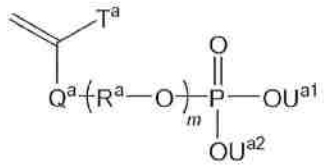
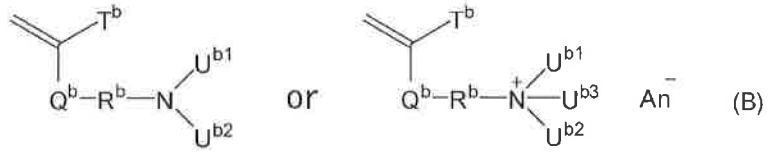
CLAIMS

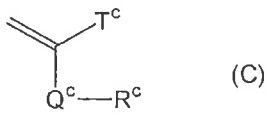
1. A copolymer which is obtainable by polymerizing a monomer mixture containing at least compounds of the following formulae (A), (B) and (C):



(A)



(B)



(C)

wherein

T^a, T^b, T^c, U^{a1}, U^{a2}, U^{b1}, U^{b2} and U^{b3} each independently represent a hydrogen atom or a linear or branched alkyl group having 1 to 5 carbon atoms;

Q^a and Q^b each independently represent a single bond, an ester bond or an amide bond,

Q^c represents a single bond, an ether bond or an ester bond;

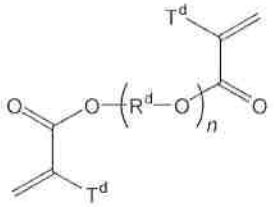
R^a and R^b each independently represent a linear or branched alkylene group having 1 to 10 carbon atoms which may be substituted by a halogen atom(s), R^c represents a linear or branched alkyl group having 1 to 18 carbon atoms, a cyclic hydrocarbon group having 3 to 10 carbon atoms, an aryl group having 6 to 10 carbon atoms, an aralkyl group having 7 to 14 carbon atoms or an aryloxyalkyl group having 7 to 14 carbon atoms, where the above-mentioned aryl portion may be substituted by a linear or branched alkyl group having 1 to 5 carbon atoms which may be substituted by a halogen atom(s);

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

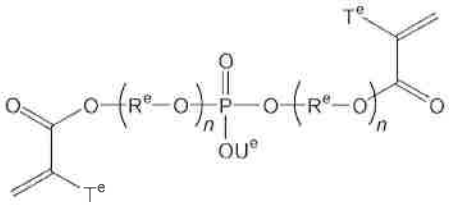
m represents an integer of 0 to 6;

and

further containing a compound of the following formula (D) or (E):



(D)



(E)

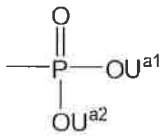
wherein

T^d, T^e and U^e each independently represent a hydrogen atom or a linear or branched alkyl group having 1 to 5 carbon atoms;

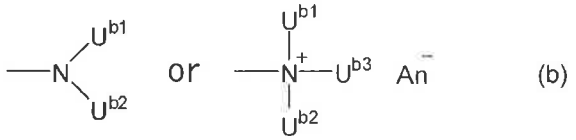
R^d and R^e each independently represent a linear or branched alkylene group having 1 to 10 carbon atoms which may be substituted by a halogen atom(s); and n represents an integer of 1 to 6.

2. A composition for forming a coating film having a function of inhibiting adhesion of a biological substance which comprises

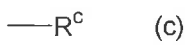
(i) a copolymer which contains a recurring unit containing an organic group of the following formula (a), a recurring unit containing an organic group of the following formula (b) and a recurring unit containing an organic group of the following formula (c):



(a)



(b)



(c)

