ethyl (meth)acrylate, n-propyl (meth)acrylate, isopropyl (meth)acrylate, n-butyl (meth)acrylate, isobutyl (meth)acrylate, t-butyl (meth)acrylate, n-pentyl (meth)acrylate, n-hexyl (meth)acrylate, 2-ethylhexyl (meth)acrylate, n-octyl (meth)acrylate, nonyl (meth)acrylate, decyl (meth)acrylate, undecyl (meth)acrylate, dodecyl (meth)acrylate, tridecyl (meth)acrylate, tetradecyl (meth)acrylate, hexadecyl (meth)acrylate, octadecyl (meth)acrylate, eicosyl (meth)acrylate, and the like.

[0034]

Examples of the (meth)acrylate having a functional group include hydroxy group-containing (meth)acrylates, such as 2-hydroxyethyl (meth)acrylate, 2-hydroxypropyl (meth)acrylate, 3-hydroxypropyl (meth)acrylate, 2-hydroxybutyl (meth)acrylate, 3-hydroxybutyl (meth)acrylate, 4-hydroxybutyl (meth)acrylate, etc.; amide group-containing compounds, such as (meth)acrylamide, N,N-dimethyl (meth)acrylamide, N-butyl (meth)acrylamide, N-methylol (meth)acrylamide, N-methylolpropane (meth)acrylamide, N-methoxymethyl (meth)acrylamide, N-butoxymethyl (meth)acrylamide, etc.; amino group-containing (meth)acrylates, such as a primary amino group-containing (meth)acrylate, a secondary amino

group-containing (meth)acrylate, a tertiary amino group-containing (meth)acrylate, etc.; epoxy group-containing (meth)acrylates, such as glycidyl (meth)acrylate, methylglycidyl (meth)acrylate, allyl glycidyl ether, etc.; and the like.

[0035]

Examples of the (meth)acrylate having an alicyclic structure include isobornyl (meth)acrylate, dicyclopentenyl (meth)acrylate, dicyclopentanyl (meth)acrylate, dicyclopentenylloxy (meth)acrylate, cyclohexyl (meth)acrylate, adamantane (meth)acrylate, and the like.

Examples of the (meth)acrylate having an aromatic structure include phenylhydroxypropyl (meth)acrylate, benzyl (meth)acrylate, 2-hydroxy-3-phenoxypropyl (meth)acrylate, and the like.

Examples of the (meth)acrylate having a heterocyclic structure include tetrahydrofurfuryl (meth)acrylate, morpholine (meth)acrylate, and the like.

[0036]

Among them, from the viewpoint of compatibility with the aforementioned urethane (meth)acrylate, those having a group with relatively high bulkiness are preferred. More specifically, (meth)acrylates having an alicyclic structure, (meth)acrylates having an aromatic structure, and (meth)acrylates having a heterocyclic structure are preferred, and (meth)acrylates having an alicyclic structure are more preferred. In addition, from the viewpoint of obtaining a resin composition for intermediate layer which readily forms an intermediate layer satisfying the requirement (a), the resin composition for intermediate layer includes, as a polymerizable monomer, preferably a (meth)acrylate having a functional group or a (meth)acrylate having an alicyclic structure, and more preferably hydroxypropyl (meth)acrylate or isobornyl (meth)acrylate.

[0037]

From the aforementioned viewpoint, a blending amount of the (meth)acrylate having an alicyclic structure in the composition for intermediate layer is preferably 32 to 53 mass%, more preferably 35 to 51 mass%, still more preferably 37 to 48 mass%, and yet still more preferably 40 to 47 mass%.

From the aforementioned viewpoint, a blending amount of the (meth)acrylate having an alicyclic structure is preferably 52 to 87 mass%, more preferably 55 to 85 mass%, still more preferably 60 to 80 mass%, and yet still more preferably 65 to 77 mass% relative to the whole amount of the polymerizable

monomers included in the resin composition for intermediate layer. When the blending amount of the (meth)acrylate having an alicyclic structure falls within the foregoing range, it becomes easier to adjust the storage elastic modulus I of the intermediate layer at 50°C as measured at a frequency of 1 Hz to the aforementioned range.

[0038]

A blending amount of the polymerizable monomer in the resin composition for intermediate layer is preferably 30 to 80 mass%, more preferably 40 to 75 mass%, still more preferably 50 to 70 mass%, and yet still more preferably 53 to 67 mass%. When the blending amount of the polymerizable monomer falls within the foregoing range, since mobility of a portion formed through polymerization of the polymerizable monomer in the intermediate layer is high, the intermediate layer tends to become flexible. Thus, it becomes easier to form the intermediate layer satisfying the aforementioned requirement (a), or to adjust the storage elastic modulus I of the intermediate layer at 50°C as measured at a frequency of 1 Hz to the aforementioned range.

From the same viewpoints, a mass ratio of the urethane (meth)acrylate and the polymerizable monomer in the resin composition for intermediate layer [(urethane (meth)acrylate)/(polymerizable monomer)] is preferably 20/80 to 60/40, more preferably 30/70 to 50/50, and still more preferably 35/65 to 45/55.

[0039]

(Energy Ray Polymerization Initiator)

In the case of using ultraviolet rays or the like as the energy rays and curing a coating film composed of the resin composition for intermediate layer to form an intermediate layer, it is preferred that the resin composition for intermediate layer further includes an energy ray polymerization initiator. In general, since the energy ray polymerization initiator is also called a "photopolymerization initiator", in the present specification, it is also referred to simply as "photopolymerization initiator".

Examples of the photopolymerization initiator include photopolymerization initiators, such as a benzoin compound, an acetophenone compound, an acyl phosphino oxide compound, a titanocene compound, a thioxanthone compound, a peroxide oxide, etc.; photosensitizers, such as an amine, a quinone, etc.; and the like. More specifically, examples thereof include 1-hydroxycyclohexyl phenyl ketone, 2-hydroxy-2-methyl-1-phenyl-propan-1-one,

benzoin, benzoin methyl ether, benzoin ethyl ether, benzoin isopropyl ether, 2,2-dimethoxy-1,2-diphenylethan-1-one, and the like.

These photopolymerization initiators may be used either alone or in combination of two or more thereof.

A blending amount of the photopolymerization initiator is preferably 0.05 to 15 parts by mass, more preferably 0.1 to 10 parts by mass, and still more preferably 0.3 to 5 parts by mass based on 100 parts by mass of a sum total of the urethane (meth)acrylate and the polymerizable monomer.

[0040]

(Other Additives)

The resin composition for intermediate layer may further contain other additives within a range where the effects of the present invention are not impaired.

Examples of the other additives include a crosslinking agent, an antioxidant, a softener (plasticizer), a filler, a rust inhibitor, a pigment, a dye, and the like.

In the case of blending those other additives, a blending amount thereof is preferably 0.01 to 6 parts by mass, and more preferably 0.1 to 3 parts by mass based on 100 parts by mass of a sum total of the component (A) and the component (B).

Though the resin composition for intermediate layer may contain a resin component other than the urethane (meth)acrylate within a range where the effects of the present invention are not impaired, it is preferred that the resin composition for intermediate layer contains only the urethane (meth)acrylate as the resin component.

The content of the resin component other than the urethane (meth)acrylate, included in the resin composition for intermediate layer, is preferably 5 mass% or less, more preferably 1 mass% or less, still more preferably 0.1 mass% or less, and yet still more preferably 0 mass%.

[0041]

So long as the aforementioned requirements (a) and (b) are satisfied, besides the formation using the aforementioned resin composition for intermediate layer, the intermediate layer may also be formed using a cured material of a curable composition including a nonreactive urethane polymer or oligomer and a polymerizable monomer, or an ethylene- α -olefin copolymer. As the

nonreactive urethane polymer or oligomer, known materials may be used; and as the polymerizable monomer, the same materials as those mentioned above can be used. Such a curable composition may contain the aforementioned energy ray polymerization initiator.

[0042]

The ethylene- α -olefin copolymer can be obtained through polymerization of ethylene and an α -olefin monomer. Examples of the α -olefin monomer include propylene, 1-butene, 2-methyl-1-butene, 2-methyl-1-pentene, 1-hexene, 2,2-dimethyl-1-butene, 2-methyl-1-hexene, 4-methyl-1-pentene, 1-heptene, 3-methyl-1-hexene, 2,2-dimethyl-1-pentene, 3,3-dimethyl-1-pentene, 2,3-dimethyl-1-pentene, 3-ethyl-1-pentene, 2,2,3-trimethyl-1-butene, 1-octene, 2,2,4-trimethyl-1-octene, and the like. These α -olefin monomers may be either alone or in combination of two or more thereof.

For the ethylene- α -olefin copolymer, other polymerizable monomers than the aforementioned monomers can also be used. Examples of the other polymerizable monomers include vinyl compounds, such as vinyl acetate, styrene, acrylonitrile, methacrylonitrile, vinyl ketone, etc.; unsaturated carboxylic acids, such as acrylic acid, methacrylic acid, etc.; unsaturated carboxylic acid esters, such as methyl acrylate, ethyl acrylate, n-propyl acrylate, methyl methacrylate, ethyl methacrylate, n-propyl methacrylate, etc.; unsaturated carboxylic acid amides, such as acrylamide, methacrylamide, etc.; and the like. These polymerizable monomers may be used either alone or in combination of two or more thereof.

