DESCRIPTION

Title of Invention: COMPOSITION FOR FORMING FILM FOR SEMICONDUCTOR, LAMINATE, AND SUBSTRATE LAMINATE

Technical Field

[0001] The present disclosure relates to a composition for forming a film for a semiconductor, a laminated body, and a substrate laminated body.

Background Art

[0002] As reduction in size and weight of electronic devices and improvement of performance thereof progresses, semiconductor chips and the like are desired to have higher integration. However, the desire is difficult to sufficiently address by means of miniaturization of circuits. In consideration of this, a method of high integration has been proposed in recent years, in which multiple semiconductor substrate (wafer) sheets are stacked in the thickness direction to form a multilayer three-dimensional structure. Proposed methods for stacking semiconductor substrates (wafers) include a method for direct joining of substrates, and a method using a joining material (for example, see Japanese Patent Application Laid-open (JP-A) No. H4-132258, Japanese Patent Application Laid-open (JP-A) No. 2010-226060, and Japanese Patent Application Laid-open (JP-A) No.2016-47895).

SUMMARY

Problem to be Solved by Disclosure

[0003] In the case of using a joining material for joining semiconductor substrates together, a process may be envisaged which includes applying a resin to a surface of a semiconductor substrate, forming a joining layer therefrom by drying, heating or the like, and joining semiconductor substrates together via the joining layer. In this process, the semiconductor substrate having the joining layer thereon tends to warp, due to, for example, a difference between the thermal expansion coefficient of the joining layer and the thermal expansion coefficient of the semiconductor substrate. If the warpage generated is large, there would be a possibility that positional misalignment occurs during joining of semiconductor substrates.

[0004] In the case of using a joining material for joining semiconductor substrates together, if the joining layer formed from the joining material does not adhere tightly, there would be an increased possibility that semiconductor substrates separate after joining, or that a position misalignment between the semiconductor substrates is generated after joining.

[0005] In consideration of the foregoing issues, it is desirable that warping of a substrate is reduced in the case of forming a joining layer on a substrate, such as a semiconductor substrate, by using a composition for forming a film for a semiconductor, and that the joining strength between the substrates is high.

One example of the present disclosure has been formulated in consideration of the foregoing, and aims to provide: a composition for forming a film for a semiconductor, wherein the composition is capable of forming a joining layer that can reduce warpage of a substrate when the joining layer is formed on the substrate and provides a high joining strength between substrates; and a laminated body and a substrate laminated body that are formed using that the composition for forming a film for a semiconductor.

In an aspect, there is provided a composition for forming a film for a semiconductor, comprising:

a siloxane compound (A) that is linear and includes at least one of a primary amino group or a secondary amino group, silicon atoms, and non-polar groups bonded to the silicon atoms, wherein, in the siloxane compound (A), a total number of primary amino groups and secondary amino groups is 2 or greater, and the silicon atoms and the non-polar groups bonded to the silicon atoms satisfy a relationship, (non-polar groups)/Si $\geq$ 1.8, as a molar ratio;

a silane compound (B) that includes at least one of a primary amino group or a secondary amino group, and one or more silicon atoms, wherein, in the silane compound (B), the one or more silicon atoms and one or more non-polar groups, if any, bonded to the one or more silicon atoms satisfy a relationship, (non-polar groups)/Si < 1.8, as a molar ratio; and

a cross-linking agent (C) that includes three or more -C(=O)OX groups in a molecule thereof (X representing a hydrogen atom or an alkyl group having from 1 to 6 carbon atoms), wherein from one to six of the three or more -C(=O)OX groups are -C(=O)OH groups, and the cross-linking agent (C) has a weight average molecular weight of from 200 to 2000.

In another aspect, there is provided a laminated body, comprising a joining layer formed from the composition for forming a film for a semiconductor as defined above and a substrate, which are layered one on the other.

In another aspect, there is provided a substrate laminated body, comprising a first substrate, a joining layer formed from the composition for forming a film for a semiconductor as defined above, and a second substrate, which are layered in this order.

In another aspect, there is provided a substrate laminated body, comprising:

a first stacked-layer region including a first substrate, a joining layer formed from the

composition for forming a film for a semiconductor as defined above, and a second substrate, which are layered in this order; and

a second stacked-layer region including a first substrate, an electrode, and a second substrate, which are layered in this order,

wherein at least one of the first stacked-layer region and at least one of the second stacked-layer region are arranged in a plane direction that is orthogonal to a layer-stacking direction.

Means for Solving Problem

[0006] Specific means for solving the problem include the following.

<1> A composition for forming a film for a semiconductor, including:

a siloxane compound (A) that is linear and includes at least one of a primary amino group or a secondary amino group, silicon atoms, and non-polar groups bonded to the silicon atoms, wherein, in the siloxane compound (A), the total number of primary amino groups and secondary amino groups is 2 or greater, and the silicon atoms and the non-polar groups bonded to the silicon atoms satisfy a relationship, (non-polar groups)/Si ≥ 1.8, as a molar ratio;

a silane compound (B) that includes at least one of a primary amino group or a secondary amino group, and one or more silicon atoms, wherein, in the silane compound (B), the one or more silicon atoms and one or more non-polar groups, if any, bonded to the one or more silicon atoms satisfy a relationship, (non-polar groups)/Si < 1.8, as a molar ratio; and

a cross-linking agent (C) that includes three or more -C(=O)OX groups in a molecule thereof (X representing a hydrogen atom or an alkyl group having from 1 to 6 carbon atoms), wherein from one to six of the three or more -C(=O)OX groups are -C(=O)OH groups, and the cross-linking agent (C) has a weight average molecular weight of from 200 to 2000.

