DESCRIPTION

Title of Invention:

ADHESIVE COMPOSITION, LAMINATE, AND METHOD FOR PRODUCING PROCESSED SEMICONDUCTOR SUBSTRATE

Technical Field

[0001]

The present invention relates to an adhesive composition, a laminate, and a method for producing a processed semiconductor substrate.

Background Art

[0002]

There is a demand for semiconductor integration technology in which semiconductor wafers conventionally integrated in a two-dimensional planar direction are further integrated (laminated) also in a three-dimensional direction for the purpose of achieving even higher integration. This three-dimensional lamination is a technology of integrating multiple layers while connecting the layers by a through silicon via (TSV). At the time of multilayer integration, respective wafers to be integrated are thinned by polishing on the side opposite to the formed circuit surface (that is, the back surface), and the thinned semiconductor wafers are laminated.

[0003]

A semiconductor wafer before thinning (also referred to herein simply as a wafer) is bonded to a support in order to be polished with a polishing apparatus. The adhesion at that time needs to be easily releasable after polishing, and is therefore referred to as temporary adhesion. This temporary adhesion needs to allow easy removal from the support. Otherwise, the thinned semiconductor wafer may be cut or deformed when a large force is applied for the removal. In order to prevent such a situation, the semiconductor wafer is easily removed. On the other hand, it is not also preferable that polishing stress at the time of polishing the back surface of the semiconductor wafer causes the semiconductor wafer to be detached or displaced. Therefore, the performance required for temporary adhesion is to withstand the stress during polishing and to allow for easy removal after polishing.

[0004]

As temporary adhesives used for such temporary adhesion, an adhesive containing polydimethylsiloxane (Patent Literature 1), a temporary adhesive containing an epoxy-modified polysiloxane (Patent Literature 2), and the like have been proposed. In these techniques, the release between the support and the semiconductor wafer is performed by inserting a sharp portion of equipment having a sharp portion, which is called a debonder, into the layer

of a temporary adhesive.

[0005]

On the other hand, release between a support and a semiconductor wafer using infrared rays has been proposed.

For example, there has been proposed a releasable adhesive composition for infrared ray release that allows for release by infrared irradiation, the adhesive composition for infrared ray release containing a component (A) cured by a hydrosilylation reaction, and at least one component (B) selected from the group consisting of a component containing an epoxy-modified polyorganosiloxane, a component containing a methyl group-containing polyorganosiloxane, and a component containing a phenyl group-containing polyorganosiloxane (Patent Literature 3).

There has also been proposed a method for releasing a laminate including: a first step of bonding a first body composed of a semiconductor formation substrate and a second body composed of a support substrate that transmits an infrared laser via a first adhesive layer provided on the first body side and a second adhesive layer provided on the second body side to form a laminate, wherein the first adhesive layer is an adhesive layer obtained by curing an adhesive (A) containing a component cured by a hydrosilylation reaction, and the second adhesive layer is an adhesive layer that transmits the infrared laser

obtained by using an adhesive (B), which is a polymer adhesive having an aromatic ring in at least one of a main chain and a side chain; and a second step of performing release between the first adhesive layer and the second adhesive layer by irradiating the laminate with the infrared laser from the second body side (Patent Literature 4).

In the release using infrared rays, the adhesive is deteriorated by irradiation with infrared rays to facilitate release.

Citation List

Patent Literature

[0006]

Patent Literature 1: WO 2017/221772 A

Patent Literature 2: WO 2018/216732 A

Patent Literature 3: WO 2020/100966 A

Patent Literature 4: WO 2020/100965 A

Summary of Invention

Technical Problem

[0007]

Since a certain degree of insertion force is required in the release by the equipment having the sharp portion in the techniques described in Patent Literature 1 and Patent

Literature 2, it takes a treatment time and damage to the semiconductor wafer or the support substrate may be a problem.

In the techniques described in Patent Literature 3 and Patent Literature 4, it is necessary to sufficiently irradiate with an infrared laser in order to facilitate release, but in this case, it takes a long treatment time, and deterioration of cleanability due to deterioration of an adhesive may be a problem.

[0008]

An object of the present invention is to provide an adhesive composition which does not require a long treatment time in release using an infrared laser, causes little damage to a body, has good cleanability, a laminate using the adhesive composition, and a method for producing a processed semiconductor substrate or electronic device layer using the laminate.

Solution to Problem

[0009]

As a result of intensive studies to solve the above-mentioned problems, the present inventors have found that the above-mentioned problems can be solved, and completed the present invention having the following gist.

[0010]

That is, the present invention includes the following items.

[1] An adhesive composition for forming an adhesive layer used in a laminate including a first body that is a semiconductor substrate or an electronic device layer, a second body that is a support substrate transmitting an infrared laser, and an adhesive layer provided between the first body and the second body, wherein after processing the first body, the adhesive layer is irradiated with the infrared laser from the second body side, and then the first body and the second body are separated,

the adhesive composition containing: an adhesive component having a siloxane bond, a release agent component, and an infrared-absorbing agent.

[2] The adhesive composition according to [1], wherein the adhesive component is a component that is cured by a hydrosilylation reaction.

[3] The adhesive composition according to [2], wherein the component that cures by the hydrosilylation reaction contains:

a component (A-1) having an alkenyl group having 2 to 40 carbon atoms bonded to a silicon atom; and

a component (A-2) having a Si-H group.

[4] The adhesive composition according to [3], wherein the component (A-1) contains a polyorganosiloxane

(a1) containing an alkenyl group having 2 to 40 carbon atoms, the alkenyl group being bonded to a silicon atom.

[5] The adhesive composition according to [3] or [4], wherein the component (A-2) contains a polyorganosiloxane having a Si-H group.

[6] The adhesive composition according to any one of [1] to [5], wherein the release agent component is polyorganosiloxane.

[7] The adhesive composition according to any one of [1] to [6], wherein an insertion force required to separate the first body and the second body by inserting a sharp portion of equipment having a sharp portion between the first body and the second body after irradiating the adhesive layer with the infrared laser is smaller than an insertion force required to separate the first body and the second body by inserting the sharp portion between the first body and the second body without irradiating the adhesive layer with the infrared laser.

[8] A laminate including:

a first body that is a semiconductor substrate or an electronic device layer;

a second body that is a support substrate that transmits an infrared laser; and

an adhesive layer provided between the first body and the second body,

wherein the adhesive layer is an adhesive layer formed from the adhesive composition according to any one of claims [1] to [7].

[9] A method for producing a processed semiconductor substrate or electronic device layer, the method including:

processing step of processing the first body of the laminate according to [8]; and

a separation step of irradiating the adhesive layer with the infrared laser from the second body side, and then separating the processed first body and the second body.

[10] The method for producing a processed semiconductor substrate or electronic device layer according to [9], wherein by irradiating the adhesive layer with the infrared laser, an insertion force required to separate the first body and the second body by inserting the sharp portion of equipment having a sharp portion between the first body and the second body is reduced as compared with a case where the adhesive layer is not irradiated with the infrared laser.

Advantageous Effects of Invention

[0011]

According to the present invention, it is possible to provide an adhesive composition which does not require a long treatment time in release using an infrared laser,

causes little damage to a body, has good cleanability, a laminate using the adhesive composition, and a method for producing a processed semiconductor substrate or electronic device layer using the laminate.

Brief Description of Drawings

[0012]

[Fig. 1] Fig. 1 is a schematic cross-sectional view of an example of a laminate according to a first embodiment.

[Fig. 2A] Fig. 2A is a schematic cross-sectional view for illustrating a method for producing a laminate showing an example in a first embodiment (part 1).

[Fig. 2B] Fig. 2B is a schematic cross-sectional view for illustrating a method for producing a laminate showing an example in a first embodiment (part 2).

[Fig. 3] Fig. 3 is a schematic cross-sectional view of an example of a laminate according to a second embodiment.

[Fig. 4A] Fig. 4A is a schematic cross-sectional view for illustrating a method for producing a laminate showing an example in the second embodiment (part 1).

[Fig. 4B] Fig. 4B is a schematic cross-sectional view for illustrating a method for producing a laminate showing an example in the second embodiment (part 2).

[Fig. 4C] Fig. 4C is a schematic cross-sectional view for illustrating a method for producing a laminate showing an example in the second embodiment (part 3).

[Fig. 5A] Fig. 5A is a schematic cross-sectional view for illustrating a processing method of a laminate showing an example in the first embodiment (part 1).

[Fig. 5B] Fig. 5B is a schematic cross-sectional view for illustrating a processing method of the laminate showing an example in the first embodiment (part 2).

[Fig. 5C] Fig. 5C is a schematic cross-sectional view for illustrating a processing method of the laminate showing an example in the first embodiment (part 3).

[Fig. 5D] Fig. 5D is a schematic cross-sectional view for illustrating a processing method of the laminate showing an example in the first embodiment (part 4).

[Fig. 5E] Fig. 5E is a schematic cross-sectional view for illustrating a processing method of the laminate showing an example in the first embodiment (part 5).

[Fig. 6A] Fig. 6A is a schematic cross-sectional view for illustrating a processing method of a laminate showing an example in a second embodiment (part 1).

[Fig. 6B] Fig. 6B is a schematic cross-sectional view for illustrating a processing method of the laminate showing an example in the second embodiment (part 2).

[Fig. 6C] Fig. 6C is a schematic cross-sectional view

for illustrating a processing method of the laminate showing an example in the second embodiment (part 3).

[Fig. 6D] Fig. 6D is a schematic cross-sectional view for illustrating a processing method of the laminate showing an example in the second embodiment (part 4).

[Fig. 6E] Fig. 6E is a schematic cross-sectional view for illustrating a processing method of the laminate showing an example in the second embodiment (part 5).

[Fig. 6F] Fig. 6F is a schematic cross-sectional view for illustrating a processing method of the laminate showing an example in the second embodiment (part 6).

[Fig. 6G] Fig. 6G is a schematic cross-sectional view for illustrating a processing method of the laminate showing an example in the second embodiment (part 7).

Description of Embodiments

[0013]

(Adhesive Composition)

The adhesive composition of the present invention contains an adhesive component having a siloxane bond, a release agent component, and an infrared-absorbing agent.

The adhesive composition is an adhesive composition for forming an adhesive layer used for, after processing a first body in a laminate, irradiating the adhesive layer with the infrared laser from the second body side, and then

separating the first body and the second body.

The laminate includes a first body that is a semiconductor substrate or an electronic device layer, a second body that is a support substrate that transmits an infrared laser, and an adhesive layer provided between the first body and the second body.

[0014]

In the present invention, an adhesive composition (adhesive composition containing a release agent component) that can be released by equipment having a sharp portion is used for forming an adhesive layer in a laminate including a first body, a second body, and an adhesive layer provided between the first body and the second body.

By using such an adhesive composition for separation between the first body and the second body using an infrared laser, the first body and the second body can be separated with a small amount of infrared laser irradiation. By doing so, the treatment time is not required. In addition, since it is not necessary to perform release with equipment having a sharp portion, or even when equipment having a sharp portion is used in combination, the insertion force can be reduced, so that damage to the body adjacent to the adhesive layer is low. Further, when the adhesive component having a siloxane bond absorbs the infrared laser, the adhesive layer is

deteriorated, and the first body and the second body are easily separated from each other. However, when the adhesive composition contains the infrared-absorbing agent, excessive deterioration of the adhesive layer by the infrared laser can be avoided. Since the deterioration of the adhesive layer is small, the cleanability of the adhesive layer is good.

The adhesive composition in the techniques described in Patent Literatures 3 and 4 contains, for example, a component containing an epoxy-modified polyorganosiloxane, but is not necessarily an adhesive composition that can be released by equipment having a sharp portion, and thus is different from the adhesive composition of the present invention.

[0015]

In the present invention, it is preferable that the insertion force (Fb) required to separate the first body and the second body by inserting a sharp portion of equipment having a sharp portion between the first body and the second body after irradiating the adhesive layer with the infrared laser is smaller than an insertion force (Fa) required to separate the first body and the second body by inserting the sharp portion between the first body and the second body without irradiating the adhesive layer with the infrared laser.

The insertion force is indicated as an absolute value.

Examples of the insertion force (Fa) include 0.1 N to 100 N.

[0016]

The ratio (Fb/Fa) of the insertion force (Fb) to the insertion force (Fa) is not particularly limited, but is preferably less than 1.0, more preferably 0.9 or less, and still more preferably 0.6 or less.

The lower limit value of the ratio (Fb/Fa) is not particularly limited, but the ratio (Fb/Fa) may be 0.01 or more, 0.05 or more, or 0.1 or more.

The insertion force is measured, for example, as follows.

After a semiconductor substrate or an electronic device layer and a support substrate are temporarily bonded to each other via an adhesive layer to obtain a laminate, release is performed using a release device. During release, a scraper replacement blade (manufactured by ESCO Company Ltd., blade thickness: 0.2 mm) is mounted on the tip of a force gauge, and the replacement blade is inserted, parallel to the substrate, into the adhesive layer between the semiconductor substrate or the electronic device layer and the support substrate to form a trigger for release. At this time, the maximum value of the force

required to insert the blade is measured with a force gauge and taken as the insertion force.

For example, a force gauge or a texture analyzer can be used to measure the insertion force. An absolute value is used as a value of the force gauge representing the insertion force.

[0017]

<Adhesive component>

The adhesive component is not particularly limited, but is preferably a component that undergoes curing, and more preferably a component that is cured by a hydrosilylation reaction.

The component that is cured by a hydrosilylation reaction is not particularly limited, but preferably contains a component containing an alkenyl group having 2 to 40 carbon atoms, the alkenyl group being bonded to a silicon atom (hereinafter, also referred to as “component (A-1)” in some cases), a component having a Si-H group (hereinafter, also referred to as “component (A-2)” in some cases), and a platinum group metal-based catalyst (A-3).

[0018]

<<Component (A-1) and Component (A-2)>>

The adhesive composition preferably contains the component (A-1).

The adhesive composition preferably contains the

component (A-2).

Hereinafter, the combination of the component (A-1), the component (A-2), and the platinum group metal-based catalyst (A-3) may be referred to as “curing component (A)” or “component (A)”.

[0019]

From the viewpoint of suitably obtaining the effects of the present invention, the component (A-1) preferably contains a polyorganosiloxane (a1) containing an alkenyl group having 2 to 40 carbon atoms, the alkenyl group being bonded to a silicon atom.