[0043]

<Pressure Sensitive Adhesive Layer>

The semiconductor processing pressure sensitive adhesive sheet of the present invention further includes a pressure sensitive adhesive layer on an intermediate layer. Thus the pressure sensitive adhesive sheet can be surely fixed to the surface of a semiconductor wafer, particularly the surface of the wafer with bumps, and protected.

As long as the pressure sensitive adhesive layer used in the present invention satisfies the aforementioned requirement (b), the kind of a pressure sensitive adhesive that constitutes the pressure sensitive adhesive layer (hereinafter also referred to simply as "pressure sensitive adhesive composition") is not limited.

Examples of such a pressure sensitive adhesive include an acrylic pressure sensitive adhesive, a rubber-based pressure sensitive adhesive, a urethane-based pressure sensitive adhesive, a silicone-based pressure sensitive adhesive, a polyvinyl ether-based pressure sensitive adhesive, an olefin-based pressure sensitive adhesive, and the like.

These pressure sensitive adhesives may be used either alone or in combination of two or more thereof.

From the viewpoint of obtaining a pressure sensitive adhesive layer satisfying the aforementioned requirement (b), the pressure sensitive adhesive layer has the storage elastic modulus A at 50°C as measured at a frequency of 1 Hz of preferably 1.8×10^6 Pa or less, more preferably 1.0×10^6 Pa or less, still more preferably 1.0×10^5 Pa or less, and yet still more preferably 9.0×10^4 Pa or less.

From the viewpoint of contemplating to stabilize the thickness of the pressure sensitive adhesive layer or preventing protrusion of the pressure sensitive adhesive layer from the end surface of the semiconductor processing sheet from occurring, the storage elastic modulus of the pressure sensitive adhesive layer is preferably 1.0×10^4 Pa or more, and more preferably 2.5×10^4 Pa or more.

A thickness of the pressure sensitive adhesive layer can be properly adjusted according to a bump height of the surface of the semiconductor as a subject of protection; however, the thickness of the pressure sensitive adhesive layer is preferably 5 to 200 μm , more preferably 7 to 150 μm , and still more preferably 10 to 100 μm .

[0044]

(Acrylic Pressure Sensitive Adhesive)

The acrylic pressure sensitive adhesive which can be used for the pressure sensitive adhesive layer of the present invention is in general an acrylic pressure sensitive adhesive including an acrylic copolymer, and the acrylic pressure sensitive adhesive is also referred to as a "main polymer". From the viewpoint that it is easy to design a pressure sensitive adhesive suited for a use application through selection of the copolymer component of the acrylic copolymer in various ways, the acrylic pressure sensitive adhesive is a preferred pressure sensitive adhesive.

The acrylic copolymer is one obtained through copolymerization of a monomer component including, as a main monomer, an alkyl (meth)acrylate (such

a monomer component will be hereinafter also referred to as "copolymer component"). As the alkyl (meth)acrylate, one having an alkyl group having 1 to 18 carbon atoms is exemplified. Examples thereof include methyl (meth)acrylate, ethyl (meth)acrylate, isopropyl (meth)acrylate, n-propyl (meth)acrylate, butyl (meth)acrylate, 2-ethylhexyl (meth)acrylate, n-octyl (meth)acrylate, isooctyl (meth)acrylate, nonyl (meth)acrylate, decyl (meth)acrylate, undecyl (meth)acrylate, dodecyl (meth)acrylate, and the like.

The acrylic copolymer contains, as the copolymerization component, the alkyl (meth)acrylate in an amount of preferably 50 mass% or more, and more preferably 50 to 99 mass% relative to the whole amount of the copolymer components.

[0045]

From the viewpoint of adjusting the storage elastic modulus A of the pressure sensitive adhesive layer to a desired value, it is preferred that the acrylic copolymer contains, as the copolymer component, an alkyl (meth)acrylate having an alkyl group having 4 or more carbon atoms in an amount of 50 to 98 mass% relative to the whole amount of the copolymer components. By adjusting the content of the alkyl (meth)acrylate having an alkyl group having 4 or more carbon atoms to the foregoing range, it becomes easy to impart appropriate pressure sensitive adhesion performance and release performance to the surface protective film. From such viewpoints, the content of the alkyl (meth)acrylate having an alkyl group having 4 or more carbon atoms is more preferably 70 to 97 mass%, and still more preferably 80 to 96 mass%.

The aforementioned alkyl (meth)acrylate having an alkyl group having 4 or more carbon atoms is preferably an alkyl (meth)acrylate having an alkyl group having 4 to 8 carbon atoms, more preferably an alkyl (meth)acrylate having an alkyl group having 6 to 8 carbon atoms, and still more preferably an alkyl acrylate having an alkyl group having 6 to 8 carbon atoms. Specifically, 2-ethylhexyl acrylate, n-octyl acrylate, isooctyl acrylate, and the like are preferred.

[0046]

It is preferred that the acrylic copolymer contains, as the copolymer component, a polymerizable monomer other than the alkyl (meth)acrylate, and specifically, it is preferred that the acrylic copolymer contains a functional group-containing monomer. The functional group-containing monomer provides a functional group necessary for a reaction of a compound having both a reactive

group capable of bonding to the foregoing functional group and an energy ray polymerizable functional group as mentioned later and/or a crosslinking agent as mentioned later. The functional group-containing monomer is a monomer having a polymerizable double bond and a functional group, such as a hydroxy group, a carboxy group, an amino group, a substituted amino group, an epoxy group, etc., in a molecule thereof.

The acrylic copolymer is preferably one obtained through copolymerization of, as the copolymer component, a copolymer component including the functional group-containing monomer in an amount of 0.1 to 40 mass% relative to the whole amount of the copolymer components. When the content of the functional group-containing monomer falls within the aforementioned range, it is possible for the acrylic copolymer to appropriately undergo crosslinking with a crosslinking agent as mentioned later.

The content of the functional group-containing monomer is more preferably 0.2 to 30 mass%. When the content of the functional group-containing monomer is 0.2 to 30 mass%, it becomes possible for the acrylic copolymer to appropriately undergo crosslinking with a crosslinking agent as mentioned later while securing an appropriate pressure sensitive adhesion performance.

[0047]

Here, examples of the carboxy group-containing monomer include acrylic acid, methacrylic acid, itaconic acid, and the like.

Specific examples of the hydroxy group-containing (meth)acrylate include hydroxymethyl (meth)acrylate, 2-hydroxyethyl (meth)acrylate, 2-hydroxypropyl (meth)acrylate, 3-hydroxypropyl (meth)acrylate, 2-hydroxybutyl (meth)acrylate, 4-hydroxybutyl (meth)acrylate, and the like.

Examples of the monomer having an epoxy group in a molecule thereof include glycidyl (meth)acrylate, methylglycidyl (meth)acrylate, allyl glycidyl ether, and the like.

The foregoing functional group-containing monomers may be used either alone or in combination of two or more thereof.

[0048]

Besides the aforementioned monomers, the acrylic copolymer may include, as the copolymer component, a (meth)acrylic acid ester other than the alkyl (meth)acrylate and the functional group-containing monomer, a dialkyl (meth)acrylamide, vinyl formate, vinyl acetate, or styrene. As the (meth)acrylic

acid ester other than the alkyl (meth)acrylate and the functional group-containing monomer, an alkoxyalkyl (meth)acrylate, an alkyleneoxyalkyl (meth)acrylate, nonylphenoxy polyethylene glycol (meth)acrylate, tetrahydrofurfuryl acrylate, a diacrylate that is an ester of a polyether with acrylic acid, and the like may be used.

As the dialkyl (meth)acrylamide, dimethyl (meth)acrylamide, diethyl (meth)acrylamide, and the like are useful.

A weight average molecular weight of the acrylic copolymer is typically 100,000 or more; however, it is preferably 800,000 or more, and more preferably 850,000 or more from the viewpoint that the generation of an adhesive residue on the surface of the wafer with bumps on releasing the semiconductor processing pressure sensitive adhesive sheet after the use can be prevented from occurring. In addition, from the viewpoint of coating properties, it is preferably 1,500,000 or less. When the weight average molecular weight of the acrylic copolymer falls within the foregoing range, the abundance of a low molecular weight body in the acrylic copolymer is controlled low, and cohesiveness of the pressure sensitive adhesive layer is improved. As a result, it becomes easy to prevent the pressure sensitive adhesive in the peripheries of bumps from the generation of an adhesive residue to be caused due to shredding by a force applied at the time of releasing of the semiconductor processing pressure sensitive adhesive sheet. On the other hand, when the weight average molecular weight of the acrylic copolymer is high in this way, the storage elastic modulus A of the pressure sensitive adhesive layer tends to become high, and in the case where the storage elastic modulus I of the intermediate layer is low, there is a concern that the semiconductor processing pressure sensitive adhesive sheet is difficult to satisfy the requirement (b). However, by selecting the kind or amount of the alkyl (meth)acrylate as the copolymer component as mentioned above, it becomes easy to adjust the storage elastic modulus A of the pressure sensitive adhesive layer to a desired value.

