

DESCRIPTION

ANTIFOULING COATING MATERIAL COMPOSITION

Technical Field

[0001]

The present invention relates to an antifouling coating composition.

Background Art

[0002]

Aquatic fouling organisms such as barnacles, tubeworms, common mussels, *Bugula neritina*, sea squirts, green laver, sea lettuce, and slimes adhere to ships (especially ship bottoms), fishing tools such as fishing nets and fishing net accessories, and structures submerged in seawater such as power plant aqueducts, leading to dysfunction, impaired appearance, and other problems of the ships and the like.

[0003]

In order to prevent such problems, a technique which forms an antifouling coating film by coating an antifouling coating composition on a ship and the like, and allows controlled release of an antifouling agent to realize an antifouling performance for a long period of time has been known (Patent Literature 1).

Citation List

Patent Literature

[0004]

Patent Literature 1: JP-A-2000-17203

Summary of Invention

Technical Problem

[0005]

The effect of the antifouling coating greatly depends on the thickness of the coating film. Since a bow, stern, draft, and the like are particularly often subject to water flow pressure during the navigation of the ship, they may be coated with a thick coating film. Therefore, the coating film is easy to crack, break, and peel.

[0006]

The present invention has been made by taking the afore-mentioned circumstances into consideration. The present invention provides an antifouling coating composition capable of forming a coating film having improved crack resistance, adhesiveness, and flexibility.

Solution to Problem

[0007]

According to the present invention, an antifouling coating composition, comprising: a polymer A; a component B; and an antifouling agent; wherein: the polymer A is a copolymer of a monomer (a) and an ethylenically unsaturated monomer (b) other than the monomer (a); the monomer (a) is represented by general formula (1); the component B is a paraffinic mineral oil including an aromatic hydrocarbon.

[0008]

The present inventors have conducted intensive studies, and have found that a composition containing a polymer A, a component B, and an antifouling agent can solve the above problems, thereby completing the present invention.

Description of Embodiments

[0009]

Hereinafter, the present invention will be described in detail.

1. Antifouling coating composition

The antifouling coating composition of the present invention contains a polymer A, a component B, and an antifouling agent.

[0010]

1-1. Polymer A

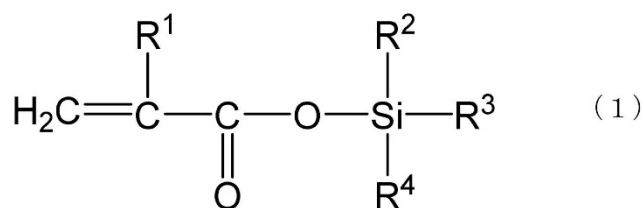
The polymer A is a copolymer of a monomer (a) and an ethylenically unsaturated monomer (b) other than the monomer (a). The polymer A contains monomeric units derived from the monomers (a) and (b).

[0011]

<Monomer (a)>

The monomer (a) is a triorganosilyl (meth) acrylate monomer and is represented by general formula (1).

[Chem. 1]



In the general formula (1), R¹ is a hydrogen or methyl group, and R² to R⁴ are the same or different, and each of R² to R⁴ represents a C3 to C8 branched alkyl group or a phenyl group.

[0012]

Examples of the C3 to C8 branched alkyl group of R² to R⁴ include isopropyl group, isobutyl group, s-butyl group, t-butyl group, 1-ethylpropyl group, 1-methylbutyl group, 1-methylpentyl group, 1,1-dimethylpropyl group, 1,1-dimethylbutyl group, texyl group, cyclohexyl group, 1,1-dimethylpentyl group, 1-methylhexyl group, 1,1-dimethylhexyl group, 1-methylheptyl group, 2-methylbutyl group, 2-ethylbutyl group, 2,2-dimethylpropyl group, cyclohexylmethyl group, 2-ethylhexyl group, 2-propylpentyl group, 3-methylpentyl group and the like. As R² to R⁴, isopropyl group, s-butyl group, t-butyl group, phenyl group, and 2-ethylhexyl group are preferable. Isopropyl group and 2-ethylhexyl group are particularly preferable.

[0013]

Examples of the monomer (a) include triisopropylsilyl (meth) acrylate, triisobutylsilyl (meth) acrylate, tri-s-butylsilyl (meth) acrylate, triisopentylsilyl (meth) acrylate, triphenylsilyl (meth) acrylate, diisopropylphenylsilyl (meth) acrylate, diisopropylisobutylsilyl (meth) acrylate, diisopropyl-s-butylsilyl (meth) acrylate, diisopropylisopentylsilyl (meth) acrylate, isopropyl-diisobutylsilyl (meth) acrylate, isopropyl-di-s-butylsilyl (meth) acrylate, t-butyl-diisobutylsilyl (meth) acrylate, t-butyl-diisopentylsilyl (meth) acrylate, t-butyl-diphenylsilyl (meth) acrylate, diisopropyltexylsilyl (meth) acrylate, diisopropylcyclohexylsilyl (meth) acrylate, tricyclohexylsilyl (meth) acrylate, tri-1,1-dimethylpentylsilyl (meth) acrylate, tri-2,2-dimethylpropylsilyl (meth) acrylate,

tricyclohexylmethylsilyl (meth) acrylate, diisopropylcyclohexylmethylsilyl (meth) acrylate, tri2-ethylhexylsilyl (meth) acrylate, tri2-propylpentylsilyl (meth) acrylate. Preferred examples thereof include triisopropylsilyl (meth) acrylate, tri-s-butylsilyl (meth) acrylate, t-butyl diphenylsilyl (meth) acrylate, and tri2-ethylhexylsilyl (meth) acrylate. These monomers (a) can be used alone, or two or more of these can be used in combination.

[0014]

<Monomer (b)>

The monomer (b) is an ethylenically unsaturated monomer other than the monomer (a), and examples of the monomer (b) include (meth) acrylate esters, vinyl compounds, aromatic compounds, dialkyl ester compounds of a dibasic acid. In this specification, (meth) acrylate ester means acrylate ester, or methacrylate ester.