From the viewpoint of suitably obtaining the effects of the present invention, the component (A-2) preferably contains a polyorganosiloxane (a2) having a Si-H group.

Here, the alkenyl group having 2 to 40 carbon atoms may be substituted. Examples of the substituent include a halogen atom, a nitro group, a cyano group, an amino group, a hydroxy group, a carboxyl group, an aryl group, and a heteroaryl group.

[0020]

In another preferred embodiment, the adhesive composition that is cured by a hydrosilylation reaction contains a polysiloxane (A1) containing one or two or more units selected from the group consisting of a siloxane unit (Q unit) represented by SiO_2, a siloxane unit (M unit)

represented by $R^1R^2R^3SiO_{1/2}$, a siloxane unit (D unit) represented by $R^4R^5SiO_{2/2}$, and a siloxane unit (T unit) represented by $R^6SiO_{3/2}$, and a platinum group metal-based catalyst (A-3). The polysiloxane (A1) contains a polyorganosiloxane (a1') containing one or two or more units selected from the group consisting of a siloxane unit (Q' unit) represented by SiO_2, a siloxane unit (M' unit) represented by $R^{1'}R^{2'}R^{3'}SiO_{1/2}$, a siloxane unit (D' unit) represented by $R^{4'}R^{5'}SiO_{2/2}$, and a siloxane unit (T' unit) represented by $R^{6'}SiO_{3/2}$, and also containing at least one selected from the group consisting of M' units, D' units, and T' units; and a polyorganosiloxane (a2') containing one or two or more units selected from the group consisting of a siloxane unit (Q" unit) represented by SiO_2, a siloxane unit (M" unit) represented by $R^{1"}R^{2"}R^{3"}SiO_{1/2}$, a siloxane unit (D" unit) represented by $R^{4"}R^{5"}SiO_{2/2}$, and a siloxane unit (T" unit) represented by $R^{6"}SiO_{3/2}$, and also containing at least one selected from the group consisting of M" units, D" units, and T" units.

Note that (a1') is an example of (a1), and (a2') is an example of (a2).

[0021]

R^1 to R^6 are groups or atoms bonded to a silicon atom, and R^1 to R^6 each independently represent an alkyl group which may be substituted, an alkenyl group which may

be substituted, or a hydrogen atom. Examples of the substituent include a halogen atom, a nitro group, a cyano group, an amino group, a hydroxy group, a carboxyl group, an aryl group, and a heteroaryl group.

[0022]

R^1' to R^6' are each a group bonded to a silicon atom, and each independently represent an optionally substituted alkyl group or an optionally substituted alkenyl group, but at least one of R^1' to R^6' is an optionally substituted alkenyl group. Examples of the substituent include a halogen atom, a nitro group, a cyano group, an amino group, a hydroxy group, a carboxyl group, an aryl group, and a heteroaryl group.

[0023]

$R^1"$ to $R^6"$ are each a group or atom bonded to a silicon atom and each independently represent an optionally substituted alkyl group or a hydrogen atom, and at least one of $R^1"$ to $R^6"$ is a hydrogen atom. Examples of the substituent include a halogen atom, a nitro group, a cyano group, an amino group, a hydroxy group, a carboxyl group, an aryl group, and a heteroaryl group.

[0024]

The alkyl group may be linear, branched, or cyclic, and is preferably a linear or branched alkyl group. The number of carbon atoms thereof is not particularly limited,

and is usually 1 to 40, preferably 30 or less, more preferably 20 or less, and still more preferably 10 or less.

[0025]

Specific examples of the linear or branched alkyl group which may be substituted include, but are not limited to, a methyl group, an ethyl group, an n-propyl group, an i-propyl group, an n-butyl group, an i-butyl group, an s-butyl group, a tertiary butyl group, an n-pentyl group, a 1-methyl-n-butyl group, a 2-methyl-n-butyl group, a 3-methyl-n-butyl group, a 1,1-dimethyl-n-propyl group, a 1,2-dimethyl-n-propyl group, a 2,2-dimethyl-n-propyl group, a 1-ethyl-n-propyl group, an n-hexyl group, a 1-methyl-n-pentyl group, a 2-methyl-n-pentyl group, a 3-methyl-n-pentyl group, a 4-methyl-n-pentyl group, a 1,1-dimethyl-n-butyl group, a 1,2-dimethyl-n-butyl group, a 1,3-dimethyl-n-butyl group, a 2,2-dimethyl-n-butyl group, a 2,3-dimethyl-n-butyl group, a 3,3-dimethyl-n-butyl group, a 1-ethyl-n-butyl group, a 2-ethyl-n-butyl group, a 1,1,2-trimethyl-n-propyl group, a 1,2,2-trimethyl-n-propyl group, a 1-ethyl-1-methyl-n-propyl group, and a 1-ethyl-2-methyl-n-propyl group, and the number of carbon atoms thereof is usually 1 to 14, preferably 1 to 10, and more preferably 1 to 6. Among them, a methyl group is particularly preferable.

[0026]

Specific examples of the cyclic alkyl group which may be substituted include, but are not limited to, cycloalkyl groups such as a cyclopropyl group, a cyclobutyl group, a 1-methyl-cyclopropyl group, a 2-methyl-cyclopropyl group, a cyclopentyl group, a 1-methyl-cyclobutyl group, a 2-methyl-cyclobutyl group, a 3-methyl-cyclobutyl group, a 1,2-dimethyl-cyclopropyl group, a 2,3-dimethyl-cyclopropyl group, a 1-ethyl-cyclopropyl group, a 2-ethyl-cyclopropyl group, a cyclohexyl group, a 1-methyl-cyclopentyl group, a 2-methyl-cyclopentyl group, a 3-methyl-cyclopentyl group, a 1-ethyl-cyclobutyl group, a 2-ethyl-cyclobutyl group, a 3-ethyl-cyclobutyl group, a 1,2-dimethyl-cyclobutyl group, a 1,3-dimethyl-cyclobutyl group, a 2,2-dimethyl-cyclobutyl group, a 2,3-dimethyl-cyclobutyl group, a 2,4-dimethyl-cyclobutyl group, a 3,3-dimethyl-cyclobutyl group, a 1-n-propyl-cyclopropyl group, a 2-n-propyl-cyclopropyl group, a 1-i-propyl-cyclopropyl group, a 2-i-propyl-cyclopropyl group, a 1,2,2-trimethyl-cyclopropyl group, a 1,2,3-trimethyl-cyclopropyl group, a 2,2,3-trimethyl-cyclopropyl group, a 1-ethyl-2-methyl-cyclopropyl group, a 2-ethyl-1-methyl-cyclopropyl group, a 2-ethyl-2-methyl-cyclopropyl group, and a 2-ethyl-3-methyl-cyclopropyl group; and a bicycloalkyl group such as a bicyclobutyl group, a bicyclopentyl group, a bicyclohexyl group, a bicycloheptyl

group, a bicyclooctyl group, a bicyclononyl group, and a bicyclodecyl group, and the number of carbon atoms thereof is usually 3 to 14, preferably 4 to 10, and more preferably 5 to 6.

[0027]

The alkenyl group may be linear or branched, and the number of carbon atoms thereof is not particularly limited, and is usually 2 to 40, preferably 30 or less, more preferably 20 or less, and still more preferably 10 or less.

[0028]

Specific examples of the linear or branched alkenyl group which may be substituted include, but are not limited to, a vinyl group, an allyl group, a butenyl group, and a pentenyl group, and the number of carbon atoms thereof is usually 2 to 14, preferably 2 to 10, and more preferably 1 to 6. Among them, an ethenyl group and a 2-propenyl group are particularly preferable.

Specific examples of the cyclic alkenyl group which may be substituted include, but are not limited to, cyclopentenyl and cyclohexenyl, and the number of carbon atoms thereof is usually 4 to 14, preferably 5 to 10, and more preferably 5 to 6.

[0029]

As described above, the polysiloxane (A1) contains a

polyorganosiloxane (a1') and a polyorganosiloxane (a2'), and an alkenyl group contained in the polyorganosiloxane (a1') and a hydrogen atom (Si-H group) contained in the polyorganosiloxane (a2') form a crosslinked structure and cure by a hydrosilylation reaction with the platinum group metal-based catalyst (A-3). As a result, a cured film is formed.

[0030]

The polyorganosiloxane (a1') contains one or two or more units selected from the group consisting of Q' units, M' units, D' units, and T' units, and also contains at least one selected from the group consisting of M' units, D' units, and T' units. As the polyorganosiloxane (a1'), two or more polyorganosiloxanes satisfying such conditions may be used in combination.

[0031]

Examples of the preferred combination of two or more units selected from the group consisting of Q' units, M' units, D' units, and T' units include, but are not limited to, (Q' units and M' units), (D' units and M' units), (T' units and M' units), or (Q' units, T' units, and M' units).

[0032]

When the polyorganosiloxane (a1') contains two or more polyorganosiloxanes, a combination of (Q' unit and M' unit) and (D' unit and M' unit), a combination of (T' unit

and M' unit) and (D' unit and M' unit), and a combination of (Q' unit, T' unit, and M' unit) and (T' unit and M' unit) are preferable, but the combination is not limited thereto.

[0033]

The polyorganosiloxane (a2') contains one or two or more units selected from the group consisting of Q" units, M" units, D" units, and T" units, and contains at least one selected from the group consisting of M" units, D" units, and T" units. As the polyorganosiloxane (a2'), two or more of polyorganosiloxane satisfying such conditions may be used in combination.

[0034]

Examples of the preferred combination of two or more units selected from the group consisting of Q" unit, M" units, D" units, and T" units include, but are not limited to, (M" units and D" units), (Q" units and M" units), or (Q" units, T" units, and M" units).

[0035]

The polyorganosiloxane (a1') is composed of siloxane units in which alkyl groups and/or alkenyl groups are bonded to silicon atoms thereof, and the proportion of alkenyl groups in the total substituents represented by R^1' to R^6' is preferably 0.1 to 50.0% by mol and more preferably 0.5 to 30.0% by mol, and the remaining R^1' to

R^6' may be alkyl groups.

[0036]

The polyorganosiloxane (a2') is composed of siloxane units in which alkyl groups and/or hydrogen atoms are bonded to silicon atoms thereof, and the proportion of hydrogen atoms among all the substituents and substituent atoms represented by R^1" to R^6" is preferably 0.1 to 50.0% by mol and more preferably 10.0 to 40.0% by mol, and the remaining R^1" to R^6" may be alkyl groups.

[0037]

When the adhesive composition contains (a1) and (a2), in a preferable aspect of the present invention, the molar ratio of the alkenyl group contained in the polyorganosiloxane (a1) and the hydrogen atom constituting the Si-H bond contained in the polyorganosiloxane (a2) is in the range of 1.0 : 0.5 to 1.0 : 0.66.

[0038]

The weight-average molecular weight of the polysiloxane such as the polyorganosiloxane (a1) or the polyorganosiloxane (a2) is not particularly limited, and each is typically 500 to 1,000,000, and is preferably 5,000 to 50,000 from the viewpoint of achieving the effects of the present invention with good reproducibility.

In the present invention, the weight-average molecular weight, the number-average molecular weight, and

the dispersity of the polyorganosiloxanes can be measured, for example, using a GPC apparatus (EcoSEC, HLC-8320GPC, manufactured by Tosoh Corporation) and a GPC column (TSKgel SuperMultiporeHZ-N and TSKgel SuperMultiporeHZ-H, manufactured by Tosoh Corporation), at a column temperature of 40°C, using tetrahydrofuran as an eluent (elution solvent), at a flow rate of 0.35 mL/min, and using polystyrene (Shodex from Showa Denko K.K.) as a standard sample.

[0039]

The viscosities of the polyorganosiloxane (a1) and the polyorganosiloxane (a2) are not particularly limited, and are each usually 10 to 1,000,000 (mPa·s), and are preferably 50 to 10,000 (mPa·s) from the viewpoint of achieving the effects of the present invention with good reproducibility. The viscosities of the polyorganosiloxane (a1) and the polyorganosiloxane (a2) are values measured with an E-type rotational viscometer at 25°C.

[0040]

The polyorganosiloxane (a1) and the polyorganosiloxane (a2) react with each other by a hydrosilylation reaction. Accordingly, the mechanism of curing is different from, for example, that through silanol groups, and therefore, neither siloxane needs to contain a silanol group or a functional group that forms a silanol

group by hydrolysis, such as an alkyloxy group.

[0041]

<<Platinum group metal-based catalyst (A-3)>>

The platinum group metal-based catalyst is a platinum-based metal catalyst.

Such a platinum-based metal catalyst is a catalyst for promoting the hydrosilylation reaction between the alkenyl group and the Si-H group.

[0042]

As a specific example of the platinum-based metal catalyst, a catalyst known as a platinum-based compound (platinum or a compound containing platinum) can be used.

Specific examples thereof include platinum fine powder, platinum black, chloroplatinic acid, an alcohol-modified product of chloroplatinic acid, a complex of chloroplatinic acid and diolefin, a platinum-olefin complex, a platinum-carbonyl complex [platinum bis(acetoacetate), platinum bis(acetylacetonate), or the like], a chloroplatinic acid-alkenylsiloxane complex (chloroplatinic acid-divinyltetramethyldisiloxane complex, chloroplatinic acid-tetravinyltetramethylcyclotetrasiloxane complex, or the like), a platinum-alkenylsiloxane complex (platinum-divinyltetramethyldisiloxane complex, platinum-tetravinyltetramethylcyclotetrasiloxane complex, or the like), and a complex of chloroplatinic acid and an

acetylene alcohol. Among them, a platinum-alkenylsiloxane complex is particularly preferable because it has a high effect of promoting the hydrosilylation reaction.

These hydrosilylation reaction catalysts may be used alone, or two or more thereof may be used in combination.

[0043]

The alkenylsiloxane used in the platinum-alkenylsiloxane complex is not particularly limited, and examples thereof include 1,3-divinyl-1,1,3,3-tetramethyldisiloxane; 1,3,5,7-tetramethyl-1,3,5,7-tetravinylcyclotetrasiloxane; alkenylsiloxane oligomers in which some of the methyl groups of the alkenylsiloxane are substituted with ethyl groups, phenyl groups, or the like; and alkenylsiloxane oligomers in which the vinyl groups of these alkenylsiloxanes are substituted with allyl groups, hexenyl groups, or the like. In particular, 1,3-divinyl-1,1,3,3-tetramethyldisiloxane is preferable since the platinum-alkenylsiloxane complex to be produced has good stability.