The aforementioned acrylic pressure sensitive adhesive can be used as an energy ray curable pressure sensitive adhesive cured upon irradiation with energy rays to become re-releasable.

More specifically, the weight average molecular weight is a value measured based on the method described in the Examples as mentioned later.

In the case of using the acrylic pressure sensitive adhesive as an energy ray curable pressure sensitive adhesive, the weight average molecular weight of a

resin having an energy ray polymerizable functional group introduced into an acrylic copolymer as mentioned later is a value measured with respect to the acrylic copolymer after introducing the energy ray polymerizable functional group thereinto, and a suitable range thereof is the same as the weight average molecular weight of the aforementioned acrylic copolymer.

[0049]

[Energy Ray Curable Pressure Sensitive Adhesive]

The energy ray curable pressure sensitive adhesive refers to a pressure sensitive adhesive cured upon irradiation with energy rays.

Examples of the pressure sensitive adhesive composition used for the energy ray curable pressure sensitive adhesive include a pressure sensitive adhesive composition (X) including an energy ray curable compound together with the aforementioned acrylic copolymer; a pressure sensitive adhesive composition (Y) including a resin in which an energy ray polymerizable functional group is introduced into the aforementioned acrylic copolymer; and the like. In the case of using the pressure sensitive adhesive composition (Y) including a resin in which an energy ray polymerizable functional group is introduced into the acrylic copolymer, a non-energy ray polymerizable acrylic copolymer or an energy ray curable compound may be used together with the resin in which an energy ray polymerizable functional group is introduced into the acrylic copolymer. Among them, in the case of using the pressure sensitive adhesive composition (Y), even when the energy ray curable compound is not used or used only in a less amount, sufficient energy ray curability can be exhibited, and the generation of an adhesive residue on an adherend to be caused due to the energy ray curable compound can be prevented from occurring, and hence, such is preferred.

[0050]

As the energy ray curable compound to be blended in the aforementioned pressure sensitive adhesive composition (X), a monomer or oligomer having an unsaturated group in a molecule thereof and capable of being polymerized and cured with irradiation with energy rays is preferred. Examples of such an energy ray curable compound include polyvalent (meth)acrylate monomers, such as trimethylolpropane tri(meth)acrylate, pentaerythritol (meth)acrylate, pentaerythritol tetra(meth)acrylate, dipentaerythritol hexa(meth)acrylate, 1,4-butylene glycol di(meth)acrylate, 1,6-hexanediol (meth)acrylate, etc., urethane (meth)acrylate, polyester (meth)acrylate, polyether (meth)acrylate, epoxy

(meth)acrylate, and oligomers thereof, and the like.

A molecular weight of the energy ray curable compound (a weight average molecular weight in the case of an oligomer) is preferably 100 to 12,000, more preferably 200 to 10,000, still more preferably 400 to 8,000, and yet still more preferably 600 to 6,000.

The content of the energy ray curable compound in the aforementioned pressure sensitive adhesive composition (X) is preferably 30 to 150 parts by mass, and more preferably 40 to 90 parts by mass based on 100 parts by mass of the total amount of the non-energy ray curable acrylic copolymer and the resin having an energy ray polymerizable functional group introduced thereinto.

[0051]

The resin in which an energy ray polymerizable functional group is introduced into the aforementioned acrylic copolymer and which is included in the aforementioned pressure sensitive adhesive composition (Y) is a resin having, as a main chain, a structure derived from the aforementioned acrylic copolymer, and preferably a resin in which an energy ray polymerizable functional group is introduced into a side chain of the aforementioned acrylic copolymer.

Examples of the energy ray polymerizable functional group include a (meth)acryloyl group, a vinyl group, an allyl group, and the like, with a (meth)acryloyl group being preferred.

As a method for producing the resin in which an energy ray polymerizable functional group is introduced into the acrylic copolymer, there is exemplified a method in which a copolymer provided with a functional group obtained through copolymerization of a functional group-containing monomer is selected as the aforementioned acrylic copolymer, and a compound having both a reactive group capable of bonding to the foregoing functional group and an energy ray polymerizable functional group (hereinafter also referred to simply as "energy ray polymerizable functional group-introducing compound") is added to bond the functional group of the copolymer to the reactive group, thereby obtaining the foregoing resin.

[0052]

Examples of the reactive group capable of bonding to the functional group include an isocyanate group, a glycidyl group, and the like. Therefore, examples of the energy ray polymerizable functional group-introducing compound include 2-isocyanatoethyl (meth)acrylate, glycidyl (meth)acrylate, and the like.

In the energy ray polymerizable functional group-introducing compound, it is preferred that the energy ray polymerizable functional group-introducing compound is added in an amount of 10 to 60 mol% based on 100 mol% of the functional group-containing monomer in the acrylic copolymer. When the energy ray polymerizable functional group-introducing compound is added in an amount of 10 to 60 mol% to the functional group-containing monomer in the acrylic copolymer, the acrylic copolymer is appropriately crosslinked with a crosslinking agent as mentioned later while securing an appropriate pressure sensitive adhesion performance of the pressure sensitive adhesive layer, whereby it becomes easy to obtain a desired storage elastic modulus. From such a viewpoint, an addition ratio of the energy ray polymerizable functional group-introducing compound is more preferably 30 to 55 mol%, and still more preferably 35 to 50 mol% based on 100 mol% of the functional group-containing monomer in the acrylic copolymer.

The acrylic pressure sensitive adhesive may be used either alone or in combination of two or more thereof.

[0053]

(Rubber-based Pressure Sensitive Adhesive)

The rubber-based pressure sensitive adhesive which can be used for the pressure sensitive adhesive layer of the present invention is not particularly limited so long as it includes a rubber-based compound and satisfies the aforementioned requirement (b). The rubber-based pressure sensitive adhesive is preferred from the standpoint that an adhesive residue is hardly generated at the time of releasing the semiconductor processing pressure sensitive adhesive sheet.

Examples of the rubber-based compound include a natural rubber, a modified natural rubber obtained through graft polymerization of a natural rubber with one or more monomers selected from an alkyl (meth)acrylate, styrene, and (meth)acrylonitrile, a diene-based homopolymer, such as polybutadiene, polyisoprene, polychloroprene, etc., a diene-based copolymer, such as polystyrene-polybutadiene, polystyrene-polyisoprene, etc., a styrene-butadiene rubber, an acrylonitrile-butadiene rubber, a methyl methacrylate-butadiene rubber, a urethane rubber, a polyisobutylene-based resin, a polybutene resin, and the like. These rubber-based compounds may be used either alone or in combination of two or more thereof.

[0054]

As a material including such a rubber-based compound, a polyisoprene material can be preferably used. Examples of a commercially available product of the polyisoprene material include "KURAPRENE" (a registered trademark, manufactured by Kuraray Co., Ltd.). A number average molecular weight (M_n) of a polyisoprene-based compound contained in the polyisoprene material is preferably 40,000 or less, and more preferably 37,000 or less.

A material having a reactive group, such as a carboxy group, etc., and capable of being crosslinked with an epoxy compound, an isocyanate compound, an amino compound, or the like, or a material having a reactive group capable of being polymerized upon irradiation with energy rays, particularly ultraviolet rays, such as a (meth)acryloyl group, etc., is preferably used. In the case of using a material having a reactive group capable of being polymerized upon irradiation with energy rays, the rubber-based pressure sensitive adhesive can be used as an energy ray curable pressure sensitive adhesive which is cured upon irradiation with energy rays to become re-releasable. In this case, the generation of an adhesive residue at the time of releasing the semiconductor processing pressure sensitive adhesive sheet can be more efficiently inhibited. Examples of such a polyisoprene compound include "KURAPRENE LIR-403" and "KURAPRENE LIR-410" each having a carboxy group (all of which are a product name, manufactured by Kuraray Co., Ltd.), and the like as well as "KURAPRENE UC-203" and "KURAPRENE UC-102" each having a methacryloyl group and a carboxy group (all of which are a product name, manufactured by Kuraray Co., Ltd.), and the like.

The rubber-based pressure sensitive adhesive may be used either alone or in combination of two or more thereof.

In the case of using the rubber-based pressure sensitive adhesive, a tackifier or the like may be further added.

[0055]

(Urethane-based Pressure Sensitive Adhesive)

The urethane-based pressure sensitive adhesive which can be used for the pressure sensitive adhesive layer of the present invention is not particularly limited so long as it is a pressure sensitive adhesive including a urethane-based polymer having at least one of a urethane bond and a urea bond in a main chain and/or a side chain thereof and satisfying the aforementioned requirement (b). The urethane-based pressure sensitive adhesive is preferred from the standpoint

that an adhesive residue is hardly generated at the time of releasing the semiconductor processing pressure sensitive adhesive sheet. Examples of a commercially available product thereof include urethane-based pressure sensitive adhesives, such as "SH-101", "SH-101M", "SH-109", and "SP-205" (all of which are a product name, manufactured by TOYOCEM Co., Ltd.).

