DESCRIPTION

SEMICONDUCTOR FILM COMPOSITION, METHOD OF MANUFACTURING SEMICONDUCTOR FILM COMPOSITION, METHOD OF MANUFACTURING SEMICONDUCTOR MEMBER, METHOD OF MANUFACTURING SEMICONDUCTOR PROCESSING MATERIAL, AND SEMICONDUCTOR DEVICE

Technical Field

[0001] The present invention relates to a semiconductor film composition, a method of manufacturing a semiconductor film composition, a method of manufacturing a semiconductor member, a method of manufacturing a semiconductor processing material, and a semiconductor device.

Background Art

[0002] Conventionally, in various technical fields such as the field of electronic devices, application of compositions containing polymers to members has been conducted.

For example, a method of producing a composite in which a composition containing a polymer such as polyethyleneimine or a polyethyleneimine derivative having cationic functional groups and having a weight average molecular weight of from 2,000 to 1,000,000 and having a pH of from 2.0 to 11.0 is applied to the surfaces of members A and B having predetermined conditions is known (see, for example, Patent Document 1). Patent Document 1 describes that a composite member to which a composition is applied is washed with a rinsing liquid containing a polyvalent carboxylic acid.

Patent Document 1 WO 2014/156616

SUMMARY

PROBLEMS TO BE SOLVED

[0003] In Patent Document 1, a polymer such as polyethyleneimine is applied to a member, a rinse liquid containing a polyvalent carboxylic acid is coated on the member, and then crosslinked by a heating reaction, and the number of steps is large. However, when a polymer such as a polyethyleneimine and a polyvalent carboxylic acid are mixed to prepare a composition to be applied to a member, the polymer and polyvalent carboxylic acid aggregate and the composition becomes cloudy, and when the composition is applied to a member, formation of agglomerates, pits and the like causes large unevenness, resulting in a film with insufficient smoothness, which is a problematic.

[0004] Examples of the disclosure are made in view of the above problem, and provide a composition for forming a film for semiconductor devices from which a

film having few aggregates and pits, and having high smoothness can be obtained, a method of manufacturing the same, and a method of manufacturing a semiconductor member using the composition for forming a film for semiconductor devices, and a method of manufacturing a semiconductor processing material using the composition for forming a film for semiconductor devices, and a semiconductor device provided with a reaction product having high smoothness.

MEANS FOR SOLVING THE PROBLEMS

[0004a] In an aspect, there is provided a composition for forming a film for semiconductor devices comprising:

from 0.001% by mass to 20% by mass with respect to the total composition of a compound (A) including a cationic functional group containing at least one of a primary nitrogen atom or a secondary nitrogen atom and having a weight average molecular weight of from 10,000 to 400,000;

a crosslinking agent (B) which includes three or more -C(=O)OX groups (X is a hydrogen atom or an alkyl group having from 1 to 6 carbon atoms) in a molecule, wherein from one to six of the three or more -C(=O)OX groups are -C(=O)OH groups, and which has a weight average molecular weight of from 200 to 600 in an amount such that the ratio (COOH/N) of the number of carboxy groups in the crosslinking agent (B) to the total number of nitrogen atoms in the compound (A) is from 0.1 to 3.0; and

from 1.0% by mass to 99.9985% by mass with respect to the total composition of water (D),

wherein the compound (A) is a polymer of an alkyleneimine selected from ethylene imine, propylene imine, butylene imine, pentylene imine, hexylene imine, heptylene imine, octylene imine, trimethylene imine, tetramethylene imine, pentamethylene imine, hexamethylene imine, or octamethylene imine, and

the crosslinking agent (B) is selected from a benzene carboxylic acid, a naphthalene carboxylic acid, a diphthalic acid, a fluorinated aromatic ring carboxylic acid, an alicyclic carboxylic acid ester, a benzene carboxylic acid ester, a naphthalene carboxylic acid ester, a diphthalic acid ester, and a fluorinated aromatic ring carboxylic acid ester.

[0004b] In another aspet, there is provided a method of manufacturing the composition for forming a film for semiconductor devices as defined above, the method comprising:

a mixing step of mixing the compound (A) and the crosslinking agent (B).

[0004c] In another aspect, there is provided a method of manufacturing a semiconductor member using the composition for forming a film for semiconductor devices as defined above, the method comprising:

an applicaition step of applying the composition for forming a film for semiconductor devices to a substrate; and

a heating step of heating the substrate to which the composition for forming a film for semiconductor devices has been applied, at a temperature of from 250°C to 425°C.

