[0004] Embodiments of the invention 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

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

According to a first aspect of the present invention, there is provided a composition for forming a film for semiconductor devices including: 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.

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

In an embodiment 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 embodiment 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 embodiment, 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, 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.

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

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

In an embodiment, 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 a second aspect of the present invention, 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 embodiment 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 embodiment 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 a third aspect of the present invention, there is provided a method of manufacturing a semiconductor member using the 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 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 a fourth aspect of the present invention, there is provided a method of manufacturing a semiconductor processing material using the 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.

[0009] According to a fifth aspect of the present invention, 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 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.

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

EFFECTS OF THE INVENTION

[0010] According to embodiments of the invention, 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

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.