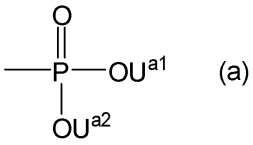
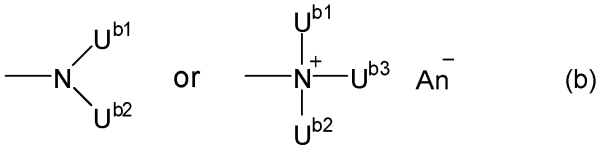
CLAIMS

1. A coating film which has a function of inhibiting adhesion of a biological substance, obtained by a method comprising a process of applying a composition for forming a coating film which comprises a copolymer comprising a recurring unit containing an organic group of the following formula (a) and a recurring unit containing an organic group of the following formula (b):


(a)


(b)

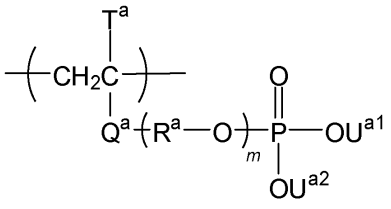
wherein U^{a1} and U^{a2} represent hydrogen atoms, U^{b1}, U^{b2} and U^{b3} each independently represents a hydrogen atom or a linear or branched alkyl group having 1 to 5 carbon atoms, An^- represents an anion selected from the group consisting of a halide ion, an inorganic acid ion, a hydroxide ion and an isothiocyanate ion,
and a solvent onto a substrate; and
a process of drying at a temperature of -200°C to 180°C,
wherein a film thickness of the coating film is 10 to 1,000Å.

2. The coating film according to Claim 1, wherein the solvent comprises water or an alcohol.

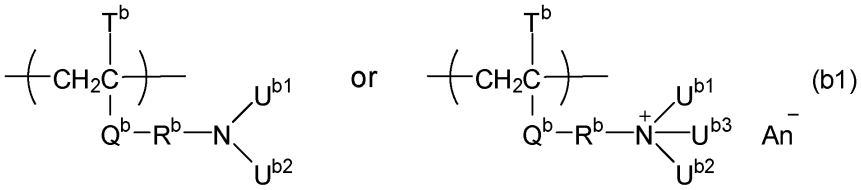
3. The coating film according to Claim 1 or 2, wherein a concentration of the copolymer in the composition for forming a coating film is 0.01% by mass to 4% by mass.

4. The coating film according to any one of Claims 1 to 3, wherein the substrate is selected from the group consisting of glass, a metal containing compound, a semi-metal containing compound and a resin.

5. The coating film according to any one of Claims 1 to 4, wherein the copolymer comprises recurring units of the following formula (a1) and the formula (b1):



(a1)



(b1)

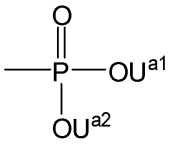
wherein U^{a1} and U^{a2} represent hydrogen atoms, T^a, T^b, U^{b1}, U^{b2} and U^{b3} each independently represents a hydrogen atom or a linear or branched alkyl group having 1 to 5 carbon atoms, Q^a and Q^b each independently represents a single bond, an ester bond or an amide bond, R^a and R^b each independently represents a linear or branched alkylene group having 1 to 10 carbon atoms which may be substituted by a halogen atom, An^- represents an anion selected from the group consisting of a halide ion, an inorganic acid ion, a hydroxide ion and an isothiocyanate ion, and m is an integer of 0 to 6.

6. The coating film according to any one of Claims 1 to 5, wherein m is 1, and R^a and R^b each independently represents an ethylene group or a propylene group.

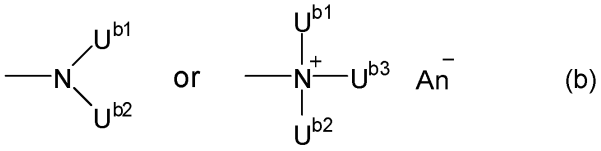
7. The coating film according to any one of Claims 1 to 6, wherein the method further comprises a process of previously adjusting a pH of the composition for forming a coating film.