<2> The composition for forming a film for a semiconductor according to <1>, wherein the weight average molecular weight of the silane compound (B) is from 130 to 10000.

<3> The composition for forming a film for a semiconductor according to <1> or <2>, wherein COOX / amino groups, which is the ratio of the number of -C(=O)OX groups in molecules of the cross-linking agent (C) to the total number of amino groups of molecules of components having an amino group contained in the composition for forming a film for a

CLAIMS

Claim 1. A composition for forming a film for a semiconductor, comprising:

a siloxane compound (A) that is linear and includes at least one of a primary amino group or a secondary amino group, silicon atoms, and non-polar groups bonded to the silicon atoms, wherein, in the siloxane compound (A), a total number of primary amino groups and secondary amino groups is 2 or greater, and the silicon atoms and the non-polar groups bonded to the silicon atoms satisfy a relationship, (non-polar groups)/Si $\geq$ 1.8, as a molar ratio;

a silane compound (B) that includes at least one of a primary amino group or a secondary amino group, and one or more silicon atoms, wherein, in the silane compound (B), the one or more silicon atoms and one or more non-polar groups, if any, bonded to the one or more silicon atoms satisfy a relationship, (non-polar groups)/Si < 1.8, as a molar ratio; and

a cross-linking agent (C) that includes three or more -C(=O)OX groups in a molecule thereof (X representing a hydrogen atom or an alkyl group having from 1 to 6 carbon atoms), wherein from one to six of the three or more -C(=O)OX groups are -C(=O)OH groups, and the cross-linking agent (C) has a weight average molecular weight of from 200 to 2000.

Claim 2. The composition for forming a film for a semiconductor according to claim 1, wherein a weight average molecular weight of the silane compound (B) is from 130 to 10000.

Claim 3. The composition for forming a film for a semiconductor according to claim 1 or claim 2, wherein COOX / amino groups, which is a ratio of a number of -C(=O)OX groups in molecules of the cross-linking agent (C) to a total number of amino groups of molecules of components having an amino group contained in the composition for forming a film for a semiconductor, is greater than or equal to 0.1 and less than or equal to 5.0.

Claim 4. The composition for forming a film for a semiconductor according to any one of claims 1 to 3, wherein siloxane compound (A) / silane compound (B), which is a ratio of a content of the siloxane compound (A) to a content of the silane compound (B), is greater than or equal to 0.01 and less than or equal to 100 as a molar ratio.

Claim 5. The composition for forming a film for a semiconductor according to any

one of claims 1 to 4, wherein a weight average molecular weight of the siloxane compound (A) is from 200 to 2000.

Claim 6. The composition for forming a film for a semiconductor according to any one of claims 1 to 5, wherein at least one X in the three or more -C(=O)OX groups in the cross-linking agent (C) is an alkyl group having from 1 to 6 carbon atoms.

Claim 7. The composition for forming a film for a semiconductor according to any one of claims 1 to 6, wherein both ends of a main chain of the siloxane compound (A) are each independently a primary amino group or a secondary amino group.

Claim 8. The composition for forming a film for a semiconductor according to any one of claims 1 to 7, wherein the silicon atoms and the non-polar groups bonded to the silicon atoms in the siloxane compound (A) satisfy a relationship, (non-polar groups)/Si $\geq$ 2.0, as a molar ratio.

Claim 9. A laminated body, comprising a joining layer formed from the composition for forming a film for a semiconductor according to any one of claims 1 to 8 and a substrate, which are layered one on the other.

Claim 10. A substrate laminated body, comprising a first substrate, a joining layer formed from the composition for forming a film for a semiconductor according to any one of claims 1 to 8, and a second substrate, which are layered in this order.

Claim 11. A substrate laminated body, comprising:

a first stacked-layer region including a first substrate, a joining layer formed from the composition for forming a film for a semiconductor according to any one of claims 1 to 8, and a second substrate, which are layered in this order; and

a second stacked-layer region including a first substrate, an electrode, and a second substrate, which are layered in this order,

wherein at least one of the first stacked-layer region and at least one of the second stacked-layer region are arranged in a plane direction that is orthogonal to a layer-stacking direction.

Claim 12. The substrate laminated body according to claim 11, wherein two or more sets each consisting of the first stacked-layer region are stacked in the layer-stacking direction, and two or more sets each consisting of the second stacked-layer region are stacked in the layer-stacking direction.

Claim 13. The substrate laminated body according to any one of claims 10 to 12,, wherein at least one of the first substrate or the second substrate is a semiconductor substrate that includes at least one element selected from the group consisting of Si, Ga, Ge, and As.