[0015]

Examples of the (meth) acrylate ester include methyl (meth) acrylate, ethyl (meth) acrylate, butyl (meth) acrylate, isobutyl (meth) acrylate, t-butyl (meth) acrylate, 2-ethylhexyl (meth) acrylate, lauryl (meth) acrylate, 2-methoxyethyl (meth) acrylate, 2-methoxypropyl (meth) acrylate, 4-methoxybutyl (meth) acrylate, benzyl (meth) acrylate, phenyl (meth) acrylate, 2-ethoxyethyl (meth) acrylate, propylene glycol monomethyl (meth) acrylate, 2-hydroxyethyl (meth) acrylate, 2-hydroxypropyl (meth) acrylate, glycidyl (meth) acrylate, flufuryl (meth) acrylate, tetrahydrofurfuryl (meth) acrylate, dimethylaminoethyl (meth) acrylate, diethylaminoethyl (meth) acrylate, 2- [2- (2-hydroxyethoxy) ethoxy] ethoxy] ethyl methacrylate, succinate mono (2- (meth) acryloyloxyethyl), N- (3-dimethylaminopropyl) (meth) acrylamide, 2- [2- (2-methoxyethoxy) ethoxy] ethyl (meth) acrylate, N, N'-dimethyl (meth) acrylamide, 2- (2-methoxyethoxy) ethyl (meth) acrylate, (meth) acrylic acid, hydroxypropyl acrylate, 2- (acetoacetyloxy) ethyl methacrylate, 2- (2-hydroxyethoxy) ethyl methacrylate, N-vinyl-2-pyrrolidone, 2- [2- (2-ethoxyethoxy) ethoxy] ethyl acrylate,

4-hydroxybutyl acrylate glycidyl ether, N-isopropylacrylamide, 2- (dimethylamino) ethyl acrylate, 2- (2-ethoxyethoxy) ethyl acrylate, 4-hydroxybutyl acrylate, tetrahydrofurfuryl acrylate, 3-chloro-2-hydroxypropyl acrylate, 2- [2- (2-ethoxyethoxy) ethoxy] ethyl methacrylate, N, N'-diethylacrylamide, 3-methoxybutyl acrylate, and other acrylate esters.

[0016]

Examples of the vinyl compounds include vinyl compounds having a functional group such as vinyl chloride, vinylidene chloride, acrylonitrile, methacrylonitrile, vinyl acetate, vinyl benzoate, vinyl butyrate, butyl vinyl ether, lauryl vinyl ether, and N-vinylpyrrolidone.

[0017]

Examples of the aromatic compounds include styrene, vinyltoluene, and α -methylstyrene.

[0018]

Examples of the dialkyl ester compounds of a dibasic acid include dimethyl maleate, dibutyl maleate, and dimethyl fumarate.

[0019]

In the present invention, these monomers (b) can be used alone, or two or more of these can be used in combination. In particular, as the monomer (b), (meth) acrylate ester is preferable from the viewpoint of physical properties of the coating film, and methyl methacrylate, butyl (meth) acrylic acid, a isobutyl (meth) acrylate, t-butyl (meth) acrylate, 2-ethylhexyl (meth) acrylate, 2-methoxyethyl (meth) acrylate, 2-ethoxyethyl (meth) acrylate, 2-

hydroxyethyl (meth) acrylate, and glycidyl (meth) acrylate, furfuryl (meth) acrylate, tetrahydrofurfuryl (meth) acrylate are more preferable particularly from the viewpoint of crack resistance.

[0020]

The content of monomer (a) in the polymer A is preferably 5 to 75mass%, more preferably 30 to 60mass%.

[0021]

The content of the monomer (a) is specifically, for example, 5, 10, 15, 20, 25, 30, 35, 40, 45, 50, 55, 60, 65, 70, 75mass%, and may be in the range between the two values exemplified herein.

[0022]

When the polymer A, in which the content of monomer (a) is within the above range, is used as the coating composition of the present invention, the coating film dissolution is particularly good.

[0023]

The weight average molecular weight (Mw) of the polymer A is preferably 5000 to 300,000. When the molecular weight is less than 5,000, the coating film of the antifouling coating becomes fragile and easily peels or cracks, and when it exceeds 300,000, the viscosity of the polymer solution increases, and the handling becomes difficult. This Mw is specifically, for example, 5000, 10000, 20000, 30000, 40,000, 50000, 60000, 70000, 80000, 90000, 100000, 200,000, 300,000, and may be in the range between the two values exemplified herein.

[0024]

Examples of the method for measuring Mw include gel permeation chromatography (GPC method).

[0025]

The polymer A may be a random copolymer, an alternating copolymer, a periodic copolymer, or a block copolymer of the monomer (a) and the monomer (b).

[0026]

The polymer A can be obtained, for example, by polymerizing the monomer (a) and the monomer (b) under the presence of a polymerization initiator.

[0027]

Examples of the polymerization initiator include azo compounds such as 2,2'-azobisisobutyronitrile, 2,2'-azobis (2-methylbutyronitrile), 2,2'-azobis (2,4-dimethylvaleronitrile), dimethyl-2,2'-azobisisobutyrate, dimethyl 2,2'-azobisisobutyrate, 2,2'-azobis (N-butyl-2-methylpropionamide; peroxides such as benzoylper oxide, di-tert-butyl peroxide, tert-butylperoxybenzoate, tert-butylperoxyisopropyl carbonate, t-butylperoxy-2-ethylhexanoate, t-hexylperoxy-2-ethylhexanoate, di-t-hexyl peroxide, t-butylperoxy-2-ethylhexyl monocarbonate, di-t-butyl peroxide, 1,1,3,3-tetramethylbutylperoxyneodecanoate, t-amylperoxyneodecanoate, t-hexylperoxypivalate, t-amylperoxypivalate, 1,1,3,3-tetramethylbutylperoxy-2-ethylhexanoate. These polymerization initiators can be used alone or two or more of these can be used in combination. As the polymerization initiators, 2,2'-azobisisobutyronitrile, 2,2'-azobis (2-methylbutyronitrile), 2,2'-azobis (2,4-dimethylvaleronitrile), dimethyl 2,2'-azobisisobutyrate and 1,1,3,3-tetramethylbutylperoxy-2-ethylhexanoate are particularly preferable. The molecular weight of the copolymer A can be adjusted by appropriately setting the amount of the polymerization initiator used.