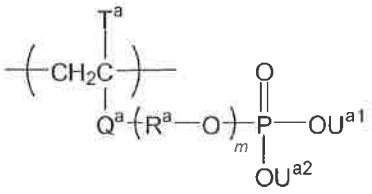
wherein

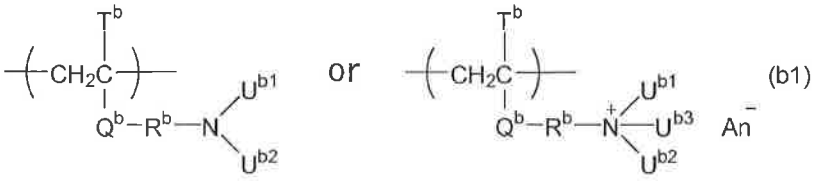
U^{a1}, U^{a2}, U^{b1}, U^{b2} and U^{b3} each independently represent a hydrogen atom or a linear or branched alkyl group having 1 to 5 carbon atoms;

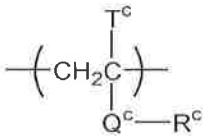
R^c represents a linear or branched alkyl group having 4 to 18 carbon atoms, a cyclic hydrocarbon group having 3 to 10 carbon atoms, an aralkyl group having 7 to 14

carbon atoms or an aryloxyalkyl group having 7 to 14 carbon atoms, where the above-mentioned aryl portion may be substituted by a linear or branched alkyl group having 1 to 5 carbon atoms which may be substituted by a halogen atom(s); and
An^- represents an anion selected from the group consisting of a halide ion, an inorganic acid ion, a hydroxide ion and an isothiocyanate ion,
wherein a ratio of the recurring unit containing the organic group of the formula (c) in the copolymer is 3 mol% to 88 mol%, and
(ii) a solvent.

3. A composition for forming a coating film having a function of inhibiting adhesion of a biological substance which comprises (i) a copolymer which contains recurring units of the following formulae (a1), (b1) and (c1):


(a1)

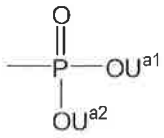

(b1)

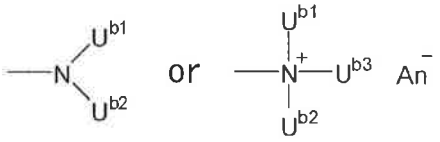

(c1)

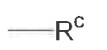
wherein
T^a, T^b, T^c, U^{a1}, U^{a2}, U^{b1}, U^{b2} and U^{b3} each independently represent a hydrogen atom or a linear or branched alkyl group having 1 to 5 carbon atoms;
Q^a and Q^b each independently represent a single bond, an ester bond or an amide bond,
Q^c represents a single bond, an ether bond or an ester bond;
R^a and R^b each independently represent a linear or branched alkylene group having 1 to 10 carbon atoms which may be substituted by a halogen atom(s), R^c represents a linear or branched alkyl group having 4 to 18 carbon atoms, an alicyclic hydrocarbon group having 3 to 10 carbon atoms, an aralkyl group having 7 to 14 carbon atoms or an aryloxyalkyl group having 7 to 14 carbon atoms, where the above-mentioned aryl portion may be substituted by a linear or branched alkyl group having 1 to 5 carbon atoms which may be substituted by a halogen atom(s);

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 represents an integer of 0 to 6, and
(ii) a solvent.

4. A coating film having a function of inhibiting adhesion of a biological substance obtainable by a method which comprises:
a process of coating a composition for forming a coating film which contains a copolymer containing a recurring unit containing an organic group of the following formula (a), a recurring unit containing an organic group of the following formula (b) and a recurring unit containing an organic group of the following formula (c):

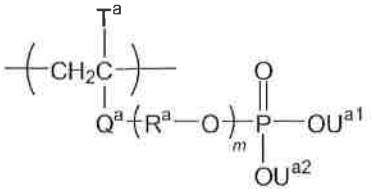

(a)


(b)