The urethane-based pressure sensitive adhesive can be used as an energy ray curable pressure sensitive adhesive which is cured upon irradiation with energy rays to become re-releasable. In this case, the generation of an adhesive residue at the time of releasing the semiconductor processing pressure sensitive adhesive sheet can be more efficiently inhibited. Examples of the pressure sensitive adhesive composition used for the energy ray curable pressure sensitive adhesive include those in which the energy ray curable compound to be blended in the aforementioned pressure sensitive adhesive composition (X) is blended. In the case of blending together with the urethane-based polymer, among the energy ray curable compounds, an energy ray curable urethane (meth)acrylate or urethane (meth)acrylate oligomer is preferred.

The energy ray curable pressure sensitive adhesive may be obtained by blending the aforementioned energy ray curable compound in the urethane-based pressure sensitive adhesive exemplified above as a commercially available product.

The urethane-based pressure sensitive adhesive may be used either alone or in combination of two or more thereof.

[0056]

(Other Pressure Sensitive Adhesives)

Examples of a pressure sensitive adhesive which can be further used for the pressure sensitive adhesive layer of the present invention include other energy ray curable pressure sensitive adhesives than the aforementioned energy ray curable pressure sensitive adhesive as well as heat expandable type or water swellable type pressure sensitive adhesives.

[0057]

(Crosslinking Agent)

The pressure sensitive adhesive layer may have a crosslinking structure in which the aforementioned acrylic copolymer or polyisoprene material, or the like is crosslinked. Examples of a crosslinking agent contained for crosslinking in the pressure sensitive adhesive composition include an organic polyvalent isocyanate

compound, an organic polyvalent epoxy compound, an organic polyvalent imine compound, and the like.

Examples of the organic polyvalent isocyanate compound may include an aromatic polyvalent isocyanate compound, an aliphatic polyvalent isocyanate compound, an alicyclic polyvalent isocyanate compound, and a trimer of such an organic polyvalent isocyanate compound; an isocyanate-terminal urethane prepolymer obtained through a reaction of such an organic polyvalent isocyanate compound with a polyol compound; and the like.

More specific examples of the organic polyvalent isocyanate compound include 2,4-tolylene diisocyanate, 2,6-tolylene diisocyanate, 1,3-xylylene diisocyanate, 1,4-xylylene diisocyanate, diphenylmethane-4,4'-diisocyanate, diphenylmethane-2,4'-diisocyanate, 3-methyldiphenylmethane diisocyanate, hexamethylene diisocyanate, isophorone diisocyanate, dicyclohexylmethane-4,4'-diisocyanate, dicyclohexylmethane-2,4'-diisocyanate, an adduct of tolylene diisocyanate and trimethylolpropane, and the like.

[0058]

Specific examples of the organic polyvalent epoxy compound include 1,3-bis(N,N'-diglycidylaminomethyl)cyclohexane, N,N,N',N'-tetraglycidyl-m-xylylenediamine, ethylene glycol diglycidyl ether, 1,6-hexanediol diglycidyl ether, trimethylolpropane diglycidyl ether, diglycidylaniline, diglycidylamine, and the like.

Specific examples of the organic polyvalent imine compound include N,N'-diphenylmethane-4,4'-bis(1-aziridinecarboxamide), trimethylolpropane-tri- β -aziridinyl propionate, tetramethylolmethane-tri- β -aziridinyl propionate, N,N'-toluene-2,4-bis(1-aziridinecarboxamide)triethylenemelamine, and the like.

As for the content of the crosslinking agent, the crosslinking agent is used in a ratio of preferably 0.01 to 20 parts by mass, more preferably 0.1 to 15 parts by mass, and still more preferably 0.5 to 8 parts by mass based on 100 parts by mass of the polymer component, such as the acrylic copolymer, the polyisoprene material, etc. When the content of the crosslinking agent is the aforementioned upper limit or less, the pressure sensitive adhesive layer is prevented from being excessively crosslinked, and an appropriate adhesive strength is readily obtained.

[0059]

(Energy Ray Polymerization Initiator)

In the case where the pressure sensitive adhesive composition (X) or pressure sensitive adhesive composition (Y) that is of an energy ray curable type is used as the aforementioned pressure sensitive adhesive composition, it is preferred that an energy ray polymerization initiator (in the present specification, also referred to as "photopolymerization initiator") is further included.

As the energy ray polymerization initiator, for example, the energy ray polymerization initiator exemplified above in the explanation of the resin composition for intermediate layer is exemplified, and it may be used either alone or in combination of two or more thereof.

A blending amount of the energy ray polymerization initiator is preferably 0.05 to 15 parts by mass, more preferably 0.1 to 10 parts by mass, and still more preferably 0.3 to 5 parts by mass based on 100 parts by mass of a sum total of the pressure sensitive adhesive composition.

[0060]

(Other Additives)

In the aforementioned pressure sensitive adhesive composition, other components than the aforementioned components, such as an antioxidant, a softener (plasticizer), a deterioration inhibitor, an antistatic agent, a flame retarder, a rust inhibitor, a filler, a silicone compound, a chain transfer agent, etc., may be properly contained.

[0061]

<Release Material>

The semiconductor processing pressure sensitive adhesive sheet of the present invention may further include a release material on the aforementioned pressure sensitive adhesive layer.

As the release material, a release sheet having been subjected to a double-sided release treatment, a release sheet having been subjected to a single-sided release treatment, and the like are useful, and those obtained by coating a release agent on a substrate for release material and the like are exemplified.

Examples of the substrate for release material include plastic films, such as polyester resin films of a polyethylene terephthalate resin, a polybutylene terephthalate resin, a polyethylene naphthalate resin, or the like; polyolefin resin films of a polypropylene resin, a polyethylene resin, or the like, etc.

Examples of the release agent include a silicone-based resin, an

olefin-based resin, an isoprene-based resin, a rubber-based elastomer, such as an isoprene-based resin, a butadiene-based resin, etc., a long-chain alkyl-based resin, an alkyd-based resin, a fluorine-based resin, and the like.

A thickness of the release material is preferably 5 to 200 μm , more preferably 10 to 120 μm , and still more preferably 15 to 80 μm .

[0062]

<Production Method of Semiconductor Processing Pressure Sensitive Adhesive Sheet>

A production method of the semiconductor processing pressure sensitive adhesive sheet is not particularly limited, and the semiconductor processing pressure sensitive adhesive sheet can be produced by a known method. The production method is hereunder described by reference to a method of forming an intermediate layer or a pressure sensitive adhesive layer by means of coating of the resin composition for intermediate layer or the pressure sensitive adhesive composition. With respect to the formation of the intermediate layer, the following method is suited for the case of casting the curable composition and curing it to obtain the intermediate layer. In addition, with respect to the formation of the pressure sensitive adhesive layer, the following method is a generally adopted method.

As the production method of the semiconductor processing pressure sensitive adhesive sheet, for example, there is exemplified a method of forming an intermediate layer 2 on a substrate 3 and then forming a pressure sensitive adhesive layer 1 as shown in Fig. 1. Examples of a method of forming the intermediate layer 2 on the substrate 3 include a method in which a solution of the resin composition for intermediate layer is directly coated on one surface of the substrate 3 to form a coating film, followed by performing a curing treatment to form the intermediate layer 2; a method in which a solution of the resin composition for intermediate layer is directly coated on the release treated surface of a release material to form a coating film, a semi-curing treatment is performed to form a semi-cured layer on the release material, the semi-cured layer is attached on the substrate 3, and before or after removing the release material, the semi-cured layer is completely cured to form the intermediate layer 2; and the like.

Next, there are exemplified a method in which a solution of the pressure sensitive adhesive composition is directly coated on the intermediate layer 2 as prepared in the aforementioned method, followed by drying to form the pressure

sensitive adhesive layer 1; a method in which a solution of the pressure sensitive adhesive composition is directly coated on the release treated surface of the release material and then dried to form the pressure sensitive adhesive layer 1 on the release material, and the pressure sensitive adhesive layer 1 is attached on the intermediated layer 2 as prepared in the aforementioned method, thereby once producing a semiconductor processing pressure sensitive adhesive sheet 10, followed by removing the release material; and the like.

[0063]

On forming the intermediate layer 2 or the pressure sensitive adhesive layer 1, by further blending an organic solvent in the resin composition for intermediate layer or pressure sensitive adhesive composition, the resin composition for intermediate layer or pressure sensitive adhesive composition may be converted to a solution form.

Examples of the organic solvent used include methyl ethyl ketone, acetone, ethyl acetate, tetrahydrofuran, dioxane, cyclohexane, n-hexane, toluene, xylene, n-propanol, isopropanol, and the like.

As such an organic solvent, the organic solvent used at the time of producing each of the components included in the resin composition for intermediate layer or pressure sensitive adhesive composition may be used as it is, or one or more other organic solvents may also be added.