[0044]

The content of the platinum group metal-based catalyst (A-3) in the adhesive composition is not particularly limited, and is, for example, in the range of 0.1 to 50.0 ppm based on the total mass of the component (A-1) and the component (A-2).

[0045]

<<Polymerization inhibitor>>

The adhesive component may contain a polymerization inhibitor for the purpose of suppressing the progress of the hydrosilylation reaction.

The polymerization inhibitor is not particularly limited as long as it is possible to suppress the progress of the hydrosilylation reaction, and specific examples thereof include alkynyl alcohols such as 1-ethynyl-1-cyclohexanol and 1,1-diphenyl-2-propyn-1-ol.

The amount of the polymerization inhibitor is not particularly limited, but is usually 1,000.0 ppm or more with respect to, for example, the total amount of the polyorganosiloxane (a1) and the polyorganosiloxane (a2) from the viewpoint of obtaining the effect, and is 10,000.0 ppm or less from the viewpoint of preventing excessive suppression of the hydrosilylation reaction.

[0046]

The content of the adhesive component in the adhesive composition is not particularly limited, but is preferably 30 mass% or more, more preferably 50 mass% or more, and particularly preferably 70 mass% or more based on the nonvolatile matter of the adhesive composition from the viewpoint of suitably obtaining the effects of the present invention. The upper limit value is not particularly

limited, but may be, for example, 95 mass% or less, 90 mass% or less, or 85 mass% or less.

The nonvolatile matter in the adhesive composition refers to a component other than the solvent in the adhesive composition.

[0047]

<Release Agent Component>

The release agent component is not particularly limited, but is preferably a polyorganosiloxane from the viewpoint of more suitably obtaining the effects of the present invention.

The polyorganosiloxane as the release agent component usually does not react with the adhesive component.

For example, the polyorganosiloxane as the release agent component is a component that does not undergo a hydrosilylation reaction.

[0048]

The polyorganosiloxane usually contains siloxane units (D units), but may contain Q units, M units, and T units. For example, the specific examples include: in the case of only a D unit, in the case of a combination of a D unit and a Q unit, in the case of a combination of a D unit and an M unit, in the case of a combination of a D unit and a T unit, in the case of a combination of a D unit, a Q unit, and an M unit, in the case of a combination of a D

unit, an M unit, and a T unit, in the case of a combination of a D unit, a Q unit, an M unit, and a T unit, and the like.

[0049]

The polyorganosiloxane is not particularly limited, and examples thereof include a polydimethylsiloxane, an epoxy group-containing polyorganosiloxane, a phenyl group-containing polyorganosiloxane, and a carbinol-modified polyorganosiloxane.

[0050]

<<Polydimethylsiloxane>>

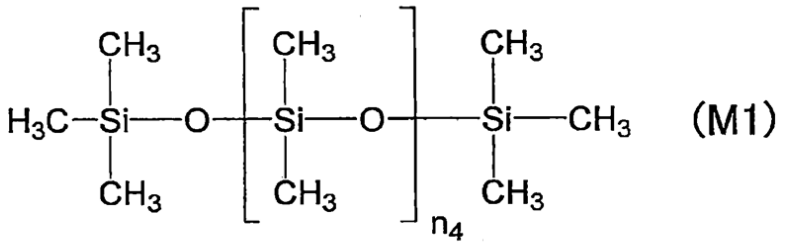
The “polydimethylsiloxane” in the present invention is an unmodified polyorganosiloxane and is a polyorganosiloxane having a methyl group as an organic group bonded to a silicon atom, unlike epoxy group-containing polydimethylsiloxane, phenyl group-containing polydimethylsiloxane, carbinol-modified polyorganosiloxane, and the like.

[0051]

Specific examples of the polydimethylsiloxane include, but are not limited to, those represented by Formula (M1).

[0052]

[Chem. 1]



(M1)

(n_4 represents the number of repeating units, and is a positive integer.)

[0053]

The weight-average molecular weight of the polydimethylsiloxane is not particularly limited, but is usually 100,000 to 2,000,000, and is preferably 200,000 to 1,200,000, and more preferably 300,000 to 900,000 from the viewpoint of achieving the effects of the present invention with good reproducibility. In addition, the dispersity is not particularly limited, and is usually 1.0 to 10.0, and is preferably 1.5 to 5.0 and more preferably 2.0 to 3.0 from the viewpoint of achieving suitable release with good reproducibility. The weight-average molecular weight and the dispersity can be measured by the above-described method related to the polyorganosiloxane.

The viscosity of the polydimethylsiloxane is not particularly limited, but is usually 1,000 to 2,000,000 mm^2/s. Note that the value of the viscosity of the polydimethylsiloxane is expressed as kinematic viscosity, and centistokes (cSt)=mm^2/s. The value can also be

determined by dividing the viscosity (mPa·s) by the density (g/cm^3). That is, the value can be determined from the viscosity measured with an E-type rotational viscometer at 25°C and the density, and can be calculated from the equation: kinematic viscosity (mm^2/s)=viscosity (mPa·s)/density (g/cm^3).

[0054]

<<Epoxy Group-Containing Polyorganosiloxane>>

Examples of the epoxy group-containing polyorganosiloxane include those containing a siloxane unit (D^{10} unit) represented by $R^{11}R^{12}SiO_{2/2}$.

[0055]

R^{11} is a group bonded to a silicon atom and represents an alkyl group, and R^{12} is a group bonded to a silicon atom and represents an epoxy group or an organic group containing an epoxy group. Specific examples of the alkyl group include the above-described examples.

The epoxy group in the organic group containing an epoxy group may be an independent epoxy group that is not fused to another ring, or may be an epoxy group forming a fused ring with another ring, such as a 1,2-epoxycyclohexyl group.

Specific examples of the organic group containing an epoxy group include, but are not limited to, 3-glycidoxypropyl and 2-(3,4-epoxycyclohexyl)ethyl.

In the present invention, preferred examples of the epoxy group-containing polyorganosiloxane include, but are not limited to, an epoxy group-containing polydimethylsiloxane.

[0056]

The epoxy group-containing polyorganosiloxane contains the above-described siloxane unit (D^{10} unit), but may contain, in addition to the D^{10} unit, Q units, M units, and/or T units.

In a preferred embodiment of the present invention, specific examples of the epoxy group-containing polyorganosiloxane include a polyorganosiloxane composed only of D^{10} units, a polyorganosiloxane containing D^{10} units and Q units, a polyorganosiloxane containing D^{10} units and M units, a polyorganosiloxane containing D^{10} units and T units, a polyorganosiloxane containing D^{10} units, Q units, and M units, a polyorganosiloxane containing D^{10} units, M units, and T units, or a polyorganosiloxane containing D^{10} units, Q units, M units, and T units.

[0057]

The epoxy group-containing polyorganosiloxane may have an epoxy group in a side chain, may have an epoxy group at one terminal, or may have an epoxy group at both terminals.

[0058]

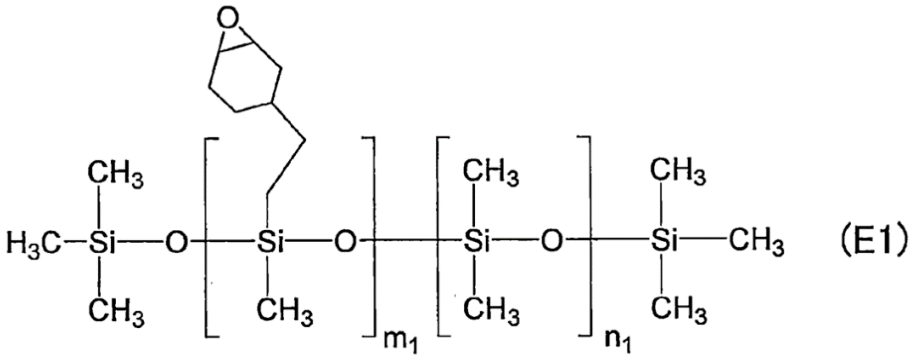
The epoxy group-containing polyorganosiloxane is preferably an epoxy group-containing polydimethylsiloxane having an epoxy value of 0.1 to 5. In addition, the weight-average molecular weight is not particularly limited, and is usually from 1,500 to 500,000, and is preferably 100,000 or less from the viewpoint of suppressing precipitation in the composition.

[0059]

Specific examples of the epoxy group-containing polyorganosiloxane include, but are not limited to, those represented by Formulas (E1) to (E3).

[0060]

[Chem. 2]

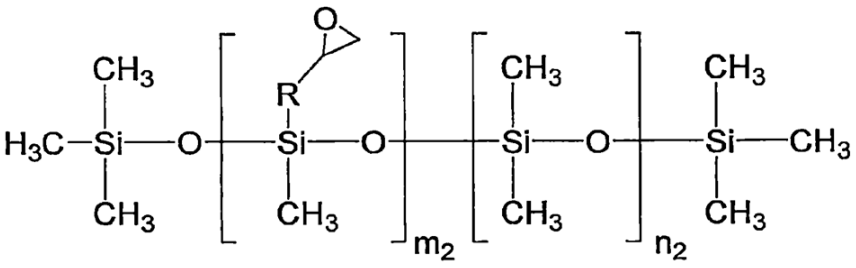


(E1)

(m_1 and n_1 represent the number of respective repeating units, and are positive integers.)

[0061]

[Chem. 3]

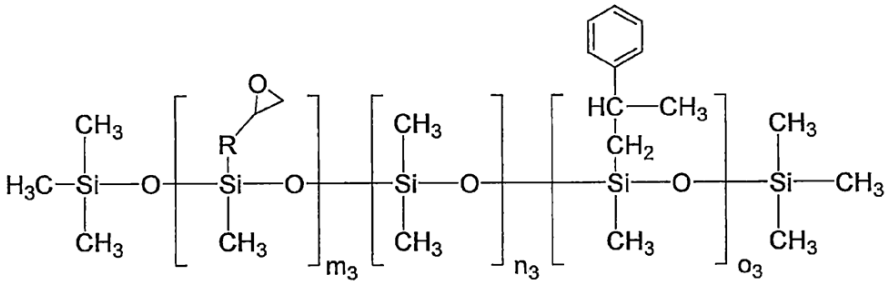


(E2)

(m_2 and n_2 represent the numbers of the respective repeating units and are positive integers, and R is an alkylene group having 1 to 10 carbon atoms which may be interrupted by at least one of an oxygen atom and an unsaturated bond (for example, a carbon-carbon double bond, a carbon-carbon triple bond, or -N=N-).)

[0062]

[Chem. 4]



(E3)

(m_3, n_3, and o_3 represent the numbers of the respective repeating units and are positive integers, and R is an alkylene group having 1 to 10 carbon atoms which may be interrupted by at least one of an oxygen atom and an unsaturated bond (for example, a carbon-carbon double bond, a carbon-carbon triple bond, or -N=N-).)

[0063]

In the general formula, when m_1, m_2, m_3, and O_3 are 2 or more, these repeating units may be arranged adjacent to each other to form a block, or may be randomly arranged.

[0064]

Note that the polyorganosiloxane represented by Formula (E3) has an epoxy group and a phenyl group and is thus an epoxy group-containing polyorganosiloxane and is also a phenyl group-containing polyorganosiloxane. Note that the epoxy group-containing polyorganosiloxane may or may not have a phenyl group.

[0065]

The weight-average molecular weight of the epoxy group-containing polyorganosiloxane is not particularly limited, but is usually 100,000 to 2,000,000, and is preferably 200,000 to 1,200,000, more preferably 300,000 to 900,000 from the viewpoint of achieving the effects of the present invention with good reproducibility. In addition, the dispersity is not particularly limited, and is usually 1.0 to 10.0, and is preferably 1.5 to 5.0 and more preferably 2.0 to 3.0 from the viewpoint of achieving suitable release with good reproducibility. The weight-average molecular weight and the dispersity can be measured by the above-described method related to the polyorganosiloxane.

The viscosity of the epoxy group-containing

polyorganosiloxane is not particularly limited, but is usually 1,000 to 2,000,000 mm^2/s. Note that the value of the viscosity of the epoxy group-containing polyorganosiloxane is expressed as kinematic viscosity, and centistokes (cSt)=mm^2/s. The value can also be determined by dividing the viscosity (mPa·s) by the density (g/cm^3). That is, the value can be determined from the viscosity measured with an E-type rotational viscometer at 25°C and the density, and can be calculated from the equation: kinematic viscosity (mm^2/s)=viscosity (mPa·s)/density (g/cm^3).

[0066]

<<Phenyl Group-Containing Polyorganosiloxane>>

Examples of the phenyl group-containing polyorganosiloxane include those containing a siloxane unit (D^{30} unit) represented by $R^{31}R^{32}SiO_{2/2}$.

[0067]

R^{31} is a group bonded to a silicon atom and represents a phenyl group or an alkyl group, and R^{32} is a group bonded to a silicon atom and represents a phenyl group. Specific examples of the alkyl group include the above-described examples, but a methyl group is preferable.

[0068]

The phenyl group-containing polyorganosiloxane contains the above-described siloxane unit (D^{30} unit), but

may contain, in addition to the D^{30} unit, Q units, M units, and/or T units.

[0069]

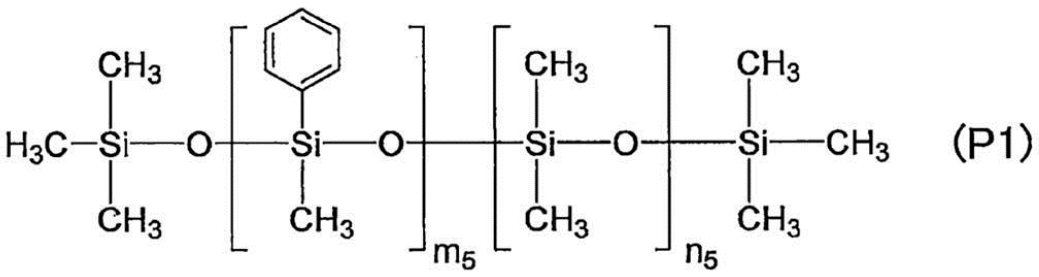
In a preferred embodiment, specific examples of the phenyl group-containing polyorganosiloxane include a polyorganosiloxane composed only of D^{30} units, a polyorganosiloxane containing D^{30} units and Q units, a polyorganosiloxane containing D^{30} units and M units, a polyorganosiloxane containing D^{30} units and T units, a polyorganosiloxane containing D^{30} units, Q units, and M units, a polyorganosiloxane containing D^{30} units, M units, and T units, or a polyorganosiloxane containing D^{30} units, Q units, M units, and T units.