[0004d] In another aspect, there is provided a method of manufacturing a semiconductor processing material using the composition for forming a film for semiconductor devices as defined above, the method comprising:

an applicaition step of applying the composition for forming a film for semiconductor devices to a substrate; and

a heating step of heating the substrate to which the composition for forming a film for semiconductor devices has been applied, at a temperature of from 250°C to 425°C.

[0004e] In another aspect, there is provided a semiconductor device comprising:

a substrate; and

a reaction product of a compound (A) including a cationic functional group containing at least one of a primary nitrogen atom or a secondary nitrogen atom and having a weight average molecular weight of from 10,000 to 400,000, and a crosslinking agent (B) which includes three or more -C(=O)OX groups (X is a hydrogen atom or an alkyl group having from 1 to 6 carbon atoms) in a molecule, wherein from one to six of the three or more -C(=O)OX groups are -C(=O)OH groups, and which has a weight average molecular weight of from 200 to 600 in an amount such that the ratio (COOH/N) of the number of carboxy groups in the crosslinking agent (B) to the total number of nitrogen atoms in the compound (A) is from 0.1 to 3.0,

wherein the compound (A) is a polymer of an alkyleneimine selected from ethylene imine, propylene imine, butylene imine, pentylene imine, hexylene imine, heptylene imine, octylene imine, trimethylene imine, tetramethylene imine, pentamethylene imine, hexamethylene imine, or octamethylene imine and

the crosslinking agent (B) is selected from selected from a benzene carboxylic acid, a naphthalene carboxylic acid, a diphthalic acid, a fluorinated aromatic ring carboxylic acid, an alicyclic carboxylic acid ester, a benzene carboxylic acid ester, a naphthalene carboxylic acid ester, a diphthalic acid ester, and a fluorinated aromatic ring carboxylic acid ester.

[0005] Specific means for solving the above described problems are as follows.

According to an example of the present disclosure, there is provided a composition for forming a film for semiconductor devices including: a compound (A) including a cationic functional group containing at least one of a primary nitrogen atom or a secondary nitrogen atom and having a weight average molecular weight of from 10,000 to 400,000; a crosslinking agent (B) which includes three or more -C(=O)OX groups (X is a hydrogen atom or an alkyl group having from 1 to 6 carbon atoms) in a molecule, wherein

from one to six of the three or more -C(=O)OX groups are -C(=O)OH groups, and which has a weight average molecular weight of from 200 to 600; and water (D), wherein the compound (A) is an aliphatic amine.

In an example of the composition for forming a film for semiconductor devices, the crosslinking agent (B) has a ring structure in the molecule.

In an example of the composition for forming a film for semiconductor devices, the ring structure is at least one of a benzene ring or a naphthalene ring.

In an example of the composition for forming a film for semiconductor devices, the crosslinking agent (B) is a compound in which at least one X in the three or more -C(=O)OX groups is an alkyl group having from 1 to 6 carbon atoms.

In an example, the composition for forming a film for semiconductor devices further comprises at least one additive (C) selected from the group consisting of an acid (C-1) having a carboxy group and having a weight average molecular weight of from 46 to 195 and a base (C-2) having a nitrogen atom and having a weight average molecular weight of from 17 to 120.

In an example of the composition for forming a film for semiconductor devices, the weight average molecular weight of the compound (A) is from 10,000 to 200,000.

In an example of the composition for forming a film for semiconductor devices, a pH of the composition at 25°C is 7.0 or less.

In an example, the composition for forming a film for semiconductor devices is used for an adhesion layer between a metal and an insulating film.

In an example, the composition for forming a film for semiconductor devices is used for a pore seal material of a low dielectric constant material.

In an example, the composition for forming a film for semiconductor devices is used for a filling material for a recess formed in a substrate.

[0006] According to another example of the present disclosure, there is provided a method of manufacturing the above composition for forming a film for semiconductor devices , the method including: a mixing step of mixing the compound (A) and the crosslinking agent (B).

In an example of the method of manufacturing the composition for forming a film for semiconductor devices, the mixing step comprises mixing a mixture of an acid (C-1) having a carboxy group and having a weight average molecular weight of from 46 to 195 and the compound (A), and the crosslinking agent (B).

In an example of the method of manufacturing the composition for forming a film for semiconductor devices, the mixing step comprises mixing a mixture of a base (C-2) having a nitrogen atom and having a weight average molecular weight of from 17 to 120 and the crosslinking agent (B), and the compound (A).

[0007] According to another example of the present disclosure, there is provided a method of manufacturing a semiconductor member using the above composition for forming a film for semiconductor devices, the method including: an application step of applying the composition for forming a film for semiconductor devices to a substrate; and a heating step of heating the substrate to which the composition for forming a film for semiconductor devices has been applied, at a temperature of from 250°C to 425°C.