A solid content concentration of the solution of the resin composition for intermediate layer or pressure sensitive adhesive composition is preferably 5 to 60 mass%, more preferably 10 to 50 mass%, and still more preferably 15 to 45 mass%.

[0064]

By coating the solution of the resin composition for intermediate layer or pressure sensitive adhesive composition on the substrate or the release material by a known coating method, a coating film can be formed.

Examples of the coating method include a spin coating method, a spray coating method, a bar coating method, a knife coating method, a roll coating method, a blade coating method, a die coating method, a gravure coating method, and the like.

In the case where the solution of the resin composition for intermediate layer or pressure sensitive adhesive composition includes an organic solvent, it is preferred that after coating this, the resultant is heated at a temperature of 80 to 150°C for 30 seconds to 5 minutes to undergo a drying treatment.

[0065]

As the curing treatment after coating the resin composition for intermediate layer to form a coating film, a method in which the formed coating film is polymerized and cured upon irradiation with energy rays, such as ultraviolet rays, etc., thereby undergoing film formation is preferred. In addition, as for the curing treatment, the curing may be completely carried out at once, or the curing may be carried out by being divided plural times.

Examples of the energy rays include ultraviolet rays, electron beams, and the like, with ultraviolet rays being preferred.

A dose of the energy rays is properly altered according to the kind of energy rays. For example, in the case of using ultraviolet rays, an illuminance of the ultraviolet rays to be irradiated is preferably 50 to 500 mW/cm², and more preferably 100 to 340 mW/cm², and a dose of the ultraviolet rays is preferably 100 to 2,500 mJ/cm², and more preferably 150 to 2,000 mJ/cm².

The intermediate layer 2 or the pressure sensitive adhesive layer 1 may be formed by means of extrusion molding. Such a method is suited for the case where the intermediate layer 2 or the pressure sensitive adhesive layer 1 is formed of an olefin-based material as a main material. A laminate in a state where the intermediate layer 2 and the pressure sensitive adhesive layer 1 are laminated may be obtained by a co-extrusion method.

[0066]

[Use Method of Semiconductor Processing Pressure Sensitive Adhesive Sheet]

In the case where the semiconductor processing pressure sensitive adhesive sheet of the present invention includes a release film, the semiconductor processing pressure sensitive adhesive sheet is used for the purpose of after releasing the release film, attaching the pressure sensitive adhesive surface of the semiconductor processing pressure sensitive adhesive sheet on the surface of a semiconductor wafer, particularly the surface of the wafer with bumps, thereby protecting the foregoing surface.

Specifically, the wafer with bumps on which the semiconductor processing pressure sensitive adhesive sheet is attached is subjected to polishing processing. In this regard, the semiconductor processing pressure sensitive adhesive sheet protects the surface of the wafer with bumps in the polishing process and prevents the bumps from being collapsed, whereby the generation of dimples or cracks on the polished surface can be inhibited. In addition, the semiconductor processing

pressure sensitive adhesive sheet is released from the wafer with bumps at the point of time when the processing including the polishing process is completed, and the surface needs not be protected any more.

On attaching the semiconductor processing pressure sensitive adhesive sheet on the wafer with bumps, attaching is carried out using a laminator or the like. In this regard, by using the semiconductor processing pressure sensitive adhesive sheet of the present invention, the intermediate layer and the pressure sensitive adhesive layer of the semiconductor processing pressure sensitive adhesive sheet appropriately transform under pressure and temperature at the time of attaching and follow the bumps, whereby an excellent laminate state can be obtained.

Though the pressure at the time of attaching the semiconductor processing pressure sensitive adhesive sheet is not particularly limited, it is preferably 0.05 to 1.0 MPa, and more preferably 0.1 to 0.5 MPa. In addition, though the temperature at the time of attaching the semiconductor processing pressure sensitive adhesive sheet is not particularly limited, it is preferably 30 to 100°C, and more preferably 40 to 80°C.

Examples

[0067]

The present invention is hereunder described in more detail based on the following Examples, but it should be construed that the present invention is by no means limited by these Examples.

[0068]

The measurement methods and evaluation methods in the present invention are as follows.

<Weight Average Molecular Weight (Mw), Number Average Molecular Weight (Mn), and Molecular Weight Distribution (Mw/Mn) of Raw Materials>

The weight average molecular weight (Mw), the number average molecular weight (Mn), and the molecular weight distribution (Mw/Mn) of raw materials used in each of the following Examples and Comparative Examples were measured under the following conditions by using a gel permeation chromatograph apparatus, and measured values as expressed in terms of standard polystyrene were adopted.

(Measurement Instruments)

Measurement apparatus: A product name: "HLC-8220GPC",
manufactured by Tosoh Corporation

Column: Column prepared by connecting a product name "TSKgel GMHXL-L" ($\times 2$) in series and a product name "TSKgel G2000HXL" ($\times 1$) (all of which are manufactured by Tosoh Corporation) in this order from an introduction port side for a measurement sample was used.

Detector: Differential refractometer
(Measurement Conditions)

Eluent: Tetrahydrofuran

Column temperature: 40°C

Flow rate: 1.0 mL/min

[0069]

<Loss Tangent ($\tan \delta$) and Storage Elastic Modulus I of Intermediate Layer>

A UV curable resin composition for forming an intermediate layer, used in each of the following Examples and Comparative Examples, was coated on a polyethylene terephthalate (PET) film-based release film (a product name: "SP-PET381031", thickness: 38 μm , manufactured by Lintec Corporation) in the fountain die method, thereby forming a coating film. Ultraviolet rays were then irradiated from the coating film side, thereby forming a semi-cured layer.

The irradiation with ultraviolet rays was performed by using a belt conveyor type ultraviolet ray irradiating device (a product name: "ECS-4011GX", manufactured by EYE GRAPHICS Co., Ltd.) as a ultraviolet ray irradiating device and using a high pressure mercury lamp (a model: "H04-L41", manufactured by EYE GRAPHICS Co., Ltd.) as a ultraviolet source under irradiation conditions at an illuminance of 112 mW/cm^2 of a light wavelength of 365 nm and at a luminous energy of 177 mJ/cm^2 (measured by a ultraviolet ray actinometer "UVPF-A1", manufactured by EYE GRAPHICS Co., Ltd.).

On the formed semi-cured layer, a polyethylene terephthalate (PET) film-based release film (a product name: "SP-PET381031", thickness: 38 μm , manufactured by Lintec Corporation) was laminated, and the laminate was further irradiated with ultraviolet rays (using the aforementioned ultraviolet ray irradiating device and ultraviolet source under irradiation conditions at an illuminance of 271 mW/cm^2 and at a luminous energy of 1,200 mJ/cm^2), thereby undergoing complete curing. There was thus formed an intermediate layer having a thickness of 200 μm , in which the release film was attached on the both surfaces.

Five intermediate layers formed in this way were prepared, the PET-based release films were released, and the release surfaces were gathered with each other and laminated successively, thereby preparing an intermediate layer laminate (thickness: 1,000 μm).

Subsequently, the obtained intermediate layer laminate was punched out in a circle having a diameter of 10 mm, thereby obtaining a sample for measuring viscoelasticity.

Using a viscoelasticity measuring device (a product name: "ARES", manufactured by TA Instruments), a strain with a frequency of 1 Hz was given to the aforementioned sample, and a storage elastic modulus (G') at -50 to 150°C was measured at a rate of temperature rise of 4°C/min, thereby obtaining a loss tangent ($\tan \delta$) at 50°C and a value of the storage elastic modulus at 50°C as the storage elastic modulus I.

[0070]

<Storage Elastic Modulus A of Pressure Sensitive Adhesive Layer>

A pressure sensitive adhesive layer of a pressure sensitive adhesive composition used in each of the following Examples and Comparative Examples, having a thickness of 50 μm , on the both surface of which a polyethylene terephthalate (PET) film-based release film (a product name: "SP-PET381031", thickness: 38 μm , manufactured by Lintec Corporation) was attached, was formed by using a knife coater.

Plural sheets of the pressure sensitive adhesive layer formed in this way were prepared, the PET-based release films were released, and the release surfaces were gathered with each other and laminated successively, thereby preparing a pressure sensitive adhesive layer laminate (thickness: 1,000 μm).

Subsequently, the obtained pressure sensitive adhesive layer laminate was punched out in a circle having a diameter of 10 mm, thereby obtaining a sample for measuring viscoelasticity.

Using a viscoelasticity measuring device (a product name: "ARES", manufactured by TA Instruments), a strain with a frequency of 1 Hz was given to the aforementioned sample, and a storage elastic modulus at -50 to 150°C was measured at a rate of temperature rise of 4°C/min, thereby obtaining a value of the storage elastic modulus at 50°C as the storage elastic modulus A.