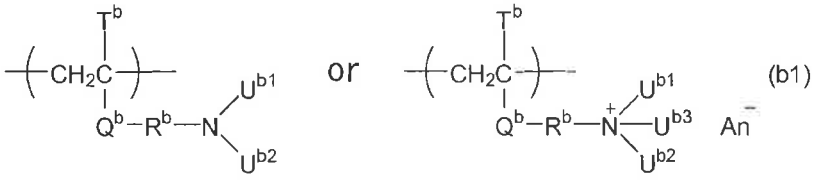

(c)

wherein
U^{a1}, U^{a2}, U^{b1}, U^{b2} and U^{b3} each independently represent a hydrogen atom or a linear or branched alkyl group having 1 to 5 carbon atoms;
R^c represents a linear or branched alkyl group having 4 to 18 carbon atoms, an alicyclic hydrocarbon group having 3 to 10 carbon atoms, an aralkyl group having 7 to 14 carbon atoms or an aryloxyalkyl group having 7 to 14 carbon atoms, where the above-mentioned aryl portion may be substituted by a linear or branched alkyl group having 1 to 5 carbon atoms which may be substituted by a halogen atom(s); and
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 washing the film obtained after a drying process by at least one kind of a solvent selected from the group consisting of water and an aqueous solution containing an electrolyte(s).

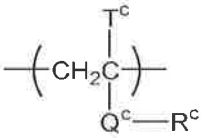
5. The coating film according to Claim 4, wherein the copolymer contains recurring units of the following formulae (a1), (b1) and (c1):



(a1)



(b1)



(c1)

wherein

T^a, T^b, T^c, U^{a1}, U^{a2}, U^{b1}, U^{b2} and U^{b3} each independently represent a hydrogen atom or a linear or branched alkyl group having 1 to 5 carbon atoms;

Q^a and Q^b each independently represent a single bond, an ester bond or an amide bond, Q^c represents a single bond, an ether bond or an ester bond;

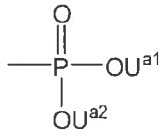
R^a and R^b each independently represent a linear or branched alkylene group having 1 to 10 carbon atoms which may be substituted by a halogen atom(s), R^c represents a linear or branched alkyl group having 4 to 18 carbon atoms, an alicyclic hydrocarbon group having 3 to 10 carbon atoms, an aralkyl group having 7 to 14 carbon atoms or an aryloxyalkyl group having 7 to 14 carbon atoms, where the above-mentioned aryl portion may be substituted by a linear or branched alkyl group having 1 to 5 carbon atoms which may be substituted by a halogen atom(s);

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

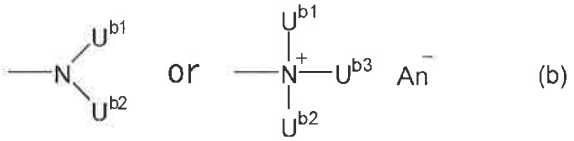
m represents an integer of 0 to 6.

6. The coating film according to Claim 4 or 5, wherein the method contains a process of provisionally adjusting a pH of the composition for forming a coating film.

7. A sol which comprises a copolymer containing a recurring unit containing an organic group of the following formula (a), a recurring unit containing an organic group of the following formula (b) and a recurring unit containing an organic group of the following formula (c):



(a)



(b)



(c)

wherein

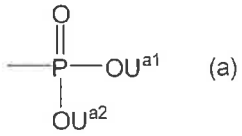
U^{a1}, U^{a2}, U^{b1}, U^{b2} and U^{b3} each independently represent a hydrogen atom or a linear or branched alkyl group having 1 to 5 carbon atoms;

R^c represents a linear or branched alkyl group having 4 to 18 carbon atoms, an alicyclic hydrocarbon group having 3 to 10 carbon atoms, an aralkyl group having 7 to 14 carbon atoms or an aryloxyalkyl group having 7 to 14 carbon atoms, where the above-mentioned aryl portion may be substituted by a linear or branched alkyl group having 1 to 5 carbon atoms which may be substituted by a halogen atom(s);

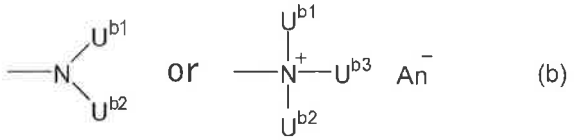
An^- represents an anion selected from the group consisting of a halide ion, an inorganic acid ion, a hydroxide ion and an isothiocyanate ion.