8. The coating film according to any one of Claims 1 to 7, wherein the method further comprises a process of washing a film obtained after the process of drying with at least one solvent selected from the group consisting of water and an aqueous solution containing an electrolyte.

9. A method for manufacturing a coating film which has a function of inhibiting adhesion of a biological substance, comprising a process of applying a composition for forming a coating film which comprises a copolymer comprising a recurring unit containing an organic group of the following formula (a) and a recurring unit containing an organic group of the following formula (b):



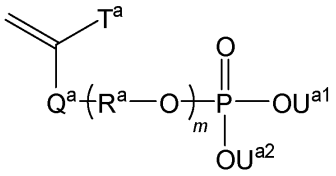
(a)



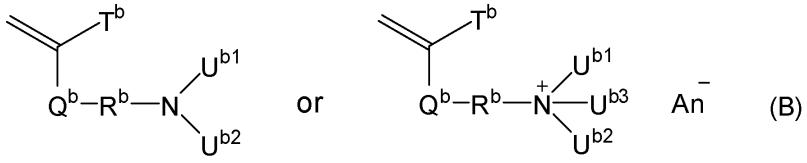
(b)

wherein U^{a1} and U^{a2} represent hydrogen atoms, U^{b1}, U^{b2} and U^{b3} each independently represents a hydrogen atom or a linear or branched alkyl group having 1 to 5 carbon atoms, An^- represents an anion selected from the group consisting of a halide ion, an inorganic acid ion, a hydroxide ion and an isothiocyanate ion,
and a solvent onto a substrate; and
a process of drying at a temperature of -200°C to 180°C,
wherein a film thickness of the coating film is 10 to 1,000Å.

10. A copolymer obtained by copolymerizing a monomer mixture comprising at least compounds of the following formula (A) and the formula (B):

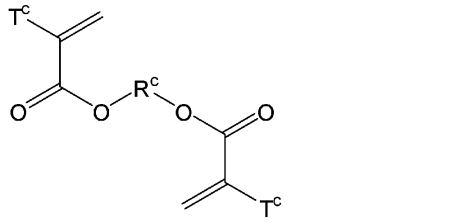


(A)

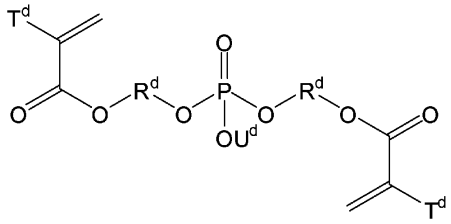


(B)

wherein U^{a1} and U^{a2} represent hydrogen atoms, T^a, T^b, U^{b1}, U^{b2} and U^{b3} each independently represents a hydrogen atom or a linear or branched alkyl group having 1 to 5 carbon atoms, Q^a and Q^b each independently represents a single bond, an ester bond or an amide bond, R^a and R^b each independently represents a linear or branched alkylene group having 1 to 10 carbon atoms which may be substituted by a halogen atom, An^- represents an anion selected from the group consisting of a halide ion, an inorganic acid ion, a hydroxide ion and an isothiocyanate ion, and m is an integer of 0 to 6,
and a compound of the following formula (C) or (D):



(C)

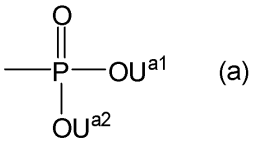


(D)

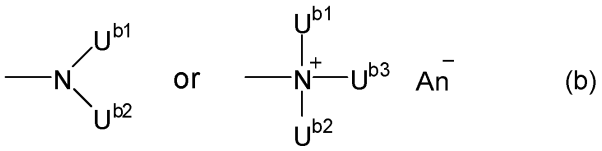
wherein T^c, T^d and U^d each independently represents a hydrogen atom or a linear or branched alkyl group having 1 to 5 carbon atoms, R^c and R^d each independently represents a linear or branched alkylene group having 1 to 10 carbon atoms which may be substituted by a halogen atom

wherein a ratio of the compound of the formula (A) based on the whole monomers forming the copolymer is 20 to 80 mol%.