[0071]

[Evaluation Methods]

<Evaluation of Bump Absorption Property>

On a wafer with spherical bumps made of an Sn-3Ag-0.5Cu alloy and having a bump height of 80 μm , a pitch of 200 μm , and a diameter of 100 μm (8-inch wafer, manufactured by Waltz Co., Ltd.), a semiconductor processing pressure sensitive adhesive sheet prepared in each of the following Examples and Comparative Examples was attached using a laminator (a product name: "RAD-3510F/12", manufactured by Lintec Corporation). On attaching, a temperature of each of a laminate table and a laminate roll of the apparatus was set to 50°C.

After lamination, a diameter of a circular air void generated in the surroundings of bumps from the substrate side was measured using a digital optical microscope (a product name: "VHX-1000", manufactured by KEYENCE Corporation).

It is indicated that the smaller the diameter of the air void, the higher the bump absorption property of the semiconductor processing pressure sensitive adhesive sheet is. The superiority or inferiority of the bump absorption property was decided according to the following criteria.

A: The diameter of the air void is less than 120 μm .

B: The diameter of the air void is 120 μm or more and less than 130 μm .

C: The diameter of the air void is 130 μm or more.

[0072]

<Evaluation of Adhesive Residue in Bump Portion>

On a wafer with spherical bumps made of an Sn-3Ag-0.5Cu alloy and having a bump height of 80 μm , a pitch of 200 μm , and a diameter of 100 μm (8-inch wafer, manufactured by Waltz Co., Ltd.), a semiconductor processing pressure sensitive adhesive sheet prepared in each of the following Examples and Comparative Examples was attached using a laminator (a product name: "RAD-3510F/12", manufactured by Lintec Corporation). On attaching, a temperature of each of a laminate table and a laminate roll of the apparatus was set to 50°C.

After lamination, UV was irradiated from the semiconductor processing pressure sensitive adhesive sheet side at an irradiation rate of 15 mm/sec by a UV irradiating device (a product name: "RAD-2000m/12", manufactured by Lintec Corporation). Subsequently, the semiconductor processing pressure sensitive adhesive sheet was released from the evaluation wafer under conditions at a

release rate of 4 mm/sec and at a temperature 40°C by using a wafer mounter (a product name: "RAD-2700F/12", manufactured by Lintec Corporation). A portion of the pressure sensitive adhesive layer surface of the semiconductor processing pressure sensitive adhesive sheet after releasing, where the bumps were embedded before releasing was observed under an observation angle of 45° by using an electron microscope (a product name: "VE-9800", manufactured by KEYENCE Corporation), thereby confirming the presence or absence of breakage of the pressure sensitive adhesive layer.

The superiority or inferiority of the adhesive residue was decided according to the following criteria.

A: A broken place is not observed (the adhesive residue is not present).

B: A broken place is observed (the adhesive residue is present).

[0073]

[Production Example 1]

<Preparation of Intermediate Layer-Provided Substrate A>

A UV curable resin composition 1 that is a resin composition for intermediate layer, which was prepared by blending 40 parts by mass of monofunctional urethane acrylate, 45 parts by mass of isobornyl acrylate (IBXA), 15 parts by mass of hydroxypropyl acrylate (HPA), 3.5 parts by mass of pentaerythritol tetrakis(3-mercaptoputyrate) (a product name: "KARENZ MT PE1", a secondary tetrafunctional thiol-containing compound, manufactured by Showa Denko K.K.), 1.8 parts by mass of a crosslinking agent, and 1.0 part by mass of 2-hydroxy-2-methyl-1-phenyl-propan-1-one (a product name: "DAROCUR 1173", manufactured by BASF SE) as a photopolymerization initiator, was obtained.

The UV curable resin composition 1 was coated on a polyethylene terephthalate (PET) film-based release film (a product name: "SP-PET381031", thickness: 38 µm, manufactured by Lintec Corporation) in the fountain die method, thereby forming a coating film.

Then, ultraviolet rays were irradiated from the coating film side, thereby forming a semi-cured layer composed of the UV curable resin composition 1.

The irradiation with ultraviolet rays was performed by using a belt conveyor type ultraviolet ray irradiating device (a product name: "ECS-4011GX", manufactured by EYE GRAPHICS Co., Ltd.) as a ultraviolet ray irradiating device and using a high pressure mercury lamp (a model: "H04-L41", manufactured by

EYE GRAPHICS Co., Ltd.) as a ultraviolet source under irradiation conditions at an illuminance of 112 mW/cm² of a light wavelength of 365 nm and at a luminous energy of 177 mJ/cm² (measured by a ultraviolet ray actinometer "UVPF-A1", manufactured by EYE GRAPHICS Co., Ltd.).

On the formed semi-cured layer, a polyethylene terephthalate (PET) film (a product name: "COSMO SHINE A4100", thickness: 50 μm, manufactured by Toyobo Co., Ltd.) was laminated, and the laminate was further irradiated with ultraviolet rays (using the aforementioned ultraviolet ray irradiating device and ultraviolet source under irradiation conditions at an illuminance of 271 mW/cm² and at a luminous energy of 1,200 mJ/cm²) from the PET film side, thereby undergoing complete curing. There was thus formed an intermediate layer-provided substrate A having a thickness of 200 μm on the PET film as the substrate.

[0074]

[Production Example 2]

<Preparation of Intermediate Layer-Provided Substrate B>

A UV curable resin composition 2 that is a resin composition for intermediate layer, which was prepared by blending 40 parts by mass of monofunctional urethane acrylate, 45 parts by mass of isobornyl acrylate (IBXA), 15 parts by mass of hydroxypropyl acrylate (HPA), 1.5 parts by mass of pentaerythritol tetrakis(3-mercaptopbutyrate) (a product name: "KARENZ MT PE1", a secondary tetrafunctional thiol-containing compound, manufactured by Showa Denko K.K.), and 1.0 part by mass of 2-hydroxy-2-methyl-1-phenyl-propan-1-one (a product name: "DAROCUR 1173", manufactured by BASF SE) as a photopolymerization initiator, was obtained.

An intermediate layer-provided substrate B having a thickness of 200 μm was formed on the PET film as the substrate by adopting the same method as in Production Example 1, except for using the UV curable resin composition 2.

[0075]

[Production Example 3]

<Preparation of Intermediate Layer-Provided Substrate C>

A UV curable resin composition 3 that is a resin composition for intermediate layer, which was prepared by blending 25 parts by mass of a urethane oligomer (Mw: 50,000) composed of polypropylene glycol (PPG, Mw: 4,000) and hexamethylene diisocyanate (HDI), 35 parts by mass of isobornyl

acrylate (IBXA), 40 parts by mass of 2-hydroxyphenoxypropyl acrylate (HPPA), and 1.0 part by mass of 2-hydroxy-2-methyl-1-phenyl-propan-1-one (a product name: "DAROCUR 1173", manufactured by BASF SE) as a photopolymerization initiator, was obtained.

An intermediate layer-provided substrate C having a thickness of 200 μm was formed on the PET film as the substrate by adopting the same method as in Production Example 1, except for using the UV curable resin composition 3.

[0076]

[Example 1]

<Preparation of Semiconductor Processing Pressure Sensitive Adhesive Sheet 1>

A solution of a resin (pressure sensitive adhesive main agent, solid content: 35.0 mass%) was prepared by adding 2-isocyanatoethyl methacrylate (a product name: "KARENZ MOI" (a registered trademark), manufactured by Showa Denko K.K.) to an acrylic copolymer composed of 94 parts by mass of 2-ethylhexyl acrylate (2EHA) and 6 parts by mass of 2-hydroxyethyl acrylate (2HEA) so that an addition ratio of 2-isocyanatoethyl methacrylate to 100 mol% of 2HEA was 50 mol%. The obtained resin had a weight average molecular weight (M_w) of 900,000 and an M_w/M_n of 9.07.

To 100 parts by mass of this pressure sensitive adhesive main agent, 1.0 part by mass of 1-hydroxycyclohexyl phenyl ketone (a product name: "IRGACURE 184"; the "IRGACURE" is a registered trademark, manufactured by BASF SE) was added as a photopolymerization initiator, and 0.75 parts by mass of a polyvalent isocyanate compound (a product name: "BHS-8515", solid content: 37.5 mass%, manufactured by TOYOCEM Co., Ltd.) was further added as a crosslinking agent. The mixture was stirred for 30 minutes to prepare a pressure sensitive adhesive composition 1.

Subsequently, a solution of the prepared pressure sensitive adhesive composition 1 was coated on a polyethylene terephthalate (PET)-based release film (a product name: "SP-PET381031", thickness: 38 μm , manufactured by Lintec Corporation) and dried, thereby forming a pressure sensitive adhesive layer having a thickness of 10 μm on the release film.

The release film on the previously prepared intermediate layer-provided substrate A was removed, the intermediate layer surface of the exposed intermediate layer-provided substrate A and the pressure sensitive adhesive layer were attached to each other, and unnecessary portions of end portions in the width

direction were removed by means of cutting, thereby preparing a semiconductor processing pressure sensitive adhesive sheet 1.

[0077]

[Example 2]

<Preparation of Semiconductor Processing Pressure Sensitive Adhesive Sheet 2>

A semiconductor processing pressure sensitive adhesive sheet 2 was prepared by adopting the same method as in Example 1, except for using the intermediate layer-provided substrate B.