[0028]

Examples of the polymerization method include solution polymerization, bulk polymerization, emulsion

polymerization, suspension polymerization, non-aqueous dispersion polymerization, and the like. Among these, solution polymerization and non-aqueous dispersion polymerization are particularly preferable in view of the capability of obtaining the polymer A simply with accuracy.

[0029]

In the polymerization reaction, an organic solvent may be used if necessary. The organic solvent is not particularly limited, but examples of the organic solvent include, aromatic hydrocarbon solvents such as xylene and toluene; aliphatic hydrocarbon solvents; ester solvents such as ethyl acetate, butyl acetate, isobutyl acetate, and methoxypropyl acetate; alcohol solvents such as isopropyl alcohol, butyl alcohol, and propylene glycol monomethyl ether; ether solvents such as dioxane, diethyl ether, and dibutyl ether; ketone solvents such as methyl ethyl ketone and methyl isobutyl ketone.

Among them, butyl acetate, isobutyl acetate, butyl alcohol, propylene glycol monomethyl ether, propylene glycol 1-monomethyl ether 2-acetate, toluene, and xylene are preferable. These solvents can be used alone, or two or more of these can be used in combination.

[0030]

The reaction temperature in the polymerization reaction may be appropriately set according to the type of the polymerization initiator and the like and is usually 50 to 160°C, preferably 60 to 150°C.

[0031]

The polymerization reaction is preferably performed under inert gas atmosphere such as nitrogen gas and argon gas.

[0032]

1-2. Component B

The component B is a paraffinic mineral oil containing an aromatic hydrocarbon.

The mineral oil is a refined fraction of petroleum and comprises paraffin, naphthenic acid, an aromatic hydrocarbon, and the like. The ring analysis (n-d-M method) in accordance with ASTM D3238 comprises paraffin carbon number (%CP), naphthen carbon number (%CN), and aromatic carbon number (%CA), and a mineral oil having a %CP of 50% or more is called paraffinic mineral oil. %CP is, for example, 50 to 95%, specifically, for example, 50, 55, 60, 65, 70, 75, 80, 85, 90, 95%, and may be in the range between the two values exemplified herein.

[0033]

This component B is a paraffinic mineral oil containing an aromatic hydrocarbon, and the content of the aromatic hydrocarbon is, for example, a %CA of 0.1 to 20% by ring analysis (n-d-M method) in accordance with ASTM D3238, preferably 0.1 to 15%, more preferably 0.3 to 12%, even more preferably 8 to 12%. %CA is specifically, for example, 0.1, 0.2, 0.3, 0.4, 0.5, 0.6, 0.7, 0.8, 0.9, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, and may be in the range between the two values exemplified herein.

[0034]

The aniline point of the component B is preferably 80 to 123°C, more preferably 80 to 120°C, and even more preferably 80 to 110°C from the viewpoint of not causing a coating film defects. This value is specifically, for example, 80, 81, 82, 83, 84, 85, 86, 87, 88, 89, 90, 91, 92, 93, 94, 95, 96, 97, 98, 99, 100, 101, 102, 103, 104, 105, 106, 107, 108, 109, 110, 111, 112, 113, 114, 115, 116, 117, 118, 119, 120, 121, 122, 123°C, and may be in the range between the two values exemplified herein. The aniline point is measured in accordance with JIS K2256.

[0035]

Examples of component B include commercially available products such as Cosmo Pure Safety 10M, Cosmo Pure Safety 22, Cosmo Pure Safety 32, Cosmo Pure Safety 46, Cosmo Pure Safety 68, Cosmo Pure Safety 100, Cosmo Pure Safety 150, Cosmo Neutral 100, Cosmo Neutral 150, Cosmo Neutral 350, Cosmo Neutral 500, Cosmo Neutral 700, Cosmo SP10, Cosmo SP15, and Cosmo SP83 (product name, available from COSMO OIL LUBRICANTS CO., LTD.).

[0036]

1-3. Antifouling agent

As the antifouling agent, for example, an inorganic chemical and an organic chemical can be mentioned.

As the inorganic chemical, for example, cuprous oxide, cuprous thiocyanate (generic name: copper rhodanide), copper powder and the like can be mentioned. Among these, cuprous oxide and copper rhodanide are particularly preferable. From the viewpoint of long-term shelf stability, the cuprous oxide surface-treated with glycerin, sucrose, stearic acid, lauric acid, lecithin, mineral oil, and the like is more preferable.

As the organic chemical, for example, copper 2-mercaptopyridine-N-oxide (generic name: copper pyrithione), zinc 2-mercaptopyridine-N-oxide (generic name: zinc pyrithione), zinc ethylenebis(dithiocarbamate) (generic name: zineb), 4,5-dichloro-2-n-octyl-3-isothiazolone (generic name: Sea-nine 211), 3,4-dichlorophenyl-N-N-dimethylurea (generic name: Diuron), 2-methylthio-4-t-butylamino-6-cyclopropylamino-s-triazine (generic name: Irgarol 1051), 2-(p-chlorophenyl)-3-cyano-4-bromo-5-trifluoromethyl pyrrole (generic name: ECONEA 28), 4-[1-(2,3-dimethylphenyl)ethyl]-1H-imidazole (generic name: Medetomidine) can be mentioned.

These antifouling agents can be used alone, or two or more of these can be used in combination.

[0037]

1-4. Other additives

Further, if necessary, the resin for antifouling coating of the present invention may be added with a resin component other than polymer A, an elution regulator, a plasticizer, a pigment, a dye, an antifoaming agent, a dehydrating agent, a thixotropic agent, an organic solvent, and the like to obtain the antifouling coating.

[0038]

Examples of the resin component other than polymer A include polymer P and the like.