11. A composition for forming a coating film which comprises (i) a copolymer comprising a recurring unit containing an organic group of the following formula (a) and a recurring unit containing an organic group of the following formula (b):



(a)



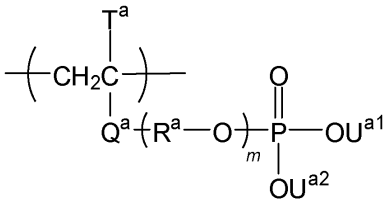
(b)

wherein U^{a1} and U^{a2} represent hydrogen atoms, U^{b1}, U^{b2} and U^{b3} each independently represents a hydrogen atom or a linear or branched alkyl group having 1 to 5 carbon atoms, An^- represents an anion selected from the group consisting of a halide ion, an inorganic acid ion, a hydroxide ion and an isothiocyanate ion;

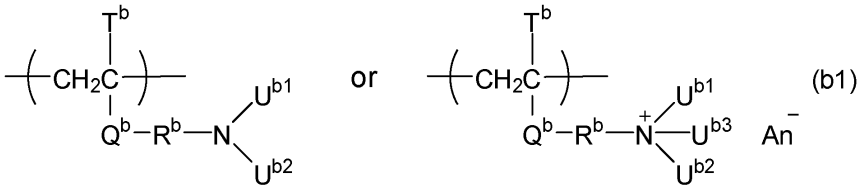
(ii) a solvent; and

(iii) a pH adjusting agent selected from the group consisting of ammonia, diethanolamine, pyridine, N-methyl-D-glucamine, tris(hydroxymethyl)aminomethane, potassium hydroxide, sodium hydroxide, sulfuric acid, phosphoric acid, hydrochloric acid, carbonic acid and choline.

12. The composition according to Claim 11, wherein the copolymer comprises recurring units of the following formula (a1) and the formula (b1):



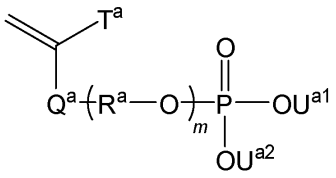
(a1)



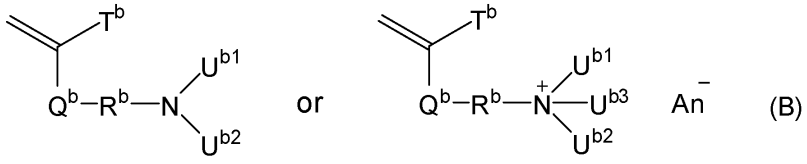
(b1)

wherein U^{a1} and U^{a2} represent hydrogen atoms, T^a, T^b, U^{b1}, U^{b2} and U^{b3} each independently represents a hydrogen atom or a linear or branched alkyl group having 1 to 5 carbon atoms, Q^a and Q^b each independently represents a single bond, an ester bond or an amide bond, R^a and R^b each independently represents a linear or branched alkylene group having 1 to 10 carbon atoms which may be substituted by a halogen atom, An^- represents an anion selected from the group consisting of a halide ion, an inorganic acid ion, a hydroxide ion and an isothiocyanate ion, and m is an integer of 0 to 6.