[0008] According to another example of the present disclosure, there is provided a method of manufacturing a semiconductor processing material using the above composition for forming a film for semiconductor devices, the method including: an application of applying the composition for forming a film for semiconductor devicesto a substrate; and a heating step of heating the substrate to which the composition for forming a film for semiconductor devices has been applied, at a temperature of from 250°C to 425°C.

[0009] According to another example of the present disclosure, there is provided a semiconductor device including: a substrate; and a reaction product of a compound (A) including a cationic functional group containing at least one of a primary nitrogen atom or a secondary nitrogen atom and having a weight average molecular weight of from 10,000 to 400,000, and a crosslinking agent (B) which includes three or more -C(=O)OX groups (X is a

hydrogen atom or an alkyl group having from 1 to 6 carbon atoms) in a molecule, wherein from one to six of the three or more -C(=O)OX groups are -C(=O)OH groups, and which has a weight average molecular weight of from 200 to 600.

In an example of the above semiconductor device, the reaction product includes at least one of an amide bond or an imide bond.

EFFECTS

[0010] According to eexamples of the disclosure, a composition for forming a film for semiconductor devices from which a film having few aggregates and pits, and having high smoothness can be obtained, a method of manufacturing the same, and a method of manufacturing a semiconductor member using the composition for forming a film for semiconductor devices, and a method of manufacturing a semiconductor processing material using the composition for forming a film for semiconductor devices, and a semiconductor device provided with a reaction product having high smoothness can be provided.

DESCRIPTION OF EMBODIMENT

[0011] In the present specification, a numeral value range represented by "(a value) to (a value)" means a range including the numeral values represented before and after "(a value) to (a value)" as a lower limit value and an upper limit value, respectively.

[0012] [Semiconductor Film Composition]

Hereinafter, an embodiment of a semiconductor film composition according to the invention will be described. The semiconductor film composition according to the embodiment includes a compound (A) including a cationic functional group containing at least one of a primary nitrogen atom or a secondary nitrogen atom and having a weight average molecular weight of from 10,000 to 400,000, a crosslinking agent (B) which includes three or more -C(=O)OX groups (X is a hydrogen atom or an alkyl group having from 1 to 6 carbon atoms) in a molecule, in which from one to six of the three or more -C(=O)OX groups are -C(=O)OH groups, and which has a weight average molecular weight of from 200 to 600, and water (D). The compound (A) is an aliphatic amine.

[0013] A semiconductor film composition according to the embodiment is used. Specifically, by coating the semiconductor film composition on a member to form a film, a film having few aggregates and pits and high smoothness can be obtained. By using the semiconductor film composition according to the embodiment, a film having high smoothness as compared with the technique of Patent Document 1 (WO 2014/156616) can be easily obtained.

[0014] By using the semiconductor film composition according to the embodiment, a film having small unevenness and favorable smoothness can be formed. For example, when a

film is formed using the semiconductor film composition according to the embodiment on a smooth substrate such as a silicon substrate, a film in which the difference between the

CLAIMS

1. A composition for forming a film for semiconductor devices comprising:

from 0.001% by mass to 20% by mass with respect to the total composition of a compound (A) including a cationic functional group containing at least one of a primary nitrogen atom or a secondary nitrogen atom and having a weight average molecular weight of from 10,000 to 400,000;

a crosslinking agent (B) which includes three or more -C(=O)OX groups (X is a hydrogen atom or an alkyl group having from 1 to 6 carbon atoms) in a molecule, wherein from one to six of the three or more -C(=O)OX groups are -C(=O)OH groups, and which has a weight average molecular weight of from 200 to 600 in an amount such that the ratio (COOH/N) of the number of carboxy groups in the crosslinking agent (B) to the total number of nitrogen atoms in the compound (A) is from 0.1 to 3.0; and

from 1.0% by mass to 99.9985% by mass with respect to the total composition of water (D),

wherein the compound (A) is a polymer of an alkyleneimine selected from ethylene imine, propylene imine, butylene imine, pentylene imine, hexylene imine, heptylene imine, octylene imine, trimethylene imine, tetramethylene imine, pentamethylene imine, hexamethylene imine, or octamethylene imine, and

the crosslinking agent (B) is selected from a benzene carboxylic acid, a naphthalene carboxylic acid, a diphthalic acid, a fluorinated aromatic ring carboxylic acid, an alicyclic carboxylic acid ester, a benzene carboxylic acid ester, a naphthalene carboxylic acid ester, a diphthalic acid ester, and a fluorinated aromatic ring carboxylic acid ester.

2. The composition for forming a film for semiconductor devices according to claim 1, wherein the crosslinking agent (B) has a ring structure in the molecule.

3. The composition for forming a film for semiconductor devices according to claim 2, wherein the ring structure is at least one of a benzene ring or a naphthalene ring.