[0070]

Specific examples of the phenyl group-containing polyorganosiloxane include, but are not limited to, those represented by Formula (P1) or (P2).

[0071]

[Chem. 5]



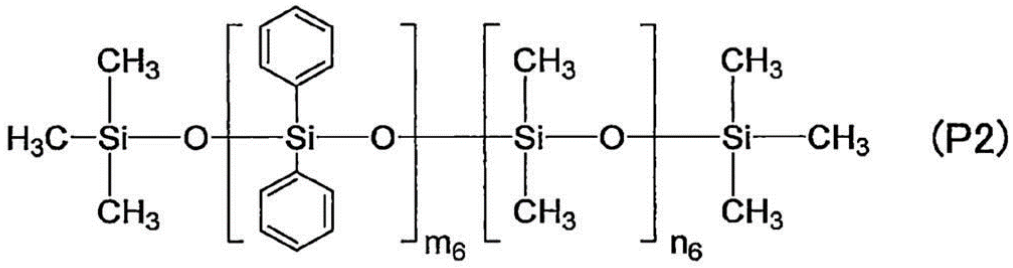
(P1)

(m5 and n5 represent the number of respective

repeating units, and are positive integers.)

[0072]

[Chem. 6]



(m6 and n6 represent the number of respective repeating units, and are positive integers.)

[0073]

In the above general formula, when m_5 and m_6 are 2 or more, these repeating units may be arranged adjacent to each other to form a block, or may be randomly arranged.

[0074]

<<Carbinol-Modified Polyorganosiloxane>>

The carbinol-modified polyorganosiloxane is not particularly limited.

The carbinol-modified polyorganosiloxane is a polyorganosiloxane having a hydroxy group directly bonded to a carbon atom. As described above, the carbinol in the “carbinol-modified polyorganosiloxane” is not limited to methanol in a narrow sense, and includes methanol derivatives.

[0075]

The carbinol-modified polyorganosiloxane is, for example, a carbinol-modified polydimethylsiloxane.

[0076]

The number of hydroxy groups directly bonded to a carbon atom in the carbinol-modified polyorganosiloxane is not particularly limited, and may be one or two or more.

[0077]

The carbinol-modified polyorganosiloxane may have a hydroxy group directly bonded to a carbon atom in a side chain, may have a hydroxy group directly bonded to a carbon atom at one end, or may have hydroxy groups directly bonded to a carbon atom at both terminals.

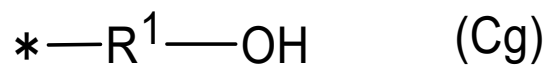
The carbinol-modified polyorganosiloxane preferably has a hydroxy group directly bonded to a carbon atom in a side chain. In this case, even when the content of the carbinol-modified polyorganosiloxane is small, it is possible to impart good releasability to the adhesive layer formed from the adhesive composition.

[0078]

The carbinol-modified polyorganosiloxane has, for example, a group represented by the following Formula (Cg) as a group directly bonded to a silicon atom.

[0079]

[Chem. 7]



(In Formula (Cg), R^1 represents a group having one or more carbon atoms. * represents a bond bonded to a silicon atom. However, the hydroxy group in Formula (Cg) is directly bonded to a carbon atom.)

[0080]

The number of hydroxy groups directly bonded to a carbon atom in the group represented by Formula (Cg) may be one or two or more. Examples of the two or more include two, three, four, and the like.

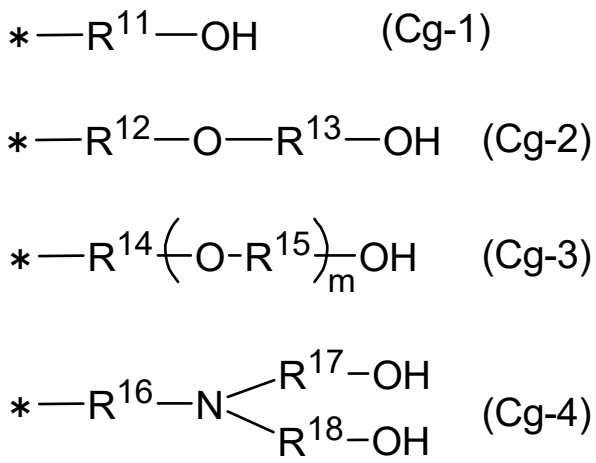
[0081]

The number of carbon atoms in R^1 is not particularly limited, and may be, for example, 1 to 30, 1 to 20, or 1 to 10.

[0082]

Examples of the group represented by Formula (Cg) include groups represented by the following Formulas (Cg-1) to (Cg-4)).

[Chem. 8]



(In Formula (Cg-1), R^{11} represents an alkylene group having 1 to 6 carbon atoms which may be substituted with an alkoxy group having 1 to 3 carbon atoms.

In Formula (Cg-2), R^{12} represents an alkylene group having 1 to 6 carbon atoms. R^{13} represents an alkylene group having 1 to 6 carbon atoms which may be substituted with an alkoxy group having 1 to 3 carbon atoms or a hydroxy group.

In Formula (Cg-3), R^{14} represents an alkylene group having 1 to 6 carbon atoms. R^{15} represents an alkylene group having 1 to 3 carbon atoms. m represents an integer of 1 to 10.

In Formula (Cg-4), R^{16} to R^{18} each independently represent an alkylene group having 1 to 6 carbon atoms.

In Formula (Cg-1) to Formula (Cg-4), * represents a bond bonded to a silicon atom.)

[0083]

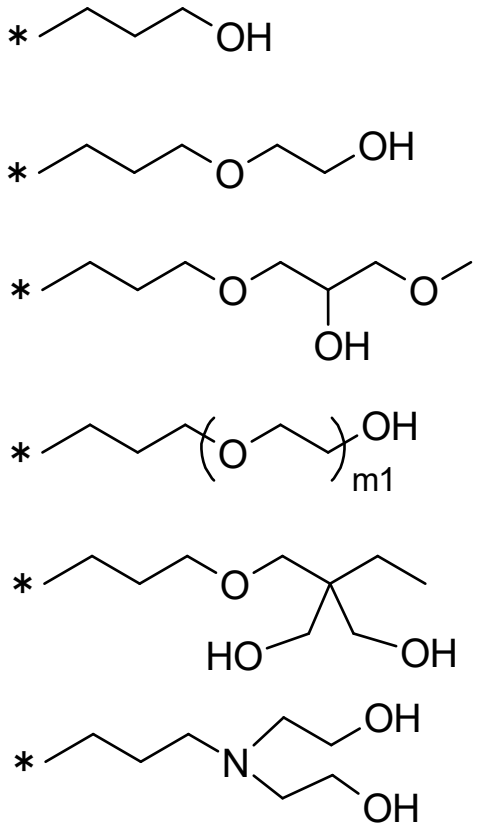
The alkylene groups of R^{11} to R^{18} may be linear,

branched, or cyclic.

[0084]

Examples of the group represented by Formula (Cg) include the following groups.

[Chem. 9]

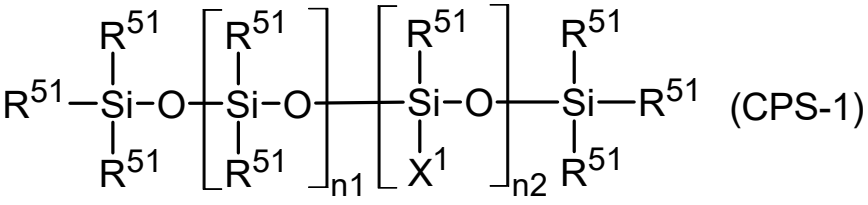


(In the formula, m1 represents an integer of 2 to 10. * represents a bond bonded to a silicon atom.)

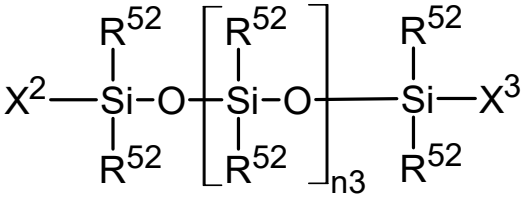
[0085]

The carbinol-modified polyorganosiloxane is represented by, for example, the following Formula (CPS-1) or (CPS-2).

[Chem. 10]



(CPS-1)



(CPS-2)

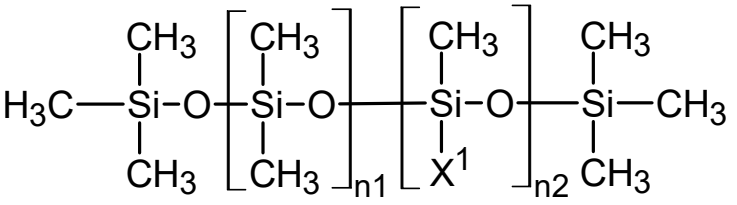
(In Formula (CPS-1), each R^{51} independently represents a hydrocarbon group. X^1 represents the group represented by Formula (Cg). n1 represents an integer of 0 or more. n2 represents an integer of 1 or more.

In Formula (CPS-2), each R^{52} independently represents a hydrocarbon group. X^2 represents the group represented by Formula (Cg). X^3 represents a hydrocarbon group or the group represented by Formula (Cg). n3 represents an integer of 0 or more.)

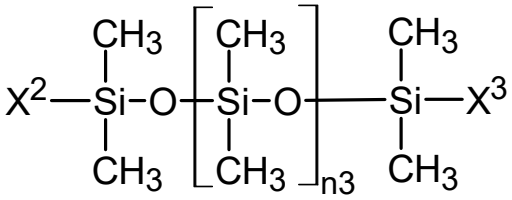
[0086]

Examples of the hydrocarbon groups in R^{51}, R^{52}, and X^3 include alkyl groups having 1 to 8 carbon atoms. As the alkyl group having 1 to 8 carbon atoms, a methyl group is preferable. That is, the carbinol-modified polyorganosiloxane is preferably polydimethylsiloxane represented by the following Formula (CPS-1a) or (CPS-2a).

[Chem. 11]



(CPS-1a)



(CPS-2a)

(In Formula (CPS-1a), X^1 represents the group represented by Formula (Cg). n1 represents an integer of 0 or more. n2 represents an integer of 1 or more.

In Formula (CPS-2a), X^2 represents the group represented by Formula (Cg). X^3 represents a methyl group or the group represented by Formula (Cg). n3 represents an integer of 0 or more.)

[0087]

Note that the carbinol-modified polyorganosiloxane represented by Formula (CPS-1) and the carbinol-modified polydimethylsiloxane represented by Formula (CPS-1a) have a hydroxy group directly bonded to a carbon atom in a side chain.

The carbinol-modified polyorganosiloxane represented by Formula (CPS-2) and the carbinol-modified polydimethylsiloxane represented by Formula (CPS-2a) have a hydroxy group(s) directly bonded to a carbon atom at one terminal or both terminals.

[0088]

Note that when n2 is 2 or more in the carbinol-modified polyorganosiloxane represented by Formula (CPS-1), siloxane units represented by $-Si(R^{51})(X^{1})-O-$ may be arranged adjacent to each other to form a block, or may be randomly arranged.

In addition, when n2 is 2 or more in the carbinol-modified polydimethylsiloxane represented by Formula (CPS-1a), siloxane units represented by $-Si(CH_3)(X^{1})-O-$ may be arranged adjacent to each other to form a block, or may be randomly arranged.

[0089]

The weight-average molecular weight of the carbinol-modified polyorganosiloxane is not particularly limited, but is usually 500 to 1,000,000, and is preferably 5,000 to 50,000 from the viewpoint of achieving the effects of the present invention with good reproducibility. In addition, the dispersity is not particularly limited, and is usually 1.0 to 10.0, and is preferably 1.5 to 5.0 and more preferably 2.0 to 3.0 from the viewpoint of achieving suitable release with good reproducibility.

The viscosity of the carbinol-modified polyorganosiloxane is not particularly limited, but is usually 100 to 200,000 mm^2/s. Note that the value of the viscosity of the polydimethylsiloxane is expressed as

kinematic viscosity, and centistokes (cSt)=mm^2/s. The value can also be determined by dividing the viscosity (mPa·s) by the density (g/cm^3). That is, the value can be determined from the viscosity measured with an E-type rotational viscometer at 25°C and the density, and can be calculated from the equation: kinematic viscosity (mm^2/s)=viscosity (mPa·s)/density (g/cm^3).

[0090]

The polyorganosiloxane as the release agent component can be used alone or in combination with two or more thereof. Here, the two polyorganosiloxanes in the two or more polyorganosiloxanes mean, for example, a combination of polydimethylsiloxane and an epoxy group-containing polyorganosiloxane, a combination of polydimethylsiloxane and a phenyl group-containing polyorganosiloxane, and the like, and do not mean, for example, a combination of two epoxy group-containing polyorganosiloxanes having different molecular weights, viscosities, types of epoxy groups, and the like.

[0091]

The polyorganosiloxane as the release agent component (B) may be a commercially available product or a synthesized product.

Examples of commercially available polyorganosiloxanes include, but are not limited to,

WACKERSILICONE FLUID AK series (AK50, AK 350, AK 1000, AK 10000, AK 1000000) and GENIOPLAST GUM, which are products manufactured by Wacker Chemie AG, dimethyl silicone oil (KF-96L, KF-96A, KF-96, KF-96H, KF-69, KF-965, KF-968) and cyclic dimethyl silicone oil (KF-995), manufactured by Shin-Etsu Chemical Co., Ltd.; epoxy group-containing polyorganosiloxane manufactured by Gelest, Inc. (trade names: CMS-227, ECMS-327, EMS-622), epoxy group-containing polyorganosiloxane manufactured by Shin-Etsu Chemical Co., Ltd. (KF-101, KF-1001, KF-1005, X-22-343), epoxy group-containing polyorganosiloxane (DOWSIL BY16-839, DOWSIL8413, DOWSIL8411) manufactured by Dow Toray Co., Ltd.; and phenyl group-containing polyorganosiloxane (PMM-1043, PMM-1025, PDM-0421, PDM-0821) manufactured by Gelest, Inc., phenyl group-containing polyorganosiloxane (KF50-3000CS) manufactured by Shin-Etsu Chemical Co., Ltd., and phenyl group-containing polyorganosiloxane (TSF431, TSF433) manufactured by Momentive Performance Materials, Inc.