The polymer P is a polymer obtained by polymerizing the monomer (b). The monomer (b) is any ethylenically unsaturated monomer other than the monomer (a). The monomer (b) used for the polymerization of the polymer P may have the same composition or different composition as the monomer (b) used for the polymerization of the polymer A.

In the present invention, the monomer (b) can be used alone, or two or more of these can be used in combination. In particular, from the viewpoint of compatibility with the polymer A, methyl (meth) acrylate, ethyl (meth) acrylate, butyl (meth) acrylate, isobutyl (meth) acrylate, t-butyl (meth) acrylate, 2 ethylhexyl (meth) acrylate, 2-methoxyethyl (meth) acrylate, 2-ethoxyethyl (meth) acrylate, flufuryl (meth) acrylate, tetrahydrofurfuryl (meth) acrylate, and benzyl (meth) acrylate are preferable.

As the polymerization method, initiator, solvent, temperature, other conditions, Mw measurement method, and the like, the one described above for polymer A can be applied.

The content of the polymer P in the composition of the present invention is not particularly limited, but

the content ratio to the polymer A (polymer P / polymer A) by mass ratio is usually 0.1 to 9.0, preferably 0.1 to 4.0 in terms of solid content.

[0039]

As the elution regulator, monocarboxylic acids and salts thereof, such as rosin, rosin derivatives, naphthenic acid, cycloalkenyl carboxylic acid, bicycloalkenyl carboxylic acid, versatic acid, trimethyl isobutenylcyclohexene carboxylic acid, and their metal salts, or the alicyclic hydrocarbon resins as mentioned above can be exemplified. These can be used alone, or two or more of these can be used in combination.

As the rosin derivative, hydrogenated rosin, disproportionated rosin, maleic acid modified rosin, formylated rosin, polymerized rosin, and the like can be exemplified.

As the alicyclic hydrocarbon resins, Quintone 1500, Quintone 1525L, and Quintone 1700 (product name, available from Zeon Corporation) and the like can be mentioned as a commercially available product for example.

Among these, rosin, rosin derivatives, naphthenic acid, versatic acid, trimethylisobutenyl cyclohexenecarboxylic acid, and metal salts thereof are preferable.

[0040]

As the plasticizer, for example, phosphoric acid esters, phthalic acid esters, adipic acid esters, sebacic acid esters, epoxidized soybean oil, alkyl vinyl ether polymer, polyalkylene glycols, t-nonyl pentasulfide, vaseline, polybutene, tris(2-ethylhexyl) trimellitate, silicone oil, liquid paraffin, chlorinated paraffin and the like can be mentioned. These can be used alone, or two or more of these can be used in combination.

[0041]

As the dehydrating agent include, for example, calcium sulphatesynthetic, zeolite adsorbents, orthoesters, silicates such as tetramethoxysilane and tetraethoxysilane, isocyanates, carbodiimides, carbodiimidazoles, and the like can be mentioned. These can be used alone, or two or more of these can be used in combination.

[0042]

2. Manufacturing method of antifouling coating composition

The antifouling coating composition of the present invention can be manufactured, for example, by mixing and dispersing a mixture solution including the polymer A, the component B, an antifouling agent, other additives, and the like using a disperser.

Regarding the mixture solution, the ingredients such as the polymer A, the component B, an antifouling agent, other additives, and the like are preferably dissolved or dispersed in the solvent.

As the disperser, for example, the one which can be used as a micro-pulverizer can be suitably used. For example, a commercially available homo mixer, sand mill, bead mill, disper, and the like can be used. Furthermore, the mixed solution can be mixed and dispersed by using a stirrer-equipped container containing glass beads for mixing and dispersing.

[0043]

3. Method for antifouling treatment, antifouling coating film, and coated object

The method for antifouling treatment of the present invention is characterized in that an antifouling coating film is formed using the above-explained antifouling coating composition on the surface of an object that is subjected to coating. The method for antifouling treatment of the present invention can prevent adhesion of aquatic fouling organisms by the gradual dissolution of the surface of the antifouling coating film such that the surface of

the coating film is continually renewed.

Examples of objects on which the coating film can be formed include ships (in particular, ship bottoms), fishing tools, structures submerged in seawater, and the like.

The thickness of the antifouling coating film can be suitably selected depending on the type of the object on which the coating film is to be formed, the navigation speed of a ship, the seawater temperature, and the like. For example, when the object on which a coating film is formed is a ship bottom, the thickness of the antifouling coating film is usually 50 to 700 μm , and preferably 100 to 600 μm .

EXAMPLES

[0044]

Examples and the like are provided hereinafter, and further clarifies characteristics of the present invention. The present invention, however, is not limited to these Examples.

In each of Production Examples, Examples, and Comparative Examples, "%" denotes "% by mass".

The weight average molecular weight (Mw) was determined by gel permeation chromatography (GPC) (using a polystyrene standard). GPC was performed under the following conditions.

Equipment: HLC-8220 GPC (available from Tosoh Corporation)

Column: TSK-gel Super HZM-M, two columns used

Flow rate: 0.35 mL/min

Detector: RI

Column thermostat temperature: 40°C

Developing solvent: THF

The non-volatile content was measured in accordance with JIS K 5601-1-2:1999 (ISO 3251:1993).

[0045]

<Production Example 1 (Production of polymer A solution_A-1)>

To a four-necked flask equipped with a thermometer, a cooler, a stirrer, and a dropping funnel, 40 g of xylene (initial solvent) was charged, nitrogen gas was introduced, and the temperature was maintained at 88°C while stirring. Then, a mixture solution of the monomers (a) and (b) shown in Table 1 and 0.8 g of 1,1,3,3-tetramethylbutylperoxy-2-ethylhexanoate (initial addition) as a polymerization initiator was added dropwise over 3 hours while maintaining at 88°C. Then, after stirring at 88°C for 1 hour, 0.2 g of 1,1,3,3-tetramethylbutylperoxy-2-ethylhexanoate (post addition) was added 3 times every hour. After further stirring at the same temperature for 2 hours, 60 g of xylene (diluting solvent) was added and the mixture was cooled to room temperature to obtain polymer A solution A-1. Table 1 shows the non-volatile content and Mw of A-1.