4. The composition for forming a film for semiconductor devices according to claim 1, wherein the crosslinking agent (B) is a compound in which at least one X in the three or more -C(=O)OX groups is an alkyl group having from 1 to 6 carbon atoms.

5. The composition for forming a film for semiconductor devices according to claim 1, further comprising at least one additive (C) selected from the group consisting of an acid (C-1) having a carboxy group and having a weight average molecular weight of from 46 to 195 and a base (C-2) having a nitrogen atom and having a weight average molecular weight

of from 17 to 120,

wherein the acid (C-1) is a formic acid, an acetic acid, a malonic acid, an oxalic acid, a citric acid, a benzoic acid, a lactic acid, a glycolic acid, a glyceric acid, a butyric acid, a methoxyacetic acid, an ethoxyacetic acid, a phthalic acid, a terephthalic acid, a picolinic acid, a salicylic acid, or a 3,4,5-trihydroxybenzoic acid and

the base (C-2) is ammonia, ethylamine, ethanolamine, diethylamine, triethylamine, ethylenediamine, N-acetylethylenediamine, N-(2-aminoethyl) ethanolamine, or N-(2-aminoethyl) glycine.

6. The composition for forming a film for semiconductor devices according to claim 1, wherein the weight average molecular weight of the compound (A) is from 10,000 to 200,000.

7. The composition for forming a film for semiconductor devices according to claim 1, wherein a pH of the composition at 25°C is 7.0 or less.

8. The composition for forming a film for semiconductor devices according to claim 1, which is used for an adhesion layer between a metal and an insulating film.

9. The composition for forming a film for semiconductor devices according to claim 1, which is used for a pore seal material of a low dielectric constant material.

10. The composition for forming a film for semiconductor devices according to claim 1, which is used for a filling material for a recess formed in a substrate.

11. A method of manufacturing the composition for forming a film for semiconductor devices according to any one of claims 1 to 10, the method comprising:

a mixing step of mixing the compound (A) and the crosslinking agent (B).

12. The method according to claim 11,

wherein the mixing step is a step of mixing a mixture of an acid (C-1) having a carboxy group and having a weight average molecular weight of from 46 to 195 and the compound (A), and the crosslinking agent (B).

13. The method according to claim 11,

wherein the mixing step is a step of mixing a mixture of a base (C-2) having a nitrogen atom and having a weight average molecular weight of from 17 to 120 and the crosslinking agent (B), and the compound (A).

14. A method of manufacturing a semiconductor member using the composition for forming a film for semiconductor devices according to any one of claims 1 to 10, the method comprising:

an applicaition step of applying the composition for forming a film for semiconductor devices to a substrate; and

a heating step of heating the substrate to which the composition for forming a film for semiconductor devices has been applied, at a temperature of from 250°C to 425°C.

15. A method of manufacturing a semiconductor processing material using the composition for forming a film for semiconductor devices according to any one of claims 1 to 7, the method comprising:

an applicaition step of applying the composition for forming a film for semiconductor devices to a substrate; and

a heating step of heating the substrate to which the composition for forming a film for semiconductor devices has been applied, at a temperature of from 250°C to 425°C.

16. A semiconductor device comprising:

a substrate; and

a reaction product of a compound (A) including a cationic functional group containing at least one of a primary nitrogen atom or a secondary nitrogen atom and having a weight average molecular weight of from 10,000 to 400,000, and a crosslinking agent (B) which includes three or more -C(=O)OX groups (X is a hydrogen atom or an alkyl group having from 1 to 6 carbon atoms) in a molecule, wherein from one to six of the three or more -C(=O)OX groups are -C(=O)OH groups, and which has a weight average molecular weight of from 200 to 600 in an amount such that the ratio (COOH/N) of the number of carboxy groups in the crosslinking agent (B) to the total number of nitrogen atoms in the compound (A) is from 0.1 to 3.0,

wherein the compound (A) is a polymer of an alkyleneimine selected from ethylene imine, propylene imine, butylene imine, pentylene imine, hexylene imine, heptylene imine, octylene imine, trimethylene imine, tetramethylene imine, pentamethylene imine, hexamethylene imine, or octamethylene imine and

the crosslinking agent (B) is selected from selected from a benzene carboxylic acid, a naphthalene carboxylic acid, a diphthalic acid, a fluorinated aromatic ring carboxylic acid, an alicyclic carboxylic acid ester, a benzene carboxylic acid ester, a naphthalene carboxylic acid ester, a diphthalic acid ester, and a fluorinated aromatic ring carboxylic acid ester.

17. The semiconductor device according to claim 16, wherein the reaction product includes at least one of an amide bond or an imide bond.