[0092]

In addition, examples of commercially available carbinol-modified polyorganosiloxanes include KF6000, KF6001, KF6002, KF6003, X-22-4039, and X-22-4015 manufactured by Shin-Etsu Chemical Co., Ltd.; DMS-C15, DMS-C16, DMS-C21, DMS-C23, DBE-C25, DBE-C22, DMS-CA21, DMS-CS26, CMS-221, CMS-222, CMS-832, CMS-626, MCR-C12, MCR-C18,

MCR-C22, MCS-C11, MCS-C13, MCR-C61, MCR-C62, and MCR-C63 manufactured by Gelest, Inc.; and DOWSIL BY 16-201, DOWSIL SF 8427 Fluid, and DOWSIL SF 8428 Fluid manufactured by Dow Toray Co., Ltd.

[0093]

The content of the release agent component in the adhesive composition is not particularly limited, but is preferably 0.01 mass% or more, more preferably 0.05 mass% or more, and particularly preferably 0.10 mass% or more based on the nonvolatile matter of the adhesive composition from the viewpoint of suitably obtaining the effects of the present invention. The upper limit is not particularly limited, but is, for example, preferably 30 mass% or less, more preferably 25 mass% or less, and particularly preferably 20 mass% or less.

[0094]

<Infrared-absorbing agent>

The infrared-absorbing agent is not particularly limited as long as it absorbs infrared rays, and may be an inorganic material or an organic material.

In the present invention, the "infrared-absorbing agent" is a component different from the adhesive component and the release agent component.

[0095]

The infrared-absorbing agent, for example, has a

function of being excited by infrared rays to transfer electrons and/or energy to other components. In addition, it has a function of converting absorbed infrared rays into heat. The infrared-absorbing agent preferably has a maximum absorption in a wavelength range of 750 to 1,400 nm. Examples of the infrared-absorbing agent include dyes and pigments, and dyes are preferably used.

[0096]

As the dye, commercially available dyes and known dyes described in documents such as "Dye Handbook " (Edited by The Society of Synthetic Organic Chemistry, published in Showa 45) can be used. Specific examples thereof include dyes such as azo dyes, metal complex azo dyes, pyrazolone azo dyes, naphthoquinone dyes, anthraquinone dyes, phthalocyanine dyes, carbonium dyes, quinoneimine dyes, methine dyes, cyanine dyes, squarylium colorants, pyrylium salts, and metal thiolate complexes.

Among the dyes, cyanine colorants, squarylium colorants, and pyrylium salts are preferable, cyanine colorants are more preferable, and indolenine cyanine colorants are particularly preferable.

[0097]

Specific examples of the cyanine colorants include compounds described in paragraphs 0017 to 0019 of JP 2001-133969 A, compounds described in paragraphs 0016 to 0021 of

JP 2002-023360 A and paragraphs 0012 to 0037 of JP 2002-040638 A, preferably compounds described in paragraphs 0034 to 0041 of JP 2002-278057 A and paragraphs 0080 to 0086 of JP 2008-195018 A, and particularly preferably compounds described in paragraphs 0035 to 0043 of JP 2007-90850 A.

The compounds described in paragraphs 0008 to 0009 of JP H5-5005 A and paragraphs 0022 to 0025 of JP 2001-222101 A can also be preferably used.

As the pigment, the compound described in paragraph 0072 to 0076 of JP 2008-195018 A is preferable.

[0098]

In addition to the dyes or pigments, a compound that absorbs infrared rays can be used.

As such a compound, a compound containing an ester bond or a siloxane bond as a chemical structure is preferable. Examples thereof include an acrylic resin, an ester resin such as tannic acid, and a silicone resin.

[0099]

The infrared-absorbing agent may be used alone or in combination of two or more thereof.

[0100]

The content of the infrared-absorbing agent in the adhesive composition is not particularly limited, but is preferably 0.01 mass% or more, more preferably 0.05 mass% or more, still more preferably 0.10 mass% or more, and

particularly preferably 1 mass% or more with respect to the nonvolatile content of the adhesive composition from the viewpoint of suitably obtaining the effect of the present invention. The upper limit is not particularly limited, but is, for example, preferably 50 mass% or less, more preferably 40 mass% or less, still more preferably 30 mass% or less, and particularly preferably 20 mass% or less.

[0101]

<Solvent>

The adhesive composition may contain a solvent for the purpose of adjusting the viscosity. Specific examples thereof include aliphatic hydrocarbons, aromatic hydrocarbons, and ketones, but are not limited thereto.

More specific examples of the solvent include, but are not limited to, hexane, heptane, octane, nonane, isononane, decane, undecane, dodecane, isododecane, menthane, limonene, toluene, xylene, mesitylene, cumene, MIBK (methyl isobutyl ketone), butyl acetate, diisobutyl ketone, 2-octanone, 2-nonanone, 5-nonanone, cyclohexanone, propylene glycol monomethyl ether acetate, and propylene glycol monomethyl ether. Such solvents can be used alone or in combination with two or more thereof.

[0102]

When the adhesive composition contains a solvent, the content thereof is appropriately determined in

consideration of the desired viscosity of the composition, the coating method to be employed, the thickness of the thin film to be produced, and the like, and is, for example, in a range of about 10 to 90 mass% with respect to the entire composition.

[0103]

The viscosity of the adhesive composition used in the present invention is not particularly limited, and is usually 500 to 20,000 mPa·s, and preferably 1,000 to 1,0000 mPa·s at 25°C.

[0104]

An example of the adhesive composition used in the present invention can be produced by mixing the component (A), the release agent component (B), the infrared-absorbing agent, and the solvent.

Note that when the adhesive composition is prepared, the components may be heated, if appropriate, as long as the components are not decomposed or deteriorated.

In the present invention, for the purpose of removing foreign matter, a solvent, a solution, or the like to be used may be filtered using a filter or the like during the production of the adhesive composition or after mixing all the components.

[0105]

(Laminate)

The laminate according to the present invention includes a first body, a second body, and an adhesive layer.

The first body is a semiconductor substrate or an electronic device layer.

The second body is a support substrate that transmits an infrared laser.

[0106]

The adhesive layer is provided between the first body and the second body.

The adhesive layer is in contact with the first body and the second body.

[0107]

The laminate of the present invention is used for temporary adhesion for processing the semiconductor substrate or the electronic device layer, and can be suitably used for processing such as thinning of the semiconductor substrate or the electronic device layer.

While the semiconductor substrate is subjected to processing such as thinning, the semiconductor substrate is supported by the support substrate. On the other hand, after the processing of the semiconductor substrate, the support substrate and the semiconductor substrate are separated.

In addition, while the electronic device layer is

subjected to processing such as thinning, the electronic device layer is supported by the support substrate. Meanwhile, after the processing of the electronic device layer, the support substrate and the electronic device layer are separated.

After the semiconductor substrate or the electronic device layer is separated from the support substrate, the residue of the adhesive layer remaining on the semiconductor substrate, the electronic device layer, or the support substrate can be removed by, for example, a cleaning agent composition for cleaning the semiconductor substrate and the like.

[0108]

Hereinafter, a case where the laminate includes a semiconductor substrate and a case where the laminate includes an electronic device layer will be described in detail separately.

The case where the laminate includes a semiconductor substrate will be described in the following <First embodiment>, and the case where the laminate includes an electronic device layer will be described in the following <Second embodiment>.

[0109]

<First embodiment>

The laminate having a semiconductor substrate is used

for processing the semiconductor substrate. While the semiconductor substrate is processed, the semiconductor substrate is bonded to the support substrate. After the processing of the semiconductor substrate, the semiconductor substrate is separated from the support substrate.

[0110]

<<Semiconductor substrate>>

The main material constituting the entire semiconductor substrate is not particularly limited as long as the material is used for this type of application, and examples thereof include silicon, silicon carbide, a compound semiconductor, and an organic resin-attached glass substrate.

The shape of the semiconductor substrate is not particularly limited, and is, for example, a disk shape. The disk-shaped semiconductor substrate does not need to have a completely circular surface, and for example, the outer periphery of the semiconductor substrate may have a linear portion called an orientation flat or may have a cut called a notch.

The thickness of the disk-shaped semiconductor substrate may be appropriately determined depending on the purpose of use of the semiconductor substrate and the like, and is not particularly limited, and is, for example, 500

to 1,000 μm.

The diameter of the disk-shaped semiconductor substrate may be appropriately determined depending on the purpose of use of the semiconductor substrate and the like, and is not particularly limited, and is, for example, 100 to 1,000 mm.

[0111]

The semiconductor substrate may have a bump. The bump is a protruding terminal. The bump is, for example, an electrode.

In the laminate, when the semiconductor substrate has a bump, the semiconductor substrate has the bump on the support substrate side.

In the semiconductor substrate, the bump is usually formed on a surface on which a circuit is formed. The circuit may be a single layer or a multilayer. The shape of the circuit is not particularly limited.

In the semiconductor substrate, a surface (back surface) opposite to the surface having the bump is a surface to be processed.

The material, size, shape, structure, and density of the bump of the semiconductor substrate are not particularly limited.

Examples of the bump include a ball bump, a print bump, a stud bump, and a plating bump.

Usually, the height, radius, and pitch of the bump are appropriately determined from the conditions of a bump height of approximately 1 to 200 μm, a bump radius of 1 to 200 μm, and a bump pitch of 1 to 500 μm.

Examples of the material of the bump include low melting point solder, high melting point solder, tin, indium, gold, silver, and copper. The bump may contain only a single component or may contain a plurality of components. More specific examples thereof include alloy plating mainly containing Sn, such as SnAg bumps, SnBi bumps, Sn bumps, and AuSn bumps.

In addition, the bump may have a laminated structure including a metal layer consisting of at least one of these components.

[0112]

An example of the semiconductor substrate is a silicon wafer having a diameter of about 300 mm and a thickness of about 770 μm.

[0113]

<<Support substrate>>

The support substrate is not particularly limited as long as it is a member capable of supporting the semiconductor substrate when the semiconductor substrate is processed and is capable of transmitting an infrared laser, and examples thereof include a silicon support substrate.

[0114]

The shape of the support substrate is not particularly limited, and examples thereof include a disk shape. The disk-shaped support substrate does not need to have a completely circular surface shape, and for example, the outer periphery of the support substrate may have a straight portion called an orientation flat or may have a cut called a notch.

The thickness of the disk-shaped support substrate may be appropriately determined depending on the size of the semiconductor substrate and the like, and is not particularly limited, and is, for example, 500 to 1,000 μm.

The diameter of the disk-shaped support substrate may be appropriately determined depending on the size of the semiconductor substrate and the like, and is not particularly limited, and is, for example, 100 to 1,000 mm.

[0115]

An example of the support substrate is a silicon wafer having a diameter of about 300 mm and a thickness of about 700 μm.

[0116]

<<Adhesive layer>>

The adhesive layer is provided between the support substrate and the semiconductor substrate.

The adhesive layer is in contact with, for example,

the semiconductor substrate. The adhesive layer may be in contact with, for example, the support substrate.

The adhesive layer is an adhesive layer formed from an adhesive composition.

[0117]

The thickness of the adhesive layer included in the laminate of the present invention is not particularly limited, and is usually 5 to 500 μm, preferably 10 μm or more, more preferably 20 μm or more, and still more preferably 30 μm or more from the viewpoint of maintaining the film strength, and is preferably 200 μm or less, more preferably 150 μm or less, still more preferably 120 μm or less, and even still more preferably 100 μm or less from the viewpoint of avoiding nonuniformity caused by a thick film.

[0118]

The method for forming the adhesive layer from the adhesive composition will be described in detail in the description of <<Method for Producing One Example of Laminate in First Embodiment>> described below.

[0119]

Hereinafter, an example of the configuration of the laminate of the first embodiment will be described with reference to the drawings.

Fig. 1 illustrates a schematic cross-sectional view

of an example of a laminate of the first embodiment.

The laminate of Fig. 1 includes a semiconductor substrate 1, an adhesive layer 2, and a support substrate 4 in this order. That is, the adhesive layer 2 is provided between the semiconductor substrate 1 and the support substrate 4. The adhesive layer 2 is in contact with the semiconductor substrate 1 and the support substrate 4.

[0120]

<<Method for producing one example of laminate in first embodiment>>

A method for producing a laminate will be described below with the laminate illustrated in Fig. 1 as an example of the laminate in the first embodiment.

An example of the laminate of the present invention can be produced, for example, by a method including the following first step and second step.

First step: a step of coating an adhesive composition onto a semiconductor substrate to form an adhesive coating layer

Second step: Step of heating the adhesive coating layer to form an adhesive layer

[0121]

The coating method for the adhesive composition is not particularly limited, and is usually a spin coating method. A method for separately forming a coating film by

a spin coating method or the like, forming a sheet-like coating film, and attaching the sheet-like coating film as an adhesive coating layer can be adopted.

The heating temperature of the coated adhesive composition varies depending on the type and amount of the adhesive component contained in the adhesive composition, whether or not a solvent is contained, the boiling point of the solvent to be used, the desired thickness of the adhesive layer, and the like, and thus cannot be generally determined, but the heating temperature is usually 80 to 150°C, and the heating time is usually 30 seconds to 5 minutes.

When the adhesive composition contains a solvent, the coated adhesive composition is usually heated.

The film thickness of an adhesive coating layer obtained by coating an adhesive composition and heating the adhesive composition, as necessary, is usually about 5 to 500 μm, and finally, is appropriately determined to fall within the above-described range of the thickness of the adhesive layer.

[0122]

In the present invention, the laminate of the present invention can be obtained by applying a load in the thickness direction of the semiconductor substrate and the support substrate while performing heat treatment or

decompression treatment or both thereof, and then performing post-heat treatment. The treatment conditions to be adopted, whether heat treatment, decompression treatment, or a combination of both, are appropriately determined taking into consideration various factors such as the type of adhesive composition, the film thickness, and the desired adhesive strength.