[0046]

<Production Examples 2 to 10 (Production of polymer A solutions_A-2 to A-7, polymer solutions_P-1 to P-3)>

The monomers, polymerization initiators, and solvents shown in Table 1 and polymerization reaction was performed under each reaction temperature condition by processes similar to those of Production Example 1 to obtain polymer A solutions A-2 to A-7 and polymer solutions P-1 to P-3. Table 1 shows the non-volatile content and Mw of A-2 to A-7 and P-1 to P-3. The numerical value in the table is mass%.

[0047]

[Table 1]

Table 1

	component	Production Example									
		1	2	3	4	5	6	7	8	9	10
initial solvent	xylene	40	44	38	46	44	47	60		60	94
	propylene glycol monomethyl ether								100		
	butyl acetate									10	
	trisopropylsilyl acrylate	60									
monomer (a)	trisopropylsilyl methacrylate		60	50	45	40	35	30			
	methyl methacrylate	30	15	10	30	34	37	10	55	40	10
monomer (b)	n-butyl acrylate			10	2	3	3	13		30	20
	2-methoxyethyl acrylate	10	25		23	23	25		45		20
	2-methoxyethyl methacrylate			30				47			
	n-butyl methacrylate									30	50
	initial addition	0.8	1.0	1.0	1.0	1.0	1.0	0.8	1.2	1.0	1.0
polymerization initiator	post addition 3 times	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
diluting solvent	xylene	60	56	62	54	56	53	40	0	30	6
reaction temperature [°C] (within ±5°C)		88	85	85	85	85	85	88	88	88	88
physical properties of copolymer solution	non-volatile content [%]	50.5	49.5	49.6	49.6	49.4	49.1	49.3	49.5	49.6	49.4
	weight average molecular weight [Mw]	49500	50300	51000	48500	52400	50100	50000	34400	45000	44700
	copolymer solution	A-1	A-2	A-3	A-4	A-5	A-6	A-7	P-1	P-2	P-3

[0048]

<Production Example 11 (Production of rosin zinc salt solution)>

To a flask equipped with a thermometer, a reflux condenser, and a stirrer, 240 g of Chinese gum rosin (WW) and 360 g of xylene were charged in the flask, and 120 g of zinc oxide was further added so that all the resin acids in the rosin formed zinc salts. The mixture was refluxed and dehydrated at 70 to 80°C for 3 hours under reduced pressure, cooled and filtered to obtain a xylene solution of rosin zinc salt (dark brown transparent liquid, solid content 50%). The non-volatile content of the obtained solution was 50.2%.

[0049]

<Production Example 12 (Production of hydrogenated rosin zinc salt solution)>

To a flask equipped with a thermometer, a reflux condenser, and a stirrer, 240 g of HYPALE CH (hydrogenated gum rosin) and 360 g of xylene were charged, and 120 g of zinc oxide was further added so that all the resin acids in the rosin form zinc salts. The mixture was refluxed and dehydrated at 70 to 80°C for 3 hours under reduced pressure, then concentrated, cooled, and filtered to obtain a xylene solution of hydrogenated rosin zinc salt (dark brown liquid, solid content 65%). The non-volatile content of the obtained solution was 65.1%.

[0050]

<Examples 1 to 27 and Comparative Examples 1 to 12 (Production of coating composition)>

The components shown in Tables 2 to 7 were blended in the ratio (mass%) shown in these tables and mixed and dispersed with glass beads having a diameter of 1.5 to 2.5 mm to produce coating compositions.

[0051]

[Table 2]

Table 2

component			Example							
			1	2	3	4	5	6	7	8
polymer solution (A)	A-1		25.8							
	A-2			25.8						
	A-3				25.8					
	A-4					25.8				
	A-5						25.8			13
	A-6							25.8		
	A-7								25.8	12.8
component B (%CA)	Cosmo SP 83 (0.3)		1							
	Cosmo Neutral 700 (7.9)			1						
	Cosmo Neutral 150 (4.0)				1					
	Cosmo SP 15 (1.3)					1				
	Cosmo Pure Safety 68 (9.2)						1			1
	Cosmo Pure Safety 32 (10.3)							1		
	Cosmo Pure Safety 22 (9.6)								1	
antifouling agent	cuprous oxide		37	37	37	37	37	37	37	37
	copper pyrithione		2	2	2	2	2	2	2	2
other additives	SANSO CIZER E-2000H		0.5							
	rosin zinc salt solution		2	2	2	2	2	2	2	2
	gum rosin solution		1	1	1	1	1	1	1	1
	hydrogenated rosin solution		1	1	1	1	1	1	1	1
	hydrogenated rosin zinc salt solution		5.4	5.4	5.4	5.4	5.4	5.4	5.4	5.4
	red oxide		4	4	4	4	4	4	4	4
	talc		10	10	10	10	10	10	10	10
	zinc oxide		5	5	5	5	5	5	5	5
	titanium oxide		0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
	Ethyl Silicate 28		0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
	hemihydrate gypsum		1	1	1	1	1	1	1	1
	Disparlon A603-20X		0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
	Disparlon 4200-20		0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
solvent	xylene		2.9	3.4	3.4	3.4	3.4	3.4	3.4	3.4
sum			100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Test Example 1 physical property test of coating film	dried film thickness 100μm	3 months	AA	AA	AA	AA	AA	AA	AA	AA
		6 months	AA	AA	AA	AA	AA	AA	AA	AA
	dried film thickness 200μm	3 months	AA	AA	AA	AA	AA	AA	AA	AA
		6 months	AA	AA	AA	AA	AA	AA	AA	AA
Test Example 2 adhesion test of coating film	dried film thickness 100μm	3 months	AA	AA	AA	AA	AA	AA	AA	AA
		6 months	A	AA	AA	AA	AA	AA	AA	AA
	dried film thickness 200μm	3 months	AA	AA	AA	AA	AA	AA	AA	AA
		6 months	A	AA	AA	AA	AA	AA	AA	AA
Test Example 3 flexibility test of coating film	dried film thickness 100μm	3 months	A	AA	AA	AA	AA	AA	AA	AA
		6 months	A	AA	AA	AA	AA	AA	AA	AA
	dried film thickness 200μm	3 months	A	AA	AA	AA	AA	AA	AA	AA
		6 months	A	A	A	A	A	A	A	A

