CLAIMS

1. An antifouling coating composition for an underwater moving body, the antifouling coating composition comprising a silicon atom-containing resin,

wherein

the silicon atom-containing resin includes:

a constituent unit (A) derived from a monomer (a) having at least one kind of silicon atom-containing group selected from the group consisting of a group represented by a formula (I) below, a group represented by a formula (II) below, a group represented by a formula (III) below, and a group represented by a formula (IV) below;

a constituent unit (B) derived from a monomer (b) which is a (meth)acrylic acid ester represented by a formula (b) below; and

a constituent unit (C) derived from a monomer (c) other than the monomer (a) and the monomer (b),

the monomer (a) has a molecular weight of greater than 2500,

a content of the constituent unit (A) is greater than 20% by mass in all constituent units contained in the silicon atom-containing resin,

the monomer (c) is a monomer having a homopolymer solubility parameter SP of greater than or equal to 9.0 and less than or equal to 9.5 and having no cyclic structure,

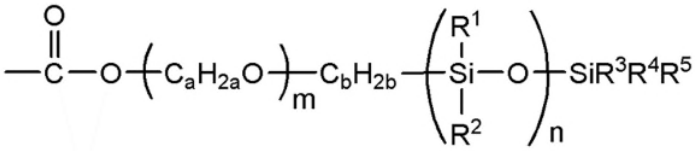
the monomer (c) is a (meth)acrylic acid alkyl ester represented by a formula below:

$CH_2=C(R^C)(COOR^D)$,

R^C is a hydrogen atom or a methyl group, and R^D is a chain alkyl group having 3 or more carbon atoms, and

a content of the constituent unit (C) is greater than 2% by mass in all constituent units contained in the silicon atom-containing resin:

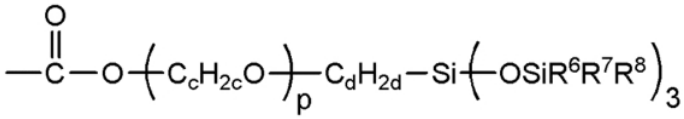
[Chemical formula 1]



(I)

[in the formula (I), a and b each independently represent an integer of 2 to 5, m represents an integer of 0 to 50, and n represents an integer of 3 to 270; and R^1 to R^5 each independently represent an alkyl group, an alkoxy group, a phenyl group, a substituted phenyl group, a phenoxy group, or a substituted phenoxy group];

[Chemical formula 2]

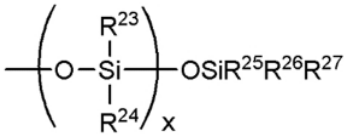


(II)

[in the formula (II), c and d each independently represent an integer of 2 to 5, and p represents an integer of 0 to 50; R^6, R^7, and R^8 each independently represent an alkyl group, R^a, or R^b;

R^a is

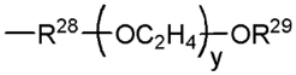
[Chemical formula 3]



(in the formula, x represents an integer of 0 to 200, and R^{23} to R^{27} are the same or different and each represent an alkyl group);

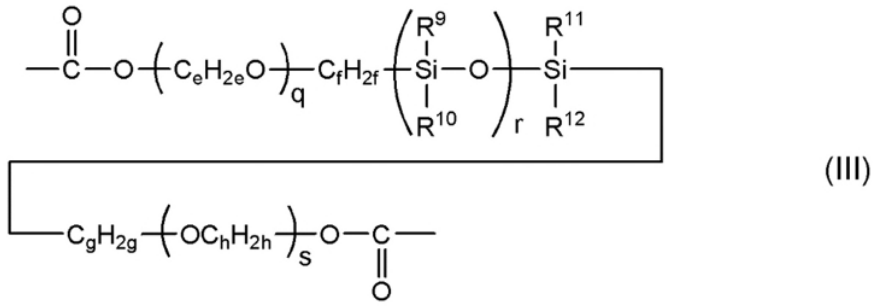
R^b is

[Chemical formula 4]



(in the formula, y represents an integer of 1 to 200, and R^{28} and R^{29} are the same or different and each represent an alkyl group)];

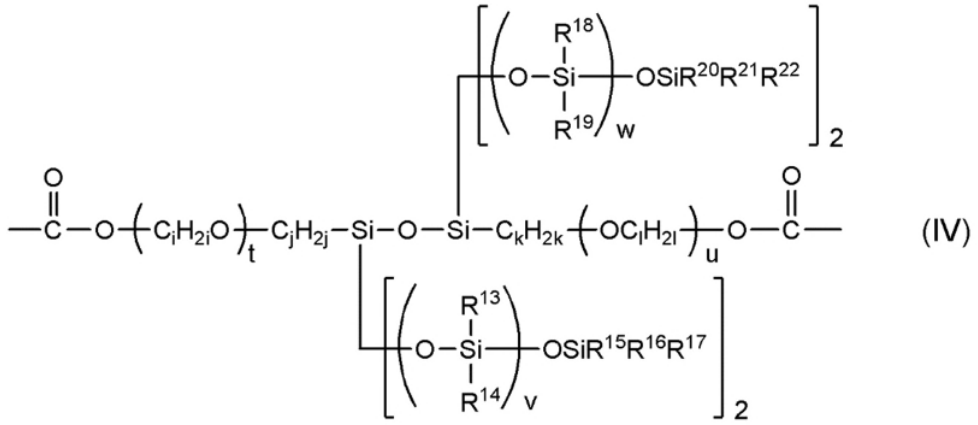
[Chemical formula 5]