13. A method for manufacturing a varnish containing a copolymer which comprises a process of reacting compounds of the following formula (A) and the formula (B):



(A)



(B)

wherein U^{a1} and U^{a2} represent hydrogen atoms, T^a, T^b, U^{b1}, U^{b2} and U^{b3} each independently represents a hydrogen atom or a linear or branched alkyl group having 1 to 5 carbon atoms, Q^a and Q^b each independently represents a single bond, an ester bond or an amide bond, R^a and R^b each independently represents a linear or branched alkylene group having 1 to 10 carbon atoms which may be substituted by a halogen atom, An^- represents an anion selected from the group consisting of a halide ion, an inorganic acid ion, a hydroxide ion and an isothiocyanate ion, and m is an integer of 0 to 6,

in a solvent with a total concentration of the both compounds of 0.01% by mass to 4% by mass.

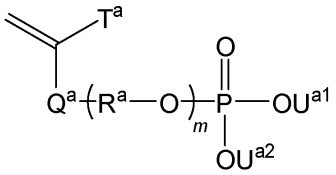
14. The manufacturing method of a varnish containing a copolymer according to Claim 13, wherein m is 1, and R^a and R^b each independently represents an ethylene group or a propylene group.

15. The manufacturing method of a varnish containing a copolymer according to Claim 13 or 14, wherein the solvent comprises water or an alcohol.

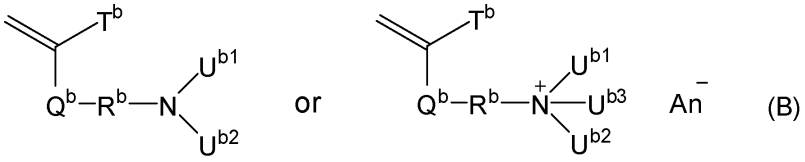
16. The manufacturing method of a varnish containing a copolymer according to any one of Claims 13 to 15, wherein the solvent comprises 10% by mass to 100% by mass of water.

17. The manufacturing method of a varnish containing a copolymer according to any one of Claims 13 to 15, wherein the solvent comprises 10% by mass to 100% by mass of an alcohol.

18. A method for manufacturing a varnish containing a copolymer which comprises a process of reacting a mixture containing compounds of the following formula (A) and the formula (B):



(A)



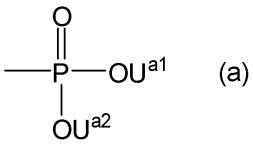
(B)

wherein U^{a1} and U^{a2} represent hydrogen atoms, T^a, T^b, U^{b1}, U^{b2} and U^{b3} each independently represents a hydrogen atom or a linear or branched alkyl group having 1 to 5 carbon atoms, Q^a and Q^b each independently represents a single bond, an ester bond or an amide bond, R^a and R^b each independently represents a linear or branched alkylene group having 1 to 10 carbon atoms which may be substituted by a halogen atom, An^- represents an anion selected from the group consisting of a halide ion, an inorganic acid ion, a hydroxide ion and an isothiocyanate ion, and m is an integer of 0 to 6,

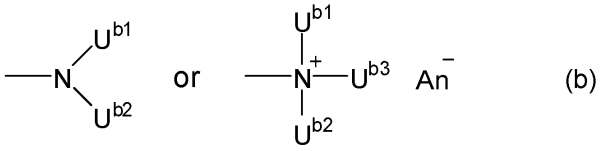
a solvent and a polymerization initiator, by adding the mixture dropwise into a solvent maintained at a temperature higher than 10-hr half-life temperature of the polymerization initiator.

19. A sol which comprises a copolymer comprising a recurring unit containing an

organic group of the following formula (a) and a recurring unit containing an organic group of the following formula (b):



(a)



(b)

wherein U^{a1} and U^{a2} represent hydrogen atoms, U^{b1}, U^{b2} and U^{b3} each independently represents a hydrogen atom or a linear or branched alkyl group having 1 to 5 carbon atoms, An^- represents an anion selected from the group consisting of a halide ion, an inorganic acid ion, a hydroxide ion and an isothiocyanate ion.

20. The sol according to Claim 19, wherein an average particle diameter in particle diameter distribution measured by a dynamic light scattering method is 2 nm or more and 500 nm or less.