[0052]

[Table 3]

Table 3

component			Example						
			9	10	11	12	13	14	15
polymer solution (A)	A-1		7	13		25			
	A-2						25		
	A-3		6					25	
	A-4				13				25
component B (%CA)	Cosmo SP 83 (0.3)			0.5		1			
	Cosmo Neutral 700 (7.9)		1				1		
	Cosmo Neutral 150 (4.0)							1	
	Cosmo SP15 (1.3)								1
	Cosmo Pure Safety 32 (10.3)			0.5	1				
other polymer solution (P)	P-1		12.8						
	P-2			12.8					
	P-3				12.8				
antifouling agent	cuprous oxide		37	37	37				
	copper pyrithione		2	2	2				
	zinc pyrithione					2	2	2	2
	copper thiocyanate (I)					1	1	1	1
	Zineb					1	1	1	1
	DCOIT					1	1	1	1
	Econea					6	6	6	6
	medetomidine					0.1	0.1	0.1	0.1
other additives	Toyo Parax A40S		0.5						
	rosin zinc salt solution		2	2	2	6.8	6.8	6.8	6.8
	gum rosin solution		1	1	1	1	1	1	1
	hydrogenated rosin solution		1	1	1	1	1	1	1
	hydrogenated rosin zinc salt solution		5.4	5.4	5.4	14	14	14	14
	red oxide		4	4	4	10	10	10	10
	talc		10	10	10	10	10	10	10
	zinc oxide		5	5	5	9	9	9	9
	titanium oxide		0.5	0.5	0.5	7	7	7	7
	Ethyl Silicate 28		0.5	0.5	0.5	0.5	0.5	0.5	0.5
	hemihydrate gypsum		1	1	1	1.5	1.5	1.5	1.5
	Disparlon A603-20X		0.2	0.2	0.2	0.2	0.2	0.2	0.2
Disparlon 4200-20		0.2	0.2	0.2	0.2	0.2	0.2	0.2	
solvent	xylene		2.9	3.4	3.4	1.7	1.7	1.7	1.7
sum			100.0	100.0	100.0	100.0	100.0	100.0	100.0
Test Example 1 physical property test of coating film	dried film thickness 100μm	3 months	AA	AA	AA	AA	AA	AA	AA
		6 months	AA	AA	AA	AA	AA	AA	AA
	dried film thickness 200μm	3 months	AA	AA	AA	AA	AA	AA	AA
		6 months	AA	AA	AA	AA	AA	AA	AA
Test Example 2 adhesion test of coating film	dried film thickness 100μm	3 months	AA	AA	AA	AA	AA	AA	AA
		6 months	AA	A	AA	A	AA	AA	AA
	dried film thickness 200μm	3 months	AA	AA	AA	A	AA	AA	AA
		6 months	AA	A	AA	A	AA	AA	AA
Test Example 3 flexibility test of coating film	dried film thickness 100μm	3 months	AA	AA	AA	AA	AA	AA	AA
		6 months	AA	A	AA	A	AA	AA	AA
	dried film thickness 200μm	3 months	AA	AA	AA	A	AA	AA	AA
		6 months	AA	A	AA	A	A	A	A

[0053]

[Table 4]

Table 4

component			Example					
			16	17	18	19	20	21
polymer solution (A)	A-5		25			5		4
	A-6			25			6	9
	A-7				25	8	7	
component B (%CA)	Cosmo Neutral 700 (7.9)					0.5		
	Cosmo Neutral 150 (4.0)						0.5	
	Cosmo SP 15 (1.3)							0.5
	Cosmo Pure Safety 68 (9.2)		1					0.5
	Cosmo Pure Safety 32 (10.3)			1			0.5	
	Cosmo Pure Safety 10 (10.7)				1	0.5		
other polymer solution (P)	P-1					4	4	4
	P-2					4	4	4
	P-3					4	4	4.8
antifouling agent	cuprous oxide					4	4	37
	copper pyrithione							2
	zinc pyrithione		2	2	2	2	2	
	copper thiocyanate (I)		1	1	1	1	1	
	Zineb		1	1	1	1	1	
	DCOIT		1	1	1	1	1	
	Econea		6	6	6	2	2	
	medetomidine		0.1	0.1	0.1	0.1	0.1	
other additives	rosin zinc salt solution		6.8	6.8	6.8	6.8	6.8	2
	gum rosin solution		1	1	1	1	1	1
	hydrogenated rosin solution		1	1	1	1	1	1
	hydrogenated rosin zinc salt solution		14	14	14	14	14	5.4
	red oxide		10	10	10	10	10	4
	talc		10	10	10	10	10	10
	zinc oxide		9	9	9	9	9	5
	titanium oxide		7	7	7	7	7	0.5
	Ethyl Silicate 28		0.5	0.5	0.5	0.5	0.5	0.5
	hemihydrate gypsum		1.5	1.5	1.5	1.5	1.5	1
	Disparlon A603-20X		0.2	0.2	0.2	0.2	0.2	0.2
	Disparlon 4200-20		0.2	0.2	0.2	0.2	0.2	0.2
solvent	xylene		1.7	1.7	1.7	1.7	1.7	3.4
sum			100.0	100.0	100.0	100.0	100.0	100.0
Test Example 1 physical property test of coating film	dried film thickness 100μm	3 months	AA	AA	AA	AA	AA	AA
		6 months	AA	AA	AA	AA	AA	AA
	dried film thickness 200μm	3 months	AA	AA	AA	AA	AA	AA
		6 months	AA	AA	AA	AA	AA	AA
Test Example 2 adhesion test of coating film	dried film thickness 100μm	3 months	AA	AA	AA	AA	AA	AA
		6 months	AA	AA	AA	AA	AA	AA
	dried film thickness 200μm	3 months	AA	AA	AA	AA	AA	AA
		6 months	AA	AA	AA	AA	AA	AA
Test Example 3 flexibility test of coating film	dried film thickness 100μm	3 months	AA	AA	AA	AA	AA	AA
		6 months	AA	AA	AA	AA	AA	A
	dried film thickness 200μm	3 months	AA	AA	AA	AA	AA	AA
		6 months	A	A	A	AA	AA	A