[0078]

[Example 3]

<Preparation of Semiconductor Processing Pressure Sensitive Adhesive Sheet 3>

A solution of a resin (pressure sensitive adhesive main agent, solid content: 25 mass%) was prepared by adding 2-isocyanatoethyl methacrylate (a product name: "KARENZ MOI" (a registered trademark), manufactured by Showa Denko K.K.) to an acrylic copolymer composed of 90 parts by mass of 2-ethylhexyl acrylate (2EHA) and 10 parts by mass of 4-hydroxybutyl acrylate (4HBA) so that an addition ratio of 2-isocyanatoethyl methacrylate to 100 mol% of 4HBA was 37 mol%. The obtained resin had a weight average molecular weight (Mw) of 1,000,000 and an Mw/Mn of 5.84.

To 100 parts by mass of this pressure sensitive adhesive main agent, 0.75 parts by mass of 1-hydroxycyclohexyl phenyl ketone (a product name: "IRGACURE 184"; the "IRGACURE" is a registered trademark, manufactured by BASF SE) was added as a photopolymerization initiator, and 0.75 parts by mass of a polyvalent isocyanate compound (a product name: "BHS-8515", manufactured by TOYOCEM Co., Ltd.) was further added as a crosslinking agent. The mixture was stirred for 30 minutes to prepare a pressure sensitive adhesive composition 2.

Subsequently, a semiconductor processing pressure sensitive adhesive sheet 3 was prepared by adopting the same method as in Example 1, except for using the pressure sensitive adhesive composition 2.

[0079]

[Example 4]

<Preparation of Semiconductor Processing Pressure Sensitive Adhesive Sheet 4>

To 50 parts by mass of a liquid polyisoprene material (a product name: "KURAPRENE UC-203"; the "KURAPRENE" is a registered trademark, manufactured by Kuraray Co., Ltd.), 50 parts by mass of toluene was added to

prepare a material A having a solid content of 50 mass%.

Furthermore, to 50 parts by mass of a liquid polyisoprene material (a product name: "KURAPRENE LIR-410"; the "KURAPRENE" is a registered trademark, manufactured by Kuraray Co., Ltd.), 50 parts by mass of toluene was added to prepare a material B having a solid content of 50 mass%.

100 parts by mass of the material A was blended with 50 parts by mass of the material B, to which was then added 4.0 parts by mass of 2,2-dimethoxy-1,2-diphenylethan-1-one (a product name: "IRGACURE 651"; the "IRGACURE" is a registered trademark, manufactured by BASF SE) as a photopolymerization initiator and also added 0.75 parts by mass of an epoxy compound (a product name: "TETRAD-C"; the "TETRAD" is a registered trademark, manufactured by Mitsubishi Gas Chemical Company, Inc.) as a crosslinking agent. The mixture was stirred for 30 minutes to prepare a pressure sensitive adhesive composition 3.

A semiconductor processing pressure sensitive adhesive sheet 4 was prepared by adopting the same method as in Example 2, except for using the pressure sensitive adhesive composition 3.

[0080]

[Example 5]

<Preparation of Semiconductor Processing Pressure Sensitive Adhesive Sheet 5>

A pressure sensitive adhesive composition 4 was prepared by adopting the same method as in Example 4, except for adding 100 parts by mass of the material A, 100 parts by mass of the material B, and 1.25 parts by mass of an epoxy compound (a product name: "TETRAD-C"; the "TETRAD" is a registered trademark, manufactured by Mitsubishi Gas Chemical Company, Inc.) as a crosslinking agent.

A semiconductor processing pressure sensitive adhesive sheet 5 was prepared by adopting the same method as in Example 4, except for using the pressure sensitive adhesive composition 4.

[0081]

[Example 6]

<Preparation of Semiconductor Processing Pressure Sensitive Adhesive Sheet 6>

To 100 parts by mass of "SH-101" (a product name, solid content: 60 mass%, manufactured by TOYOCEM Co., Ltd.) as a urethane-based pressure sensitive adhesive, 6 parts by mass of "T-501B" (a product name, solid content: 75 mass%,

manufactured by TOYOCEM Co., Ltd.) as a polyvalent isocyanate component and 43 parts by mass of "EXL-810TL" (a product name, solid content: 61 mass%, manufactured by Dainichiseika Color & Chemicals Mfg. Co., Ltd.) as a polyfunctional urethane acrylate (containing 1-hydroxycyclohexyl phenyl ketone as a photopolymerization initiator). The mixture was stirred for 30 minutes to prepare a pressure sensitive adhesive composition 5.

A semiconductor processing pressure sensitive adhesive sheet 6 was prepared by adopting the same method as in Example 1, except for using the pressure sensitive adhesive composition 5.

[0082]

[Example 7]

<Preparation of Semiconductor Processing Pressure Sensitive Adhesive Sheet 7>

A solution of a resin (pressure sensitive adhesive main agent, solid content: 58.5 mass%) was prepared by adding 2-isocyanatoethyl methacrylate (a product name: "KARENZ MOI" (a registered trademark), manufactured by Showa Denko K.K.) to an acrylic copolymer composed of 94 parts by mass of 2-ethylhexyl acrylate (2EHA) and 6 parts by mass of 2-hydroxyethyl acrylate (2HEA) so that an addition ratio of 2-isocyanatoethyl methacrylate to 100 mol% of 2HEA was 50 mol%. The obtained resin had a weight average molecular weight (Mw) of 300,000 and an Mw/Mn of 3.86.

To 100 parts by mass of this pressure sensitive adhesive main agent, 1.0 part by mass of 1-hydroxycyclohexyl phenyl ketone (a product name: "IRGACURE 184"; the "IRGACURE" is a registered trademark, manufactured by BASF SE) was added as a photopolymerization initiator, and 0.75 parts by mass of a polyvalent isocyanate compound (a product name: "BHS-8515", manufactured by TOYOCEM Co., Ltd.) was further added as a crosslinking agent. The mixture was stirred for 30 minutes to prepare a pressure sensitive adhesive composition 6.

A semiconductor processing pressure sensitive adhesive sheet 7 was prepared by adopting the same method as in Example 1, except for using the pressure sensitive adhesive composition 6.

[0083]

[Comparative Example 1]

<Preparation of Semiconductor Processing Pressure Sensitive Adhesive Sheet 8>

To 100 parts by mass of a liquid polybutadiene material (a product name: "NISSO-PB GQ-2000", solid content: 45 mass%; the "NISSO-PB" is a registered

trademark, manufactured by Nippon Soda Co., Ltd.), 8.0 parts by mass of polyfunctional polybutadiene isocyanate (a product name: "NISSO-PB TP-1001", solid content: 50 mass%, manufactured by Nippon Soda Co., Ltd.) was added as a crosslinking agent. The mixture was stirred for 30 minutes to prepare a pressure sensitive adhesive composition 7.

A semiconductor processing pressure sensitive adhesive sheet 8 was prepared by adopting the same method as in Example 2, except for using the pressure sensitive adhesive composition 7.

[0084]

[Comparative Example 2]

<Preparation of Semiconductor Processing Pressure Sensitive Adhesive Sheet 9>

To 30 parts by weight of a styrene/ethylene-butylene block copolymer (a product name: "TUFTEC H-1041", styrene/ethylene-butylene ratio (weight ratio) = 30/70; the "TUFTEC" is a registered trademark, manufactured by Asahi Kasei Chemicals Corporation), 70 parts by weight of toluene was added to prepare a pressure sensitive adhesive composition 8 having a solid content of 30 mass%.

A semiconductor processing pressure sensitive adhesive sheet 9 was prepared by adopting the same method as in Example 1, except for using the pressure sensitive adhesive composition 8.

[0085]

[Comparative Example 3]

<Preparation of Semiconductor Processing Pressure Sensitive Adhesive Sheet 10>

To 30 parts by weight of a styrene/ethylene-butylene block copolymer (a product name: "TUFTEC H-1051", styrene/ethylene-butylene ratio (weight ratio) = 20/80, manufactured by Asahi Kasei Chemicals Corporation), 70 parts by weight of toluene was added to prepare a pressure sensitive adhesive composition 9 having a solid content of 30 mass%.

A semiconductor processing pressure sensitive adhesive sheet 10 was prepared by adopting the same method as in Comparative Example 2, except for using the pressure sensitive adhesive composition 9.

[0086]

[Comparative Example 4]

<Preparation of Semiconductor Processing Pressure Sensitive Adhesive Sheet 11>

A solution of an acrylic copolymer (pressure sensitive adhesive main agent, $M_w = 720,000$, $M_w/M_n = 5.98$, solid content: 40.0 mass%) composed of 59.5 parts

by mass of 2-ethylhexyl acrylate (2EHA), 30 parts by mass of vinyl acetate (VAc), 10 parts by mass of 2-hydroxyethyl acrylate (2HEA), and 0.5 parts by mass of acrylic acid was prepared.