8. The sol according to Claim 7, 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.

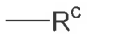
9. A method for manufacturing a coating film comprising a process of coating a composition for forming a coating film which comprises a copolymer containing a recurring unit containing an organic group of the following formula (a), a recurring unit containing an organic group of the following formula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



(a)



(b)



(c)

wherein

U^{a1}, U^{a2}, U^{b1}, U^{b2} and U^{b3} each independently represent a hydrogen atom or a linear or branched alkyl group having 1 to 5 carbon atoms;

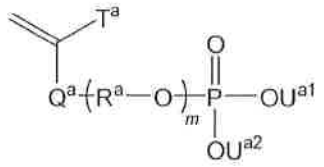
R^c represents a linear or branched alkyl group having 4 to 18 carbon atoms, a cycloalkyl group having 3 to 8 carbon atoms, an aralkyl group having 7 to 14 carbon atoms or an aryloxyalkyl group having 7 to 14 carbon atoms, where, the above-mentioned aryl portion may be substituted by a linear or branched alkyl group having 1 to 5 carbon atoms which may be substituted by a halogen atom(s); and

An^- represents an anion selected from the group consisting of a halide ion, an inorganic acid ion, a hydroxide ion and an isothiocyanate ion,

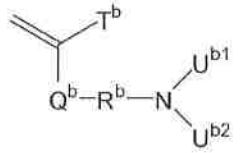
wherein a ratio of the recurring unit containing an organic group of the formula (c) in the copolymer is 3 mol% to 88 mol%, and

a solvent, onto a substrate.

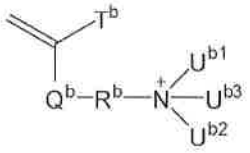
10. A method for producing a varnish containing a copolymer which comprises a process of adding dropwise a mixture containing compounds of the following formulae (A), (B) and (C):



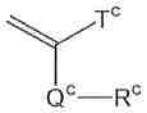
(A)



or



(B)



(C)

wherein

T^a, T^b, T^c, U^{a1}, U^{a2}, U^{b1}, U^{b2} and U^{b3} each independently represent a hydrogen atom or a linear or branched alkyl group having 1 to 5 carbon atoms;

Q^a and Q^b each independently represent a single bond, an ester bond or an amide bond, Q^c represents a single bond, an ether bond or an ester bond;

R^a and R^b each independently represent a linear or branched alkylene group having 1 to 10 carbon atoms which may be substituted by a halogen atom(s), R^c represents a linear or branched alkyl group having 4 to 18 carbon atoms, an alicyclic hydrocarbon group having 3 to 10 carbon atoms, an aralkyl group having 7 to 14 carbon atoms or an aryloxyalkyl group having 7 to 14 carbon atoms, where, the above-mentioned aryl portion may be substituted by a linear or branched alkyl group having 1 to 5 carbon atoms which may be substituted by a halogen atom(s);

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

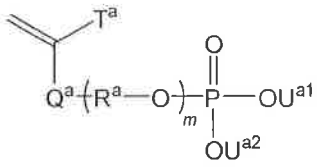
m represents an integer of 0 to 6,

wherein a ratio of the recurring unit containing an organic group of the formula (c) in the copolymer is 3 mol% to 88 mol%,

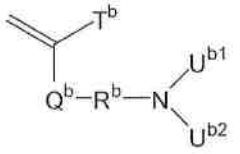
a solvent and a polymerization initiator

to a solvent which has been maintained at a temperature higher than a 10 hour half-life temperature of the polymerization initiator, and reacting these.

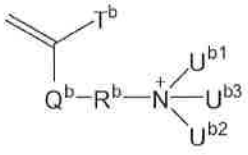
11. A method for producing a copolymer which comprises a process of polymerizing a monomer mixture containing at least compounds of the following formulae (A), (B) and (C):



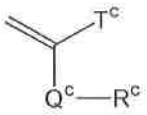
(A)



or



(B)



(C)

wherein

T^a, T^b, T^c, U^{a1}, U^{a2}, U^{b1}, U^{b2} and U^{b3} each independently represent a hydrogen atom or a linear or branched alkyl group having 1 to 5 carbon atoms;

Q^a and Q^b each independently represent a single bond, an ester bond or an amide bond, Q^c represents a single bond, an ether bond or an ester bond;

