less on an element basis.

<2> The sealing composition for a semiconductor according to <1>, wherein the polymer includes a structural unit that is derived from an alkyleneimine having from 2 to 8 carbon atoms and that includes a tertiary nitrogen atom as a cationic functional group.

<3> The sealing composition for a semiconductor according to <2>, wherein the polymer further includes a structural unit that is derived from an alkyleneimine having from 2 to 8 carbon atoms and that includes a secondary nitrogen atom as a cationic functional group.

[0008] <4> The sealing composition for ~~sealing~~ a semiconductor according to any one of <1> to <3>, wherein the polymer includes primary nitrogen atoms, and a proportion of the primary nitrogen atoms to all the nitrogen atoms in the polymer is 33% by mole or more.

<5> The sealing composition for a semiconductor according to any one of <1> to <4>, wherein the branching degree of the polymer is 55% or more.

<6> The sealing composition for a semiconductor according to any one of <1> to <5>, wherein the sealing composition has an average particle diameter measured by a dynamic light scattering method of 150 nm or less.

<7> The sealing composition for a semiconductor according to any one of <1> to <6>, wherein the polymer is a polyethyleneimine or a derivative of a polyethyleneimine.

<8> The sealing composition for a semiconductor according to any one of <1> to <7>, wherein the polymer has a cationic functional group equivalent of from 27 to 430.

[0009] <9> A method of producing a semiconductor device, comprising a sealing composition application process of applying the sealing composition for a semiconductor according to any one of <1> to <8> to an interlayer dielectric layer formed on a substrate.

<10> The method of producing a semiconductor device according to <9>, wherein the interlayer dielectric layer includes a porous silica and has a silanol residue derived from the porous silica on a surface thereof.

<11> The method of producing a semiconductor device according to <9> or <10>, the method further comprising a process of forming a concave groove having a width of from 10 nm to 32 nm in the interlayer dielectric layer, wherein the sealing composition application process includes bringing the sealing composition for a semiconductor into contact with the interlayer dielectric layer at at least a side surface of the concave groove.

<12> A semiconductor device comprising a structure in which:

an interlayer dielectric layer;

a polymer layer containing a polymer that includes two or more cationic functional groups including at least one of a tertiary nitrogen atom or a quaternary nitrogen atom, that

remaining reaction product was dissolved in water, and the chlorine ion was removed by an anion exchange polymer, thereby obtaining 8.4 g (purity: about 40%) of ~~ultra~~hyperbranched polyethyleneimine 4.

^{1}H-NMR (D_2O): δ 2.8 - 2.4 (br. m)

[0116] With regard to the hyperbranched polyethyleneimine 4, cationic functional group equivalent, the amount (% by mole) of primary nitrogen atom, the amount (% by mole) of secondary nitrogen atom, the amount (% by mole) of tertiary nitrogen atom, the amount (% by mole) of quaternary nitrogen atom, and the branching degree were measured, respectively, in the same manner as in the hyperbranched polyethyleneimine 1.

As a result, the cationic functional group equivalent was 43, the amount of primary nitrogen atom was 47% by mole, the amount of secondary nitrogen atom was 5% by mole, the amount of tertiary nitrogen atom was 48% by mole, the amount of quaternary nitrogen atom was 0% by mole, and the branching degree was 90%.

The weight average molecular weight of the hyperbranched polyethyleneimine 4 was not able to be measured at the moment, but it is thought that the weight average molecular weight thereof is in the range of from 2,000 to 1,000,000 in consideration of the synthesis conditions described above.

[0117] [Example 1]

<Preparation of Sealing composition for a semiconductor>

A sealing composition for a semiconductor (hereinafter, it is also referred to as the "sealing composition 1") was obtained by dissolving the hyperbranched polyethyleneimine 1 (250 mg) in 100 mL of water.

With regard to the sealing composition 1 thus obtained, the content of sodium, the content of potassium, and the volume average particle diameter was measured, respectively.

The results of the measurements are listed in Table 1 below.

[0118] Here, the content of sodium and the content of potassium were measured using an inductively coupled plasma mass spectrometer (ICP-MS), respectively. The lower limit of measurement in this measurement is 1 ppb by weight for both of the content of sodium and the content of potassium.