[0054]

[Table 5]

Table 5

component			Example					
			22	23	24	25	26	27
polymer solution (A)	A-1		25.8	25.8	25.8	25.8	25.8	25.8
component B (%CA)	Cosmo Neutral 700 (7.9)		1					
	Cosmo Neutral 150 (4.0)			1				
	Cosmo SP 15 (1.3)				1			
	Cosmo Pure Safety 68 (9.2)					1		
	Cosmo Pure Safety 32 (10.3)						1	
	Cosmo Pure Safety 22 (9.6)							1
antifouling agent	cuprous oxide		37	37	37	37	37	37
	copper pyrithione		2	2	2	2	2	2
other additives	SANSO CIZER E-2000H		0.5	0.5	0.5	0.5	0.5	0.5
	rosin zinc salt solution		2	2	2	2	2	2
	gum rosin solution		1	1	1	1	1	1
	hydrogenated rosin solution		1	1	1	1	1	1
	hydrogenated rosin zinc salt solution		5.4	5.4	5.4	5.4	5.4	5.4
	red oxide		4	4	4	4	4	4
	talc		10	10	10	10	10	10
	zinc oxide		5	5	5	5	5	5
	titanium oxide		0.5	0.5	0.5	0.5	0.5	0.5
	Ethyl Silicate 28		0.5	0.5	0.5	0.5	0.5	0.5
	hemihydrate gypsum		1	1	1	1	1	1
	Disparlon A603-20X		0.2	0.2	0.2	0.2	0.2	0.2
	Disparlon 4200-20		0.2	0.2	0.2	0.2	0.2	0.2
solvent	xylene		2.9	2.9	2.9	2.9	2.9	2.9
sum			100.0	100.0	100.0	100.0	100.0	100.0
Test Example 1 physical property test of coating film	dried film thickness 100μm	3 months	AA	AA	AA	AA	AA	AA
		6 months	AA	AA	AA	AA	AA	AA
	dried film thickness 200μm	3 months	AA	AA	AA	AA	AA	AA
		6 months	AA	AA	AA	AA	AA	AA
Test Example 2 adhesion test of coating film	dried film thickness 100μm	3 months	AA	AA	AA	AA	AA	AA
		6 months	AA	AA	AA	AA	AA	AA
	dried film thickness 200μm	3 months	AA	A	A	AA	AA	AA
		6 months	A	A	A	AA	AA	AA
Test Example 3 flexibility test of coating film	dried film thickness 100μm	3 months	AA	AA	AA	AA	AA	AA
		6 months	AA	AA	A	AA	AA	AA
	dried film thickness 200μm	3 months	A	A	A	AA	AA	AA
		6 months	A	A	A	A	A	A

[0055]

[Table 6]

Table 6

component			Comparative Example					
			1	2	3	4	5	6
polymer solution (A)	A-1		25.8	25.8	25.8	25.8		
	A-2						25.8	
	A-3							25.8
component B (%CA)	Moresco White P-100 (0)					1		
	Moresco White P-260 (0)				1			
	Moresco White P-350P (0)			1			1	1
antifouling agent	cuprous oxide		37	37	37	37	37	37
	copper pyrithione		2	2	2	2	2	2
other additives	SANSO CIZER E-2000H		0.5	0.5	0.5	0.5		
	rosin zinc salt solution		2	2	2	2	2	2
	gum rosin solution		1	1	1	1	1	1
	hydrogenated rosin solution		1	1	1	1	1	1
	hydrogenated rosin zinc salt solution		5.4	5.4	5.4	5.4	5.4	5.4
	red oxide		4	4	4	4	4	4
	talc		10	10	10	10	10	10
	zinc oxide		5	5	5	5	5	5
	titanium oxide		0.5	0.5	0.5	0.5	0.5	0.5
	Ethyl Silicate 28		0.5	0.5	0.5	0.5	0.5	0.5
	hemihydrate gypsum		1	1	1	1	1	1
	Disparlon A603-20X		0.2	0.2	0.2	0.2	0.2	0.2
	Disparlon 4200-20		0.2	0.2	0.2	0.2	0.2	0.2
solvent	xylene		3.9	2.9	2.9	2.9	3.4	3.4
sum			100.0	100.0	100.0	100.0	100.0	100.0
Test Example 1 physical property test of coating film	dried film thickness 100μm	3 months	A	A	A	A	A	A
		6 months	B	B	B	B	B	B
	dried film thickness 200μm	3 months	B	B	B	B	B	B
		6 months	C	B	B	B	B	B
Test Example 2 adhesion test of coating film	dried film thickness 100μm	3 months	B	B	B	B	B	B
		6 months	C	B	B	B	B	B
	dried film thickness 200μm	3 months	C	C	C	C	C	C
		6 months	C	C	C	C	C	C
Test Example 3 flexibility test of coating film	dried film thickness 100μm	3 months	C	B	B	B	B	B
		6 months	C	C	C	C	C	C
	dried film thickness 200μm	3 months	C	C	C	C	C	C
		6 months	C	C	C	C	C	C

[0056]

[Table 7]