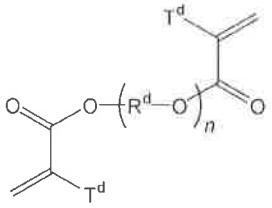
R^a and R^b each independently represent a linear or branched alkylene group having 1 to 10 carbon atoms which may be substituted by a halogen atom(s), R^c represents a linear or branched alkyl group having 1 to 18 carbon atoms, a cyclic hydrocarbon group having 3 to 10 carbon atoms, an aryl group having 6 to 10 carbon atoms, an aralkyl group having 7 to 14 carbon atoms or an aryloxyalkyl group having 7 to 14 carbon atoms, where the above-mentioned aryl portion may be substituted by a linear or branched alkyl group having 1 to 5 carbon atoms which may be substituted by a halogen atom(s);

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

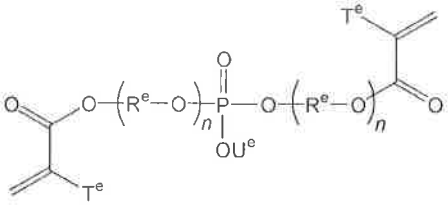
m represents an integer of 0 to 6;

and

further containing a compound of the following formula (D) or (E):



(D)



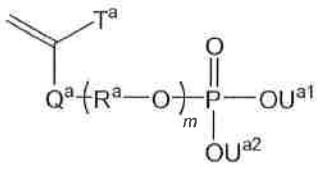
(E)

wherein

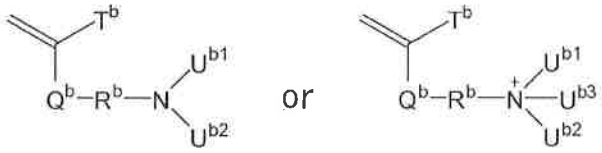
T^d, T^e and U^e each independently represent a hydrogen atom or a linear or branched alkyl group having 1 to 5 carbon atoms;

R^d and R^e each independently represent a linear or branched alkylene group having 1 to 10 carbon atoms which may be substituted by a halogen atom(s); and n represents an integer of 1 to 6.

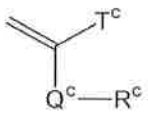
12. A method for producing a sol which comprises a process of polymerizing a monomer mixture containing at least compounds of the following formulae (A), (B) and (C):



(A)



(B)



(C)

wherein

T^a, T^b, T^c, U^{a1}, U^{a2}, U^{b1}, U^{b2} and U^{b3} each independently represent a hydrogen atom or a linear or branched alkyl group having 1 to 5 carbon atoms;

Q^a and Q^b each independently represent a single bond, an ester bond or an amide bond,

Q^c represents a single bond, an ether bond or an ester bond;

R^a and R^b each independently represent a linear or branched alkylene group having 1

to 10 carbon atoms which may be substituted by a halogen atom(s), R^c represents a linear or branched alkyl group having 1 to 18 carbon atoms, a cyclic hydrocarbon group having 3 to 10 carbon atoms, an aralkyl group having 7 to 14 carbon atoms or an aryloxyalkyl group having 7 to 14 carbon atoms, where the above-mentioned aryl portion may be substituted by a linear or branched alkyl group having 1 to 5 carbon atoms which may be substituted by a halogen atom(s);
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 represents an integer of 0 to 6.

13. The copolymer according to Claim 1, wherein which is for forming a coating film having a function of inhibiting adhesion of a biological substance.

14. The sol according to Claim 7 or 8, which is for forming a coating film having a function of inhibiting adhesion of a biological substance.

15. The manufacturing method according to Claim 9, wherein the coating film has a function of inhibiting adhesion of a biological substance.

16. The producing method according to Claim 10, wherein the varnish is for forming a coating film having a function of inhibiting adhesion of a biological substance.

17. The producing method according to Claim 11, wherein the copolymer is for forming a coating film having a function of inhibiting adhesion of a biological substance.

18. The producing method according to Claim 12, wherein the sol is for forming a coating film having a function of inhibiting adhesion of a biological substance.