(III)

[in the formula (III), e, f, g, and h each independently represent an integer of 2 to 5, q and s each independently represent an integer of 0 to 50, and r represents an integer of 3 to 270; R^9 to R^{12} each independently represent an alkyl group, an alkoxy group, a phenyl group, a substituted phenyl group, a phenoxy group, or a substituted phenoxy group];

[Chemical formula 6]



(IV)

[in the formula (IV), i, j, k, and l each independently represent an integer of 2 to 5, t and u each independently represent an integer of 0 to 50, and v and w each independently represent an integer of 0 to 70; and R^{13} to R^{22} are the same or different and each represent an alkyl group]; and

$CH_2=C(R^A)(COOR^B)$ (b)

[in the formula (b), R^A represents a hydrogen atom or a methyl group; and R^B represents a monovalent group including one or more kinds selected from the group consisting of a hydroxyl group, a carboxy group, and an oxyalkylene chain] , and

wherein

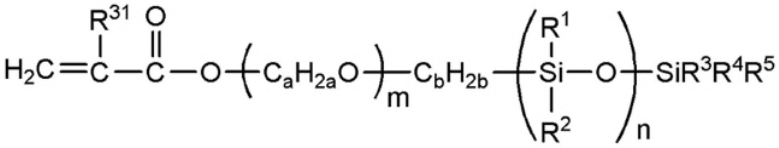
the antifouling coating composition further comprises at least one kind of solvent selected from the group consisting of hydrocarbons, ethers, esters, ketones and alcohols, and

the silicon atom-containing resin is dissolved in the solvent.

2. The antifouling coating composition for an underwater moving body according to claim 1, wherein R^B in the formula (b) represents a monovalent group containing an oxyalkylene chain.

3. The antifouling coating composition for an underwater moving body according to claim 1 or 2, wherein the monomer (a) is at least one kind selected from the group consisting of a monomer (a1) represented by a formula (I') below, a monomer (a2) represented by a formula (II') below, a monomer (a3) represented by a formula (III') below, and a monomer (a4) represented by a formula (IV') below:

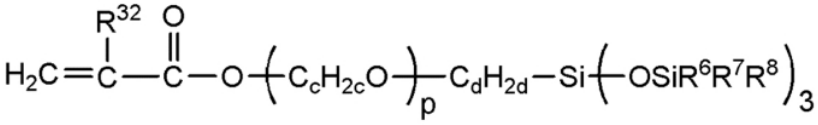
[Chemical formula 7]



(I')

[in the formula (I'), R^{31} represents a hydrogen atom or a methyl group, and a, b, m, n and R^1 to R^5 represent the same meaning as previously mentioned];

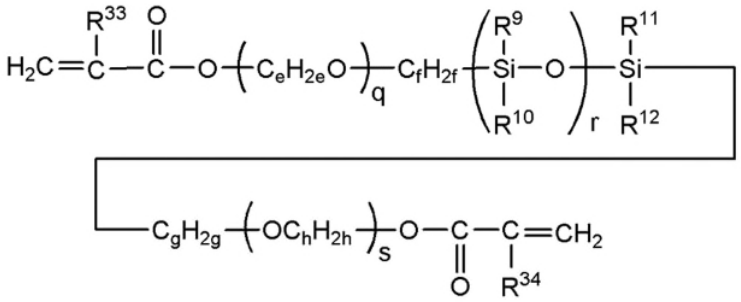
[Chemical formula 8]



(II')

[in the formula (II'), R^{32} represents a hydrogen atom or a methyl group, and c, d, p, and R^6 to R^8 represent the same meaning as previously mentioned];