[0123]

The heat treatment is appropriately determined from the range of usually 20 to 160°C from the viewpoint of removing the solvent from the composition. In particular, from the viewpoint of suppressing or avoiding excessive curing and unnecessary deterioration of the adhesive component (A), the heating temperature is preferably 150°C or lower, and more preferably 130°C or lower, and the heating time is appropriately determined depending on the heating temperature and the type of the adhesive. However, from the viewpoint of reliably exhibiting suitable adhesion, the heating time is usually 30 seconds or longer, and preferably 1 minute or longer. From the viewpoint of suppressing deterioration of the adhesive layer and other members, the heating time is usually 10 minutes or shorter, preferably 5 minutes or shorter.

[0124]

In the decompression treatment, the adhesive coating

layers in contact with each other may be exposed to an atmospheric pressure of 10 to 10,000 Pa. The time for the decompression treatment is usually 1 to 30 minutes.

[0125]

The load in the thickness direction of the semiconductor substrate and the support substrate is not particularly limited as long as the load does not adversely affect the semiconductor substrate, the support substrate, and those layers therebetween, and can bring them into close contact with each other, but is usually within the range of 10 to 50,000 N.

[0126]

The temperature of the post-heating is preferably 120°C or higher from the viewpoint of achieving a sufficient curing rate and the like, and is preferably 260°C or lower from the viewpoint of preventing deterioration of the substrate and each layer, and the like.

The post-heating time is usually 1 minute or more, and preferably 5 minutes or more from the viewpoint of achieving suitable bonding of the substrate and the layer constituting the laminate, and is usually 180 minutes or less, and preferably 120 minutes or less from the viewpoint of suppressing or avoiding an adverse effect on each layer due to excessive heating, and the like.

The heating can be performed using a hot plate, an oven, or the like. When post-heating is performed using a hot plate, heating may be performed with either the semiconductor substrate or the support substrate of the laminate facing downward. Preferably, the post-heating is performed with the semiconductor substrate facing downward from the viewpoint of achieving suitable release with excellent reproducibility.

One object of the post-heat treatment is to achieve an adhesive layer as a more preferable self-standing film, and to suitably achieve, particularly, curing by a hydrosilylation reaction.

[0127]

Figs. 2A to 2C are views for describing one aspect of producing the laminate.

First, a laminate in which an adhesive coating layer 2a is formed on the semiconductor substrate 1 is prepared (Fig. 2A). This laminate can be obtained, for example, by coating the adhesive composition onto the semiconductor substrate 1, followed by heating.

Next, the laminate illustrated in Fig. 2A and the support substrate 4 are bonded to each other such that the adhesive coating layer 2a and the support substrate 4 are in contact with each other. Then, after a load is applied in the thickness direction between the semiconductor

substrate 1 and the support substrate 4 under reduced pressure, a heating device (not illustrated, a hot plate) is disposed on the surface opposite to a surface of the semiconductor substrate 1 with which the adhesive coating layer 2a is in contact, and the adhesive coating layer 2a is heated and cured by the heating device to be converted into the adhesive layer 2 (Fig. 2B).

The laminate illustrated in Fig. 1 is obtained by the steps illustrated in Figs. 2A to 2B.

[0128]

<Second embodiment>

The laminate including an electronic device layer is used for processing of the electronic device layer. While the electronic device layer is being processed, the electronic device layer is bonded to the support substrate. After the electronic device layer is processed, the electronic device layer is separated from the support substrate.

[0129]

<<Electronic Device Layer>>

The electronic device layer refers to a layer having an electronic device, and in the present invention, the electronic device layer refers to a layer in which a plurality of semiconductor chip substrates are embedded in a sealing resin, that is, a layer including a plurality of

semiconductor chip substrates and a sealing resin disposed between the semiconductor chip substrates.

Here, the “electronic device” means a member constituting at least a part of an electronic component. The electronic device is not particularly limited, and can be one in which various mechanical structures and circuits are formed on the surface of a semiconductor substrate. The electronic device is preferably a composite of a member made of metal or a semiconductor and a resin that seals or insulates the member. The electronic device may be one in which a rewiring layer, which will be described below, and/or a semiconductor element or other elements are sealed or insulated with a sealing material or an insulating material, and has a single-layer or multi-layer structure.

[0130]

<<Support substrate>>

As the support substrate, those similar to those described in the section of <<Support Substrate>> above of <First embodiment> above are exemplified.

[0131]

<<Adhesive layer>>

The adhesive layer is formed using the adhesive composition described above.

The detailed description of the adhesive layer is as described in the <<Adhesive layer>> section of the <First

embodiment> above.

[0132]

Hereinafter, an example of the configuration of the laminate of the second embodiment will be described with reference to the drawings.

The laminate in Fig. 3 includes a support substrate 24, an adhesive layer 22, and an electronic device layer 26 in this order.

The electronic device layer 26 includes a plurality of semiconductor chip substrates 21 and a sealing resin 25 which is a sealing material disposed between the semiconductor chip substrates 21.

The adhesive layer 22 is provided between the electronic device layer 26 and the support substrate 24. The adhesive layer 22 is in contact with the electronic device layer 26 and the support substrate 24.

[0133]

<<Method for Producing One Example of Laminate in Second Embodiment>>

A method for producing a laminate will be described below with the laminate illustrated in Fig. 3 as an example of the laminate in the second embodiment.

The laminate of the present invention can be produced, for example, by a method including the following step 1 to step 4.

Step 1: Step of coating a surface of the support substrate with the adhesive composition to form an adhesive coating layer (as necessary, further heating is performed to form an adhesive layer)

Step 2: Step of placing a semiconductor chip substrate on the adhesive coating layer or the adhesive layer, and bonding the semiconductor chip substrate to the adhesive coating layer or the adhesive layer while performing at least one of heat treatment or decompression treatment

Step 3: Step of curing the adhesive coating layer by post-heat treatment to form an adhesive layer

Step 4: Step of sealing the semiconductor chip substrate fixed onto the adhesive layer using a sealing resin

To describe step 2 in more detail, for example, there is the following step (i) of the embodiment.

(i) The semiconductor chip substrate is placed on the adhesive coating layer or the adhesive layer, and while at least one of the heat treatment and the decompression treatment is performed, a load is applied in the thickness direction of the semiconductor chip substrate and the support substrate to bring the semiconductor chip substrate and the support substrate into close contact with each other, and the semiconductor chip substrate is bonded to

the adhesive coating layer or the adhesive layer.

[0134]

Step 3 may be performed after the semiconductor chip substrate in step 2 is bonded to the adhesive coating layer, or may be performed in combination with step 2. For example, by placing the semiconductor chip substrate on the adhesive coating layer and heating and curing the adhesive coating layer while applying a load in the thickness direction of the semiconductor chip substrate and the support substrate, adhesion between the semiconductor chip substrate and the adhesive coating layer and curing from the adhesive coating layer to the adhesive layer may be performed together, and the adhesive layer and the semiconductor chip substrate may be bonded to each other.

In addition, step 3 may be performed before step 2, and the semiconductor chip substrate may be placed on the adhesive layer, and while a load is applied in the thickness direction of the semiconductor chip substrate and the support substrate, the adhesive layer and the semiconductor chip substrate may be bonded to each other.

[0135]

The coating method, the heating temperature of the applied adhesive composition, the heating means and the like are as described in <<Method for Producing One Example of Laminate in First Embodiment>> section of <First

Embodiment> above.

[0136]

Hereinafter, the procedure of the method for producing a laminate of the second embodiment will be described in more detail with reference to the drawings. In this producing method, the laminate illustrated in Fig. 3 is manufactured.

As illustrated in Fig. 4A, an adhesive coating layer 22' composed of the adhesive composition is formed on the support substrate 24. At that time, the adhesive coating layer 22' may be heated to form the adhesive layer 22.

Next, as illustrated in Fig. 4B, the semiconductor chip substrate 21 is placed on the adhesive layer 22 or the adhesive coating layer 22', and while at least one of the heat treatment and the decompression treatment is performed, a load is applied in the thickness direction of the semiconductor chip substrate 21 and the support substrate 24 to bring the semiconductor chip substrate 21 and the support substrate 24 into close contact with each other, and the semiconductor chip substrate 21 is bonded to the adhesive layer 22 or the adhesive coating layer 22'. When the semiconductor chip substrate 21 is bonded to the adhesive coating layer 22', the adhesive coating layer 22' is cured by post-heat treatment to form the adhesive layer 22, and the semiconductor chip substrate 21 is fixed to the

adhesive layer 22.

Next, as illustrated in Fig. 4C, the semiconductor chip substrate 21 fixed onto the adhesive layer 22 is sealed using the sealing resin 25. In Fig. 4C, the plurality of semiconductor chip substrates 21 temporarily bonded onto the support substrate 24 via the adhesive layer 22 are sealed with the sealing resin 25. The electronic device layer 26, which includes the semiconductor chip substrate 21 and the sealing resin 25 between the semiconductor chip substrates 21, is formed on the adhesive layer 22, and as described above, the electronic device layer 26 is a base material layer in which the plurality of semiconductor chip substrates are embedded in the sealing resin.

[0137]

<<<Sealing Step>>>

The semiconductor chip substrate 21 is sealed using a sealing material.

As the sealing material for sealing the semiconductor chip substrate 21, a member capable of insulating or sealing a member made of metal or a semiconductor is used.

In the present invention, for example, a resin composition (sealing resin) is used as the sealing material. The type of the sealing resin is not particularly limited as long as the sealing resin can seal

and/or insulate metal or a semiconductor, and for example, an epoxy-based resin or a silicone-based resin is preferably used.

The sealing material may contain, in addition to the resin component, other components such as a filler. Examples of the filler include spherical silica particles.

In the sealing step, for example, the sealing resin heated to 130 to 170°C is supplied onto the adhesive layer 22 to cover the semiconductor chip substrate 21 while maintaining a high viscosity state, and is compression-molded to form a layer composed of the sealing resin 25 on the adhesive layer 22. At this time, the temperature condition is, for example, 130 to 170°C. In addition, the pressure applied to the semiconductor chip substrate 21 is, for example, 50 to 500 N/cm^2.

[0138]

(Method for Producing Processed Semiconductor Substrate or Processed Electronic Device Layer)

When the laminate according to the present invention is used, a method for producing a processed semiconductor substrate or a method for producing a processed electronic device layer can be provided.

In the "method for producing a processed semiconductor substrate", the laminate described in the section of <First embodiment> above of the (Laminate) above

is used. In addition, in the "method for producing a processed electronic device layer", the laminate described in the section of <Second embodiment> above of the (Laminate) above is used.

The "method for producing a processed semiconductor substrate" will be described in <Third embodiment> below, and the "method for producing a processed electronic device layer" will be described in <Fourth embodiment> below.

[0139]

A method for producing a processed semiconductor substrate or electronic device layer includes the following steps.

·Processing step of processing first body of laminate of present invention

·Separation step of irradiating the adhesive layer with an infrared laser from the second body side, and then separating the processed first body and second body

[0140]

Examples of the infrared laser include a laser having a wavelength of 1 μm to 20 μm. The wavelength of the infrared laser is preferably 9.2 to 10.8 μm.

Examples of the light source of the infrared laser include a semiconductor laser, a He-Ne laser, an Ar laser, a carbon dioxide laser, a YAG laser, and a fiber laser.

The output of the infrared ray by the infrared laser

is, for example, preferably 10 W to 100 W, and more preferably 30 W to 90 W.

[0141]

The irradiation of the adhesive layer with the infrared laser does not necessarily have to be performed on the entire region of the adhesive layer. Even if the region irradiated with the infrared laser and the region not irradiated with the infrared laser are mixed, the second body can be released from the laminate by applying a slight external force and pulling up the second body as long as the adhesive strength of a part of the adhesive layer is sufficiently reduced. The ratio and positional relationship between the region irradiated with the infrared laser and the region not irradiated with the infrared laser vary depending on the adhesive composition forming the adhesive layer, the thickness of the adhesive layer, the strength of the infrared laser to be irradiated, and the like, but those skilled in the art can appropriately set the conditions without requiring an excessive test. For example, a region not irradiated with the infrared laser may be provided next to a region irradiated with the infrared laser, with the same width as the drawing line width of the infrared ray.

The irradiation of the adhesive layer with the infrared laser may be performed only at an end portion of

the adhesive layer sandwiched between the first body and the second body.

[0142]

After the adhesive layer is irradiated with the infrared laser, in order to more easily separate the first body and the second body, equipment having a sharp portion may be inserted between the first body and the second body.

[0143]

Examples of the method for separating the first body and the second body include a method in which after the adhesive force of the adhesive layer is reduced by the irradiation of the adhesive layer with the infrared laser, the first body and the second body are respectively held by holders, and one or both of the holders are moved in a direction in which the first body and the second body are separated.

Examples of the holder include a suction plate.

[0144]

In the separation step, preferably, by irradiating the adhesive layer with an infrared laser, compared to a case where the adhesive layer is not irradiated with an infrared laser, the insertion force required when the sharp portion of the equipment having the sharp portion is inserted between the first body and the second body to separate the first body and the second body is reduced. In

other words, it is preferable that the insertion force (Fb) required to separate the first body and the second body by inserting a sharp portion of equipment having a sharp portion between the first body and the second body after irradiating the adhesive layer with the infrared laser is smaller than an insertion force (Fa) required to separate the first body and the second body by inserting the sharp portion between the first body and the second body without irradiating the adhesive layer with the infrared laser.

The insertion force is indicated as an absolute value.

Examples of the insertion force (Fa) include 0.1 N to 100 N.

[0145]

The ratio (Fb/Fa) of the insertion force (Fb) to the insertion force (Fa) is not particularly limited, but is preferably less than 1.0, more preferably 0.9 or less, and still more preferably 0.6 or less.

The lower limit value of the ratio (Fb/Fa) is not particularly limited, but the ratio (Fb/Fa) may be 0.01 or more, 0.05 or more, or 0.1 or more.

The insertion force is measured, for example, as described above.

[0146]

<Third embodiment>

The method for producing a processed semiconductor substrate of the present invention includes the following step 5A and the following step 6A. The method for producing a processed semiconductor substrate may further include the following step 7A.