To 100 parts by mass of the foregoing pressure sensitive adhesive main agent, 6.0 parts by mass of a polyvalent isocyanate compound (a product name: "BHS-8515", manufactured by TOYO CHEM Co., Ltd.) was added as a crosslinking agent. The mixture was stirred for 30 minutes to prepare a pressure sensitive adhesive composition 10.

A semiconductor processing pressure sensitive adhesive sheet 11 was prepared by adopting the same method as in Comparative Example 1, except for using the pressure sensitive adhesive composition 10.

[0087]

[Comparative Example 5]

<Preparation of Semiconductor Processing Pressure Sensitive Adhesive Sheet 12>

A solution of a resin (pressure sensitive adhesive main agent, solid content: 35.0 mass%) was prepared by adding 2-isocyanatoethyl methacrylate (a product name: "KARENZ MOI" (a registered trademark), manufactured by Showa Denko K.K.) to an acrylic copolymer composed of 74 parts by mass of butyl acrylate (BA), 20 parts by mass of methyl methacrylate (MMA), and 6 parts by mass of 2-hydroxyethyl acrylate (2HEA) an addition ratio of 2-isocyanatoethyl methacrylate to 100 mol% of 2HEA was 80 mol%. The obtained resin had a weight average molecular weight (Mw) of 690,000 and an Mw/Mn of 6.32.

To 100 parts by mass of this pressure sensitive adhesive main agent, 0.5 parts by mass of a polyvalent isocyanate compound (a product name: "BHS-8515", manufactured by TOYO CHEM Co., Ltd.) was added as a crosslinking agent. The mixture was stirred for 30 minutes to prepare a pressure sensitive adhesive composition 11.

Subsequently, a solution of the prepared pressure sensitive adhesive composition 11 was coated on a polyethylene terephthalate (PET)-based release film (a product name: "SP-PET381031", thickness: 38 μm , manufactured by Lintec Corporation) and dried, thereby forming a pressure sensitive adhesive layer having a thickness of 10 μm on the release film.

The release film on the previously prepared intermediate layer-provided substrate C was removed, the intermediate layer surface of the exposed intermediate layer-provided substrate C and the pressure sensitive adhesive layer

were attached to each other, and unnecessary portions of end portions in the width direction were removed by means of cutting, thereby preparing a semiconductor processing pressure sensitive adhesive sheet 12.

[0088]

[Comparative Example 6]

<Preparation of Semiconductor Processing Pressure Sensitive Adhesive Sheet 13>

A semiconductor processing pressure sensitive adhesive sheet 13 was prepared by adopting the same method as in Comparative Example 4, except for using the intermediate layer-provided substrate A.

[0089]

Table 1

	Sheet No.	Intermediate layer-provided substrate No.	Properties of semiconductor processing pressure sensitive adhesive sheet and respective members ¹⁾				Evaluation results	
			(a) Loss tangent of intermediate layer	(b) A/I	Storage elastic modulus A of pressure sensitive adhesive layer	Storage elastic modulus I of intermediate layer	Bump absorption property	Adhesive residue
			[-]	[-]	[$\times 10^4$ Pa]	[$\times 10^4$ Pa]	[-]	[-]
Example 1	1	A	3.62	0.241	3.40	14.1	A	A
Example 2	2	B	1.87	0.472	3.40	7.20	A	A
Example 3	3	A	3.62	0.211	2.97	14.1	A	A
Example 4	4	B	1.87	0.939	6.76	7.20	A	A
Example 5	5	B	1.87	1.26	9.09	7.20	B	A
Example 6	6	A	3.62	0.694	9.78	14.1	A	A
Example 7	7	A	3.62	0.452	6.37	14.1	A	B
Comparative Example 1	8	B	1.87	3.10	22.3	7.20	C	A
Comparative Example 2	9	A	3.62	2.35	33.2	14.1	C	A
Comparative Example 3	10	A	3.62	5.18	73.1	14.1	C	A
Comparative Example 4	11	B	1.87	3.78	27.2	7.20	C	B
Comparative Example 5	12	C	0.725	0.947	10.7	11.3	C	A
Comparative Example 6	13	A	3.62	1.93	27.2	14.1	C	A

¹⁾ Measured at 50°C at a frequency of 1Hz

□

[0090]

From Table 1, it is noted that the semiconductor processing pressure sensitive adhesive sheets 1 to 7 as prepared in Examples 1 to 7 are excellent in the bump absorption property.

On the other hand, in the semiconductor processing pressure sensitive adhesive sheets 8 to 11 and 13 as prepared in Comparative Examples 1 to 4 and 6, the value of the ratio $[A/I]$ of the storage elastic modulus A of the pressure sensitive adhesive layer and the storage elastic modulus I of the intermediate layer at 50°C as measured at a frequency of 1 Hz is more than 1.8, and therefore, the transformation of the pressure sensitive adhesive layer to an extent that it is able to follow the bumps did not take place. As a result, there were revealed such results that the bump absorption property is poor.

In addition, in the semiconductor processing pressure sensitive adhesive sheet 12 as prepared in Comparative Example 5, since the loss tangent of the intermediate layer at 50°C as measured at a frequency of 1 Hz is less than 1.0, the intermediate layer cannot be thoroughly transformed due to a stress at the time of lamination on the bump wafer, so that it cannot follow the bumps. Thus, there were revealed such results that the bump absorption property is poor.

Industrial Applicability

[0091]

Since the semiconductor processing pressure sensitive adhesive sheet of the present invention is excellent in the absorption property of bumps, in particular, the generation of an air void between the bump and the semiconductor processing pressure sensitive adhesive sheet can be prevented.

For that reason, for example, the semiconductor processing pressure sensitive adhesive sheet of the present invention is suitable as a surface protective sheet which on grinding the back surface of a semiconductor wafer with bumps, is attached on the bumps of the semiconductor wafer to protect the bumps.

Reference Signs List

[0092]

- 1: Pressure sensitive adhesive layer
- 2: Intermediate layer
- 3: Substrate

10: Semiconductor processing pressure sensitive adhesive sheet

CLAIMS

[Claim 1]

A semiconductor processing pressure sensitive adhesive sheet comprising a substrate having thereon an intermediate layer and a pressure sensitive adhesive layer in this order,

wherein the intermediate layer is formed of a resin composition including urethane (meth)acrylate and a thiol group-containing compound,

the pressure sensitive adhesive layer is formed of an acrylic pressure sensitive adhesive, a rubber-based pressure sensitive adhesive, or a urethane-based pressure sensitive adhesive, and

the semiconductor processing pressure sensitive adhesive sheet satisfying the following (a) and (b):

(a) a loss tangent of the intermediate layer at 50°C as measured at a frequency of 1 Hz is 1.0 or more, and

(b) a ratio $[A/I]$ of a storage elastic modulus A of the pressure sensitive adhesive layer and a storage elastic modulus I of the intermediate layer at 50°C as measured at a frequency of 1 Hz is 1.8 or less.

[Claim 2]

The semiconductor processing pressure sensitive adhesive sheet according to claim 1, wherein the ratio $[A/I]$ of the storage elastic modulus A of the pressure sensitive adhesive layer and the storage elastic modulus I of the intermediate layer at 50°C as measured at a frequency of 1 Hz is 1.0 or less.

[Claim 3]

The semiconductor processing pressure sensitive adhesive sheet according to claim 1 or 2, wherein the storage elastic modulus I of the intermediate layer at 50°C as measured at a frequency of 1 Hz is 1.0×10^6 Pa or less.

[Claim 4]

The semiconductor processing pressure sensitive adhesive sheet according to any one of claims 1 to 3, wherein a thickness of the intermediate layer is 50 to 400 μm .

[Claim 5]

The semiconductor processing pressure sensitive adhesive sheet according to any one of claims 1 to 4, wherein the acrylic pressure sensitive adhesive, the rubber-based pressure sensitive adhesive, or the urethane-based pressure

sensitive adhesive is an energy ray curable pressure sensitive adhesive.

[Claim 6]

The semiconductor processing pressure sensitive adhesive sheet according to any one of claims 1 to 5, wherein the acrylic pressure sensitive adhesive includes an acrylic copolymer containing, as a copolymer component, an alkyl (meth)acrylate having an alkyl group having 4 or more carbon atoms in an amount 50 to 98 mass% relative to the whole amount of the copolymer components.

[Claim 7]

The semiconductor processing pressure sensitive adhesive sheet according to claim 6, wherein the alkyl (meth)acrylate having an alkyl group having 4 or more carbon atoms is an alkyl (meth)acrylate having an alkyl group having 6 to 8 carbon atoms.

[Claim 8]

The semiconductor processing pressure sensitive adhesive sheet according to any one of claims 1 to 7, wherein the acrylic pressure sensitive adhesive includes a resin having an energy ray polymerizable functional group introduced into an acrylic copolymer and having a weight average molecule weight of 800,000 or more.

[Claim 9]

A method of protecting a surface of a semiconductor wafer, comprising attaching the semiconductor processing pressure sensitive adhesive sheet according to any one of claims 1 to 8 to a surface of a semiconductor wafer.