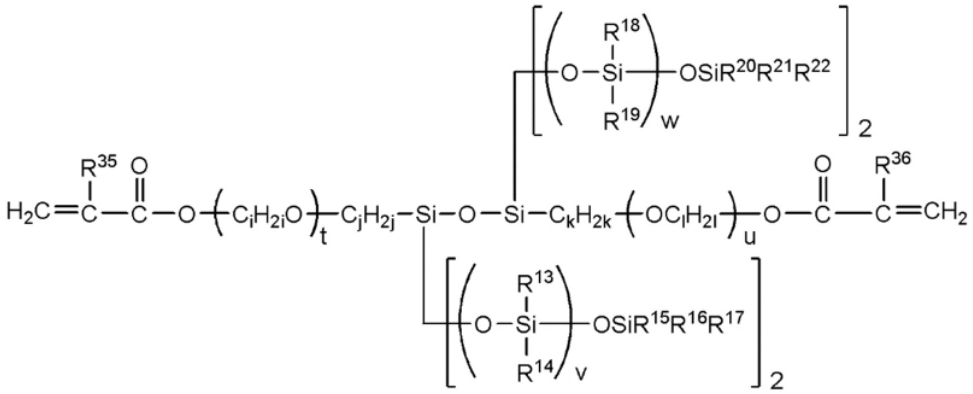
[Chemical formula 9]



(III')

[in the formula (III'), R^{33} and R^{34} each independently represent a hydrogen atom or a methyl group, and e, f, g, h, q, r, s and R^{9} to R^{12} represent the same meaning as previously mentioned]; and

[Chemical formula 10]



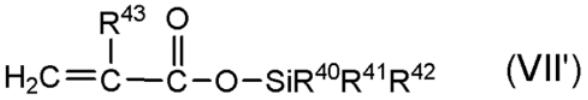
(IV')

[in the formula (IV'), R^{35} and R^{36} each independently represent a hydrogen atom or a methyl group, and i, j, k, l, t, u, v, w and R^{13} to R^{22} represent the same meaning as previously mentioned].

4. The antifouling coating composition for an underwater moving body according to claim 1 or 2, further comprising a constituent unit (D) derived from a monomer (d) having a triorganosilyloxycarbonyl group.

5. The antifouling coating composition for an underwater moving body according to claim 4, wherein the monomer (d) is a monomer (d1) represented by a formula (VII') below:

[Chemical formula 11]



(VII')

[in the formula (VII'), R^{43} represents a hydrogen atom or a methyl group, and R^{40}, R^{41} and R^{42} are the same or different and each represent a hydrocarbon group having 1 to 20 carbon atoms].

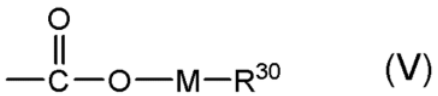
6. The antifouling coating composition for an underwater moving body according to claim 1 or 2, wherein a content of the constituent unit (B) is greater than or equal to 1% by mass and less than or equal to 30% by mass in all constituent units contained in the silicon atom-containing resin.

7. The antifouling coating composition for an underwater moving body according to claim 1 or 2, wherein the monomer (b) has a homopolymer solubility parameter SP of greater than or equal to 10.0.

8. The antifouling coating composition for an underwater moving body according to claim 1 or 2, further comprising at least one kind selected from the group consisting of a defoaming agent and an anti-sagging agent.

9. The antifouling coating composition for an underwater moving body according to claim 1 or 2, wherein the silicon atom-containing resin further includes a constituent unit (E) derived from a monomer (e) having at least one kind of metal atom-containing group selected from the group consisting of a group represented by a formula (V) below and a group represented by a formula (VI) below:

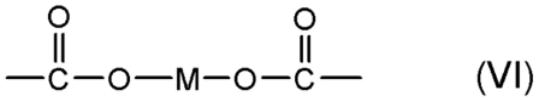
[Chemical formula 12]



(V)

[in the formula (V), M represents a divalent metal atom, and R^{30} represents an organic acid residue or an alcohol residue]; and

[Chemical formula 13]

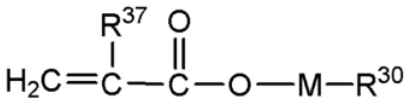


(VI)

[in the formula (VI), M represents a divalent metal atom].

10. The antifouling coating composition for an underwater moving body according to claim 9, wherein the monomer (e) is at least one kind selected from the group consisting of a monomer (e1) represented by a formula (V') below and a monomer (e2) represented by a formula (VI') below:

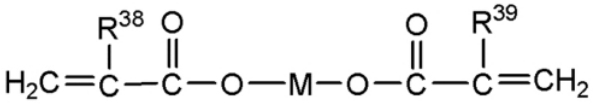
[Chemical formula 14]



(V')

[in the formula (V'), R^{37} represents a hydrogen atom or a methyl group, and M and R^{30} represent the same meaning as previously mentioned]; and

[Chemical formula 15]



(VI')

[in the formula (VI'), R^{38} and R^{39} each independently represent a hydrogen atom or a methyl group, and M represents the same meaning as previously mentioned].

11. A coating film formed from the antifouling coating composition for an underwater moving body according to claim 1.

12. A composite coating film comprising a primer coating film formed from an antirust paint, and a coating film formed from the antifouling coating composition

for an underwater moving body according to claim 1 and overlaid on the primer coating film.

13. A ship comprising the coating film according to claim 11 or the composite coating film according to claim 12.

14. An in-water structure comprising the coating film according to claim 11 or the composite coating film according to claim 12.