Here, step 5A is a step of processing the semiconductor substrate in the laminate described in the section of <First embodiment> above.

In addition, step 6A is a step of separating the processed semiconductor substrate in step 5A and the support substrate.

In addition, step 7A is a step of cleaning the processed semiconductor substrate after step 6A.

[0147]

The processing performed on the semiconductor substrate in step 5A is, for example, processing on the side opposite to the circuit surface of the wafer, and includes thinning of the wafer by polishing the back surface of the wafer. Thereafter, for example, a through-silicon via (TSV) or the like is formed, and the thinned wafer is then released from the support substrate to form a laminate of wafers which are three-dimensionally mounted. In addition, for example, before or after that, a wafer back surface electrode and the like are also formed. Heat of approximately 250 to 350°C is applied to thinning of a

wafer and a TSV process in a state of being bonded to the support substrate. The laminate of the present invention, including the adhesive layer, ordinarily has heat resistance against the load.

The processing is not limited to the above-described processing, and includes, for example, implementation of a process of mounting a semiconductor component in a case where a substrate for mounting the semiconductor component is temporarily adhered to the support substrate to support the substrate.

[0148]

In 6A step, the method of separating (releasing) the semiconductor substrate and the support substrate is the separation step described above.

[0149]

The substrate can be cleaned by spraying a cleaning agent composition onto the surface of at least one of the separated semiconductor substrate and the support substrate, or immersing the separated semiconductor substrate or the support substrate in a cleaning agent composition.

In addition, the surface of the processed semiconductor substrate or the like may be cleaned using a removal tape or the like.

As an example of cleaning the substrate, step 7A of

cleaning the processed semiconductor substrate may be performed after step 6A.

Examples of the cleaning agent composition to be used for cleaning include the following.

[0150]

The cleaning agent composition usually contains a solvent.

Examples of the solvent include lactones, ketones, polyhydric alcohols, compounds having an ester bond, derivatives of polyhydric alcohols, cyclic ethers, esters, and aromatic organic solvents.

Examples of the lactones include γ-butyrolactone.

Examples of the ketones include acetone, methyl ethyl ketone, cyclohexanone, methyl-n-pentyl ketone, methyl isopentyl ketone, and 2-heptanone.

Examples of the polyhydric alcohols include ethylene glycol, diethylene glycol, propylene glycol, and dipropylene glycol.

Examples of the compound having an ester bond include ethylene glycol monoacetate, diethylene glycol monoacetate, propylene glycol monoacetate, and dipropylene glycol monoacetate.

Examples of the derivatives of polyhydric alcohols include monoalkyl ethers such as monomethyl ether, monoethyl ether, monopropyl ether, and monobutyl ether of

the polyhydric alcohols or the compounds having an ester bond, or compounds having an ether bond such as monophenyl ether. Among them, propylene glycol monomethyl ether acetate (PGMEA) and propylene glycol monomethyl ether (PGME) are preferable.

Examples of the cyclic ethers include dioxane.

Examples of the esters include methyl lactate, ethyl lactate (EL), methyl acetate, ethyl acetate, butyl acetate, methyl pyruvate, ethyl pyruvate, methyl methoxypropionate, and ethyl ethoxypropionate.

Examples of the aromatic organic solvents include anisole, ethyl benzyl ether, cresyl methyl ether, diphenyl ether, dibenzyl ether, phenetole, butyl phenyl ether, ethylbenzene, diethylbenzene, pentylbenzene, isopropylbenzene, toluene, xylene, cymene, and mesitylene.

These can be used alone or in combination with two or more thereof.

Among them, propylene glycol monomethyl ether acetate (PGMEA), propylene glycol monomethyl ether (PGME), cyclohexanone, and ethyl lactate (EL) are preferable.

[0151]

In addition, a mixed solvent obtained by mixing PGMEA and a polar solvent is also preferable. The blending ratio (mass ratio) may be appropriately determined in consideration of compatibility between PGMEA and the polar

solvent or the like, and is preferably in the range of 1:9 to 9:1, more preferably 2:8 to 8:2.

For example, when EL is blended as the polar solvent, the mass ratio of PGMEA:EL is preferably 1:9 to 9:1, more preferably 2:8 to 8:2. In addition, when PGME is blended as the polar solvent, the mass ratio of PGMEA:PGME is preferably 1:9 to 9:1, more preferably 2:8 to 8:2, still more preferably 3:7 to 7:3. In addition, when PGME and cyclohexanone are blended as the polar solvent, the mass ratio of PGMEA:(PGME + cyclohexanone) is preferably 1:9 to 9:1, more preferably 2:8 to 8:2, still more preferably 3:7 to 7:3.

[0152]

The cleaning agent composition may contain or may not contain a salt, but it is preferable that the cleaning agent composition does not contain a salt from the viewpoint of enhancing versatility in processing a semiconductor substrate using a laminate, and suppressing cost.

[0153]

An example of the case where the cleaning agent composition contains a salt includes a cleaning agent composition containing a quaternary ammonium salt and a solvent.

The quaternary ammonium salt is composed of a

quaternary ammonium cation and an anion, and is not particularly limited as long as the quaternary ammonium salt is used for this type of application.

Such quaternary ammonium cations typically include tetra(hydrocarbon)ammonium cations. On the other hand, examples of an anion paired therewith include, but are not limited to, a hydroxide ion (OH^-); a halogen ion such as a fluorine ion (F^-), a chlorine ion (Cl^-), a bromine ion (Br^-), and an iodine ion (I^-); a tetrafluoroborate ion (BF_4^-); or a hexafluorophosphate ion (PF_6^-).

[0154]

The quaternary ammonium salt is preferably a halogen-containing quaternary ammonium salt, and more preferably a fluorine-containing quaternary ammonium salt.

In the quaternary ammonium salt, the halogen atom may be contained in the cation or the anion, and is preferably contained in the anion.

[0155]

In a preferred embodiment, the fluorine-containing quaternary ammonium salt is tetra(hydrocarbon)ammonium fluoride.

Specific examples of the hydrocarbon group in tetra(hydrocarbon)ammonium fluoride include an alkyl group having 1 to 20 carbon atoms, an alkenyl group having 2 to 20 carbon atoms, an alkynyl group having 2 to 20 carbon

atoms, and an aryl group having 6 to 20 carbon atoms.

In a more preferred embodiment, the tetra(hydrocarbon)ammonium fluoride includes tetraalkylammonium fluoride.

Specific examples of tetraalkylammonium fluoride include, but are not limited to, tetramethylammonium fluoride, tetraethylammonium fluoride, tetrapropylammonium fluoride, and tetrabutylammonium fluoride. Among them, tetrabutylammonium fluoride is preferable.

[0156]

As the quaternary ammonium salt such as tetra(hydrocarbon)ammonium fluoride, a hydrate may be used. In addition, the quaternary ammonium salts such as tetra(hydrocarbon)ammonium fluoride may be used alone or in combination of two or more thereof.

The amount of the quaternary ammonium salt is not particularly limited as long as the quaternary ammonium salt dissolves in the solvent contained in the cleaning agent composition, but is usually 0.1 to 30 mass% with respect to the cleaning agent composition.

[0157]

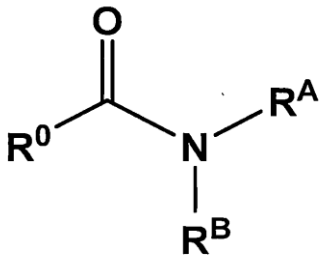
When the cleaning agent composition contains a salt, the solvent to be used in combination is not particularly limited as long as the solvent is used for this type of application and dissolves a salt such as a quaternary

ammonium salt, but from the viewpoint of obtaining a cleaning agent composition having excellent cleanability with good reproducibility, the viewpoint of obtaining a cleaning agent composition having excellent uniformity by dissolving a salt such as a quaternary ammonium salt well, and the like, the cleaning agent composition preferably contains one or two or more amide-based solvents.

[0158]

Suitable examples of the amide-based solvents include an acid amide derivative represented by Formula (Z).

[Chem. 12]



(Z)

[0159]

In the formula, R^0 represents an ethyl group, a propyl group or an isopropyl group, and is preferably an ethyl group or an isopropyl group, and more preferably an ethyl group. R^A and R^B each independently represent an alkyl group having 1 to 4 carbon atoms. The alkyl group having 1 to 4 carbon atoms may be linear, branched, or cyclic, and specific examples thereof include a methyl group, an ethyl group, a propyl group, an isopropyl group,

a cyclopropyl group, a n-butyl group, an isobutyl group, a s-butyl group, a t-butyl group, and a cyclobutyl group. Among them, R^A and R^B are preferably a methyl group or an ethyl group, more preferably both are a methyl group or an ethyl group, and still more preferably both are a methyl group.

[0160]

Examples of the acid amide derivative represented by Formula (Z) include N,N-dimethylpropionamide, N,N-diethylpropionamide, N-ethyl-N-methylpropionamide, N,N-dimethylbutyramide, N,N-diethylbutyramide, N-ethyl-N-methylbutyramide, N,N-dimethylisobutyramide, N,N-diethylisobutyramide, or N-ethyl-N-methylisobutyramide. Among them, N,N-dimethylpropionamide and N,N-dimethylisobutyramide are particularly preferable, and N,N-dimethylpropionamide is more preferable.

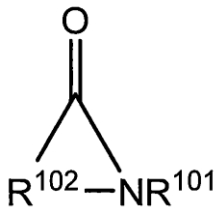
[0161]

The acid amide derivative represented by Formula (Z) may be synthesized by a substitution reaction between a corresponding carboxylic acid ester and an amine, or a commercially available product may be used.

[0162]

Another example of the preferable amide-based solvents includes a lactam compound represented by Formula (Y).

[Chem. 13]



(Y)

[0163]

In Formula (Y), R^{101} represents a hydrogen atom or an alkyl group having 1 to 6 carbon atoms, and R^{102} represents an alkylene group having 1 to 6 carbon atoms. Specific examples of the alkyl group having 1 to 6 carbon atoms include a methyl group, an ethyl group, an n-propyl group, and an n-butyl group, and specific examples of the alkylene group having 1 to 6 carbon atoms include, but are not limited to, a methylene group, an ethylene group, a trimethylene group, a tetramethylene group, a pentamethylene group, and a hexamethylene group.

[0164]

Specific examples of the lactam compound represented by Formula (Y) include an α-lactam compound, a β-lactam compound, a γ-lactam compound, and a δ-lactam compound, and these compounds can be used alone or in combination of two or more thereof.

[0165]

In a preferred embodiment, the lactam compound represented by Formula (Y) contains 1-alkyl-2-pyrrolidone

(N-alkyl-γ-butyrolactam), in a more preferred embodiment, contains N-methylpyrrolidone (NMP) or N-ethylpyrrolidone (NEP), and in a still more preferred embodiment, contains N-methylpyrrolidone (NMP).

[0166]

The cleaning agent composition used in the present invention may contain water as the solvent, but usually, only an organic solvent is intended to be used as the solvent, for example, from the viewpoint of avoiding corrosion of the substrates and the like. In this case, it is not denied that hydrated water of the salt or trace amounts of water contained in the organic solvent are contained in the cleaning agent composition. The water content of the cleaning agent composition used in the present invention is usually 5 mass% or less.

[0167]

The constituent elements and method elements related to the above-described steps of the method for producing a processed semiconductor substrate of the present invention may be variously changed without departing from the gist of the present invention.

The method for producing a processed semiconductor substrate of the present invention may include steps other than the above-described steps.

[0168]

An example of the third embodiment will be described with reference to Figs. 5A to 5E. This example is an example of production of a thinned semiconductor substrate.

First, a laminate is prepared (Fig. 5A). This laminate is the same laminate as that illustrated in Figs. 1 and 2B.

Next, the surface of the semiconductor substrate 1 opposite to a surface in contact with the adhesive layer 2 is polished using a polishing apparatus (not shown) to thin the semiconductor substrate 1 (Fig. 5B). A through electrode or the like may be formed on the thinned semiconductor substrate 1.

Next, the adhesive layer 2 is irradiated with an infrared laser L from the support substrate 4 side (Fig. 5C). The irradiation with the infrared laser may be performed on the entire surface or a part of the adhesive layer 2.

Next, the thinned semiconductor substrate 1 and the support substrate 4 are separated from each other using a release device (not illustrated) (Fig. 5D).

Then, the thinned semiconductor substrate 1 is obtained (Fig. 5E).

Here, the residue of the adhesive layer 2 may remain on the thinned semiconductor substrate 1. Accordingly, it is preferable to clean the thinned semiconductor substrate

1 using the cleaning agent composition to remove the residue of the adhesive layer 2 from the semiconductor substrate 1.

[0169]

<Fourth embodiment>

The method for producing a processed electronic device layer of the present invention includes the following step 5B and the following step 6B. The method for producing a processed electronic device layer may further include the following step 7B.

Here, step 5B is a step of processing the electronic device layer in the laminate described in the section of <Second embodiment> above.

In addition, step 6B is a step of separating the electronic device layer processed in step 5B from the support substrate.

In addition, step 7B is a step of cleaning the processed electronic device layer after step 6B.

Hereinafter, a specific example of the fourth embodiment will be described with reference to Figs. 6A to 6G.

[0170]

Examples of the processing performed on the electronic device layer in step 5B include a grinding step and a wiring layer formation step.

[0171]

<<Grinding Step>>

The grinding step is a step of grinding the resin part of the layer of the sealing resin 25 in the electronic device layer 26 such that a part of the semiconductor chip substrate 21 is exposed.

For example, as illustrated in Fig. 6B, the sealing resin portion is ground by grinding the layer of the sealing resin 25 of the laminate illustrated in Fig. 6A until the layer has a thickness substantially equal to that of the semiconductor chip substrate 21. The laminate illustrated in Fig. 6A is the same laminate as the laminate illustrated in Figs. 3 and 4C.

[0172]

<<Wiring layer formation step>>

The wiring layer formation step is a step of forming a wiring layer on the exposed semiconductor chip substrate 21 after the grinding step.

In Fig. 6C, a wiring layer 28 is formed on an electronic device layer 26 including a semiconductor chip substrate 21 and a layer of a sealing resin 25.