[0119] In addition, in order to confirm the micelle forming property, the volume average particle diameter was measured by a dynamic light scattering method using ELSZ-2 manufactured by OTSUKA ELECTRONICS CO., LTD. The volume average particle diameter was less than the detection limit (< 10 nm).

Meanwhile, the measuring condition was a cumulative number of 70 times, a repeat count of 1 time, and a histogram analysis and a cumulant analysis were used as the

CLAIMS

1. A sealing composition for a semiconductor, comprising a polymer that includes two or more cationic functional groups including at least one of a tertiary nitrogen atom or a quaternary nitrogen atom, that has a weight average molecular weight of from 2,000 to 1,000,000, and that has a branching degree of 48% or more, wherein a content of sodium and a content of potassium in the sealing composition are each 10 ppb by weight or less on an element basis.

2. The sealing composition for a semiconductor according to claim 1, wherein the polymer includes a structural unit that is derived from an alkyleneimine having from 2 to 8 carbon atoms and that includes a tertiary nitrogen atom as a cationic functional group.

3. The sealing composition for a semiconductor according to claim 2, wherein the polymer further includes a structural unit that is derived from an alkyleneimine having from 2 to 8 carbon atoms and that includes a secondary nitrogen atom as a cationic functional group.

4. The sealing composition for a semiconductor according to any one of claim 1 to claim 3, wherein the polymer includes primary nitrogen atoms, and a proportion of the primary nitrogen atoms to all the nitrogen atoms in the polymer is 33% by mole or more.

5. The sealing composition for a semiconductor according to any one of claim 1 to claim ~~34~~4, wherein the branching degree of the polymer is 55% or more.

6. The sealing composition for a semiconductor according to any one of claim 1 to claim ~~35~~5, wherein the sealing composition has an average particle diameter measured by a dynamic light scattering method of 150 nm or less.

7. The sealing composition for a semiconductor according to any one of claim 1 to claim ~~36~~6, wherein the polymer is a polyethyleneimine or a derivative of a polyethyleneimine.

8. The sealing composition for a semiconductor according to any one of claim 1 to claim ~~37~~7, wherein the polymer has a cationic functional group equivalent of from 27 to 430.

9. A method of producing a semiconductor device, comprising a sealing composition application process of applying the sealing composition for a semiconductor according to any one of claim 1 to claim ~~3~~ 8 to an interlayer dielectric layer formed on a substrate.

10. The method of producing a semiconductor device according to claim 9, wherein the interlayer dielectric layer includes a porous silica and has a silanol residue derived from the porous silica on a surface thereof.

11. The method of producing a semiconductor device according to claim 9 or claim 10, the method further comprising a process of forming a concave groove having a width of from 10 nm to 32 nm in the interlayer dielectric layer, wherein the sealing composition application process includes bringing the sealing composition for a semiconductor into contact with the interlayer dielectric layer at at least a side surface of the concave groove.

12. A semiconductor device comprising a structure in which:

an interlayer dielectric layer;

a polymer layer containing a polymer that includes two or more cationic functional groups including at least one of a tertiary nitrogen atom or a quaternary nitrogen atom, that has a weight average molecular weight of from 2,000 to 600,000, and that has a branching degree of 48% or more; and

a layer including copper

are disposed in this order.

13. A polymer that comprises two or more cationic functional groups including at least one of a tertiary nitrogen atom or a quaternary nitrogen atom, that has a weight average molecular weight of from 2,000 to 1,000,000, and that has a branching degree of 48% or more, wherein the polymer includes primary nitrogen atoms and secondary nitrogen atoms, and a proportion of the primary nitrogen atoms to all the nitrogen atoms in the polymer is 33% by mole or more.

14. The polymer according to claim 13, wherein the polymer is a polyethyleneimine or a derivative of a polyethyleneimine.

15. A method of producing the polymer according to claim 13 or claim 14, the method comprising a process of reacting a raw material polymer containing a secondary nitrogen atom with a compound represented by the following Formula (m-1):