The wiring layer 28 is also called a redistribution layer (RDL), and is a thin-film wiring body constituting wiring connected to a substrate, and may have a single-layer or multi-layer structure. The wiring layer may be,

but is not limited to, one in which wiring is formed of a conductor (for example, metals such as aluminum, copper, titanium, nickel, gold, and silver, and alloys such as a silver-tin alloy) between dielectrics (for example, silicon oxide (SiO_x) or a photosensitive resin such as photosensitive epoxy).

Examples of the method for forming the wiring layer 28 include the following methods.

First, a dielectric layer of silicon oxide (SiO_x), a photosensitive resin, or the like is formed on the layer of the sealing resin 25. The dielectric layer consisting of silicon oxide can be formed by, for example, a sputtering method, a vacuum vapor deposition method, or the like. The dielectric layer consisting of a photosensitive resin can be formed by coating the layer of the sealing resin 25 with a photosensitive resin by a method such as spin coating, dipping, roller blade, spray coating, or slit coating.

Subsequently, wiring is formed on the dielectric layer with a conductor such as metal. As a method for forming the wiring, for example, known semiconductor process techniques such as lithography processing such as photolithography (resist lithography) or etching processing can be used. Examples of such lithography processing include lithography processing using a positive resist material and lithography processing using a negative resist

material.

In the method for producing a laminate according to a fourth embodiment, a bump can be further formed or an element can be mounted on the wiring layer 28. The element can be mounted on the wiring layer 28 using, for example, a chip mounter or the like.

The laminate according to the fourth embodiment may be a laminate prepared in a process based on a fan-out-type technology in which a terminal provided on a semiconductor chip substrate is mounted on a wiring layer extending outside a chip area.

[0173]

In 6B step, the method for separating (releasing) the electronic device layer and the support substrate is the separation step described above.

[0174]

Figs. 6D to 6F are schematic cross-sectional views for describing a separation method for the laminate, and Fig. 6G is a schematic cross-sectional view for describing a cleaning method after separation of the laminate. One embodiment of the method for producing the semiconductor package (electronic component) can be described with reference to Figs. 6D to 6G.

The step of separating the laminate is a step of separating the electronic device layer 26 and the support

substrate 24, as illustrated in Figs. 6D to 6F. Specifically, the adhesive layer 22 is irradiated with the infrared laser L from the support substrate 24 side (Fig. 6D). The irradiation with the infrared laser may be performed on the entire surface or a part of the adhesive layer 22. Next, the thinned electronic device layer 26 and the support substrate 24 are separated using a release device (not illustrated) (Fig. 6E).

[0175]

The substrate can be cleaned by spraying the cleaning agent composition onto the surface of at least one of the separated electronic device layer and the support substrate, or immersing the separated electronic device layer or the support substrate in the cleaning agent composition.

In addition, the surface of the processed electronic device layer or the like may be cleaned using a removal tape or the like.

For example, in Fig. 6F, the adhesive layer 22 is bonded to the electronic device layer 26 after the separation step, but the adhesive layer 22 can be removed by decomposing the adhesive layer 22 using a cleaning agent composition such as an acid or an alkali. By removing the adhesive layer, a processed electronic device layer (electronic component) as illustrated in Fig. 6G can be

suitably obtained.

[0176]

The constituent elements and method elements related to the above-described steps of the method for producing a processed electronic device layer of the present invention may be variously changed without departing from the gist of the present invention.

The method for producing a processed electronic device layer of the present invention may include steps other than the above-described steps.

Examples

[0177]

Hereinafter, the present invention will be more specifically described with reference to Examples, but the present invention is not limited to the following Examples. The apparatus used is as follows.

[0178]

[Apparatus]

(1) Stirrer A: Rotation and revolution mixer ARE-500, manufactured by THINKY CORPORATION

(2) Stirrer B: Mixing rotor VMR-5R, manufactured by AS ONE Corporation

(3) Measurement of viscosity: TVE-22H, rotational viscometer manufactured by Toki Sangyo Co., Ltd.

(4) Spin coating device: coater manufactured by APOGEE Co., Ltd.

(5) Vacuum heating bonding apparatus: VE09-07, manufactured by Ayumi Industry Co., Ltd.

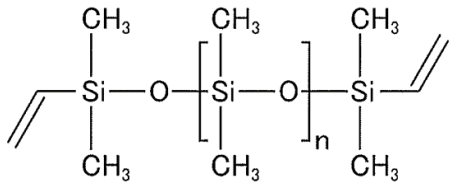
(6) Force gauge: RZE-10 manufactured by Aikoh Engineering Co., Ltd.

(7) Infrared laser release device: AFS-MCTII-FX manufactured by Aflair

[0179]

The structures and properties of the polysiloxanes used (formula (V) and formula (W)) are shown below.

[Chem. 14]



(V)

(In formula (V), n represents the number of repeating units and is a positive integer.) Polysiloxanes having a structure represented by formula (V) and exhibiting the characteristics in Table 1 below were used.

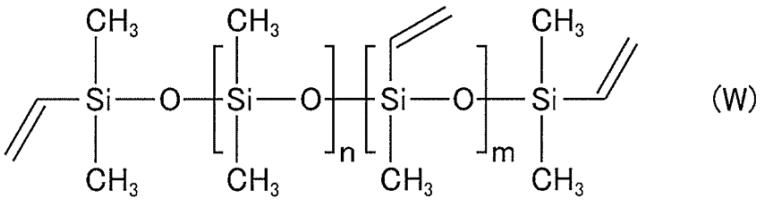
[0180]

[Table 1]

Vinyl group-containing linear polydimethylsiloxane	Number average molecular weight Mn	Vinyl group content (mol/kg)
V1	6000	0.24

[0181]

[Chem. 15]



(W)

(In formula (W), n and m represent the number of repeating units, and each independently represent a positive integer.) It also has 2.7 mol/kg of vinyl groups and the number average molecular weight (Mn) as determined by GPC is 9000.

[0182]

[1] Preparation of Adhesive Composition

[Preparation Example 1]

To a 50 mL screw tube, 1.0 g of 1,1-diphenyl-2-propyn-1-ol (manufactured by Tokyo Chemical Industry Co., Ltd.) and 1.0 g of 1-ethynyl-1-cyclohexanol (manufactured by Wacker Chemie AG) were added, and the mixture was stirred with a stirrer A for 5 minutes to obtain a mixture (I).

To a 650 mL stirring container dedicated to a rotation and revolution mixer, 210.71 g of a p-menthane solution (concentration: 81.2 mass%) of a vinyl group-containing MQ resin (manufactured by Wacker Chemie AG) and 0.05 g of a platinum catalyst (valence 0, platinum content

1 wt%) diluted with a polysiloxane of the above formula (W) were added, and the mixture was stirred with a stirrer A for 5 minutes to obtain a mixture (II).

To a 200 mL stirring container dedicated to a rotation and revolution mixer, 0.17 g of the obtained mixture (I) and 60.22 g of the obtained mixture (II) were added, and the mixture was stirred with a stirrer A for 5 minutes to obtain a mixture (III).

To the resulting mixture (III), 16.84 g of the following mixture A, 13.01 g of the following mixture B, 0.80 g of epoxy-modified silicone (X-22-343, manufactured by Shin-Etsu Silicone Co., Ltd.), and 2.17 g of p-menthane were added, and the mixture was stirred with a stirrer A for 5 minutes to obtain a mixture (IV).

Mixture A: a mixture obtained by mixing a vinyl group-containing MQ resin (manufactured by Wacker Chemie AG), a vinyl group-containing linear polydimethylsiloxane represented by formula (V) and having a viscosity of 200 mPa · s (V1 in Table 1), and a SiH group-containing linear polydimethylsiloxane having a viscosity of 100 mPa · s (manufactured by Wacker Chemie AG) at a mass ratio of 54.1 : 36.4 : 9.5

Mixture B: a mixture in which GENIOPLAST GUM (manufactured by Wacker Chemie AG), a SiH group-containing linear polydimethylsiloxane having a viscosity of 100 mPa·s

(manufactured by Wacker Chemie AG), and p-menthane are mixed at a mass ratio of 30.31 : 63.50 : 6.19

Finally, the obtained mixture (IV) was filtered through a 300-mesh nylon filter to obtain an adhesive composition.

[0183]

[Preparation Example 2]

To a 50 mL screw tube, 2.0 g of tannic acid AL (manufactured by Fuji Chemical Industry Co., Ltd.: corresponding to an infrared-absorbing agent) and 8.0 g of propylene glycol monomethyl ether were added, and the mixture was stirred with a stirrer A for 5 minutes to obtain a mixture (V). To a 100 mL lidded glass container, 0.5 g of the obtained mixture (V) and 9.5 g of the mixture (IV) obtained in Preparation Example 1 were added, and the mixture was stirred with a stirrer A for 5 minutes. The obtained mixture was filtered through a nylon filter 300 mesh to obtain an adhesive composition (VI) containing an infrared-absorbing agent.

[0184]

[2] Preparation of laminate

[Example 1]

The adhesive composition (VI) obtained in Preparation Example 2 was coated to a 4 cm square silicon substrate by spin coating at 950 rpm for 30 seconds, and then heated at

90°C for 1.5 minutes (preheating treatment) to form an adhesive coating layer. Thereafter, in a vacuum heating bonding apparatus, a silicon substrate having the adhesive coating layer and a 4 cm square silicon substrate were bonded so as to sandwich the adhesive coating layer, and heated (post-heat treatment) at 130°C for 5 minutes and further at 200°C for 5 minutes with the substrate having the adhesive coating layer facing downward on a hot plate, thereby preparing a laminate. Bonding was performed using a vacuum heating bonding apparatus at a temperature of 70°C and a degree of vacuum of 1000 Pa under a load of 150 kg for 3 minutes.

[0185]

[Comparative Example 1]

A laminate was produced in the same manner as in Example 1, except that the adhesive composition obtained in Preparation Example 1 was used.

[0186]

[3] Laser irradiation

[Example 2]

The laminate produced in Example 1 was irradiated with a laser having a wavelength of 9.3 μm from the direction perpendicular to the silicon wafer on the carrier side on the entire surface of a 4 cm square substrate using an infrared laser release device. The laser irradiation

conditions were as follows.

·Scan speed: 1000 nm/sec

·Laser power: 60 W

·Frequency: 20 Hz

[0187]

[Comparative Example 2]

The irradiation with the infrared laser was performed in the same manner as in Example 2 except that the laminate produced in Comparative Example 1 was used.

[0188]

[4] Evaluation of insertion force

[Example 3]

The device side of the laser-irradiated laminate in Example 2 was fixed on a workbench with a double-sided tape. Next, a force gauge blade having a razor blade attached to the tip thereof was inserted into the adhesive layer of the fixed laminate, and the maximum value of the absolute value of the force gauge at that time was taken as the insertion force.

[0189]

[Comparative Example 3]

The insertion force was evaluated by the same test method as in Example 3 except that the laser-irradiated laminate in Comparative Example 2 was used.

[0190]

The evaluation results of Example 3 and Comparative Example 3 are shown in Table 2.

[0191]

[Table 2]

	Insertion force (N)
Example 3	1.0 N
Comparative Example 3	1.8 N

[0192]

From the results of Example 3 and Comparative Example 3, it became clear that in a case where the laminate on which the adhesive layer containing the infrared-absorbing agent is formed is irradiated with an infrared laser, equipment having a sharp portion can be inserted between the substrates with a low insertion force in the laminate in which the mixture containing the infrared-absorbing agent is used as the adhesive layer. From this, it was confirmed that when the composition and process according to the present invention were used, the substrate was less damaged when the laminate was separated, and release was possible.

Reference Signs List

[0193]

1 Semiconductor substrate

2 Adhesive layer

2a Adhesive coating layer

4	Support substrate
21	Semiconductor chip substrate
22	Adhesive layer
22'	Adhesive coating layer
24	Support substrate
25	Sealing resin
26	Electronic device layer
28	Wiring layer
L	Infrared laser

CLAIMS

[claim 1] An adhesive composition for forming an adhesive layer used in a laminate comprising a first body that is a semiconductor substrate or an electronic device layer, a second body that is a support substrate transmitting an infrared laser, and an adhesive layer provided between the first body and the second body, wherein after processing the first body, the adhesive layer is irradiated with the infrared laser from the second body side, and then the first body and the second body are separated,

the adhesive composition containing: an adhesive component having a siloxane bond, a release agent component, and an infrared-absorbing agent.

[claim 2] The adhesive composition according to claim 1, wherein the adhesive component is a component that is cured by a hydrosilylation reaction.

[claim 3] The adhesive composition according to claim 2, wherein the component that cures by the hydrosilylation reaction contains:

a component (A-1) having an alkenyl group having 2 to 40 carbon atoms bonded to a silicon atom; and

a component (A-2) having a Si-H group.

[claim 4] The adhesive composition according to claim 3, wherein the component (A-1) contains a polyorganosiloxane (a1) containing an alkenyl group having 2 to 40 carbon

atoms, the alkenyl group being bonded to a silicon atom.

[claim 5] The adhesive composition according to claim 3, wherein the component (A-2) contains a polyorganosiloxane having a Si-H group.

[claim 6] The adhesive composition according to claim 1, wherein the release agent component is polyorganosiloxane.

[claim 7] The adhesive composition according to claim 1, wherein an insertion force required to separate the first body and the second body by inserting a sharp portion of equipment having a sharp portion between the first body and the second body after irradiating the adhesive layer with the infrared laser is smaller than an insertion force required to separate the first body and the second body by inserting the sharp portion between the first body and the second body without irradiating the adhesive layer with the infrared laser.

[claim 8] A laminate comprising:

a first body that is a semiconductor substrate or an electronic device layer;

a second body that is a support substrate that transmits an infrared laser; and

an adhesive layer provided between the first body and the second body,

wherein the adhesive layer is an adhesive layer formed from the adhesive composition according to any one

of claims 1 to 7.

[claim 9] A method for producing a processed semiconductor substrate or electronic device layer, the method comprising:

processing step of processing the first body of the laminate according to claim 8; and

a separation step of irradiating the adhesive layer with the infrared laser from the second body side, and then separating the processed first body and the second body.

[claim 10] The method for producing a processed semiconductor substrate or electronic device layer according to claim 9, wherein by irradiating the adhesive layer with the infrared laser, an insertion force required to separate the first body and the second body by inserting the sharp portion of equipment having a sharp portion between the first body and the second body is reduced as compared with a case where the adhesive layer is not irradiated with the infrared laser.