Table 7

component			Comparative Example					
			7	8	9	10	11	12
polymer solution (A)	A-1						25	
	A-3							25
	A-4		25.8					
	A-5			25.8				
	A-6				25.8			
	A-7					25.8		
component B (%CA)	Moresco White P-260 (0)		1					
	Moresco White P-350P (0)						1	1
antifouling agent	cuprous oxide		37	37	37	37		
	copper pyrithione		2	2	2	2		
	zinc pyrithione						2	2
	copper thiocyanate (I)						1	1
	Zineb						1	1
	DCOIT						1	1
	Econea						6	6
	medetomidine						0.1	0.1
other additives	rosin zinc salt solution		2	2	2	2	6.8	6.8
	gum rosin solution		1	1	1	1	1	1
	hydrogenated rosin solution		1	1	1	1	1	1
	hydrogenated rosin zinc salt solution		5.4	5.4	5.4	5.4	14	14
	red oxide		4	4	4	4	10	10
	talc		10	10	10	10	10	10
	zinc oxide		5	5	5	5	9	9
	titanium oxide		0.5	0.5	0.5	0.5	7	7
	Ethyl Silicate 28		0.5	0.5	0.5	0.5	0.5	0.5
	hemihydrate gypsum		1	1	1	1	1.5	1.5
	Disparlon A603-20X		0.2	0.2	0.2	0.2	0.2	0.2
	Disparlon 4200-20		0.2	0.2	0.2	0.2	0.2	0.2
solvent	xylene		3.4	4.4	4.4	4.4	1.7	1.7
sum			100.0	100.0	100.0	100.0	100.0	100.0
Test Example 1 physical property test of coating film	dried film thickness 100μm	3 months	A	A	A	A	A	A
		6 months	B	B	B	B	B	B
	dried film thickness 200μm	3 months	B	B	B	B	B	B
		6 months	B	C	C	C	B	B
Test Example 2 adhesion test of coating film	dried film thickness 100μm	3 months	B	B	B	B	B	B
		6 months	B	C	C	C	B	B
	dried film thickness 200μm	3 months	C	C	C	C	B	B
		6 months	C	C	C	C	C	C
Test Example 3 flexibility test of coating film	dried film thickness 100μm	3 months	B	C	C	C	B	B
		6 months	C	C	C	C	C	C
	dried film thickness 200μm	3 months	C	C	C	C	C	C
		6 months	C	C	C	C	C	C

[0057]

Details of component B, antifouling agent, and other additives in the tables are as follows.

<Component B>

Cosmo SP 83: %CP 67.2, %CN 32.5, %CA 0.3, aniline point 119.0°C

Cosmo SP 15: %CP 67.1, %CN 31.6, %CA 1.3, aniline point 102.0°C

Cosmo Neutral 700: %CP 66.8, %CN 25.3, %CA 7.9, aniline point 110.1°C

Cosmo Neutral 150: %CP 68.3, %CN 27.7, %CA 4.0, aniline point 104.9°C

Cosmo Pure Safety 68: %CP 63.1, %CN 27.7, %CA 9.2, aniline point 99.5°C

Cosmo Pure Safety 32: %CP 64.0, %CN 25.7, %CA 10.3, Aniline point 93.4°C

Cosmo Pure Safety 22: %CP 62.1, %CN 28.3, %CA 9.6, aniline point 88.8°C

Cosmo Pure Safety 10: %CP 59.0, %CN 30.3, %CA 10.7, aniline point 81.6°C

Moresco White P-350P: %CP 70, %CN 30, %CA 0, aniline point 122°C

Moresco White P-260: %CP 70, %CN 30, %CA 0, aniline point 118.0°C

Moresco White P-100: %CP 70, %CN 30, %CA 0, aniline point 108.2°C

[0058]

<Antifouling agent>

cuprous oxide: product name "NC-301" (available from NISSIN CHEMCO LTD.)

copper pyrithione: product name "Copper Omadine" (available from Lonza Inc.)

zinc pyrithione: product name "Zinc Omadine" (available from Lonza Inc.)

copper thiocyanate (I): product name "Copper thiocyanate (I)" (available from by Wako Pure Chemical Industries, Ltd.)

Zineb: product name "Zineb" (available from Sigma-Aldrich, Inc.)

DCOIT: 4,5-dichloro-2-n-octyl-3-isothiazolone (available from Tokyo Chemical Industry Co., Ltd.)

Econia: product name "Econea 028" 2-(p-chlorophenyl)3-cyano-4-bromo-5-trifluoromethyl pyrrole, (available from JANSSEN PMP)

medetomidine: (±)4-(1-(2,3-Dimethylphenyl) ethyl)-1H-imidazole (available from Wako Pure Chemical Industries, Ltd.)

[0059]

<Other additives>

Toyo Parax A40S: chlorinated paraffin, chlorine content 40.5% (available from Tosoh Corporation)

SANSO CIZER E-2000H: Epoxy soybean oil (available from New Japan Chemical Co., Ltd.)

rosin zinc salt solution: The one produced in Production Example 11 was used.

gum rosin solution: xylene solution (50% solids) of Chinese gum rosin (WW)

hydrogenated rosin solution: 50% solids xylene solution of product name "HYPALE CH" (available from ARAKAWA CHEMICAL INDUSTRIES, LTD.)

hydrogenated rosin zinc salt solution: The one produced in Production Example 12 was used.

red oxide: product name "Bengarakingyoku" (available from Morishitabengara Corporation)

talk: product name "TALC MS" (available from NIPPON TALC Co., Ltd.)

zinc oxide: product name "zinc oxide II" (available from Seido Chemical Industry Co., Ltd.)

titanium oxide: product name “FR-41” (available from FURUKAWA CO., LTD.)

Ethyl Silicate 28: tetraethoxysilane: product name “Ethyl Silicate 28” (available from COLCOAT CO., LTD)

hemihydrate gypsum: product name “NP3D” (NORITAKE CO., LIMITED)

Disparlon A603-20X: amide thixotropic agent: product name “Disparlon A603-20X” (available from Kusumoto Chemicals, Ltd.)

Disparlon 4200-20: polyethylene oxide thixotropic agent: product name “Disparlon 4200-20” (available from Kusumoto Chemicals, Ltd.)

[0060]

The following tests were conducted on the coating compositions of Examples and Comparative Examples.

<Test Example 1 (Physical property test of coating film)>

A rotating drum with a diameter of 515 mm and a height of 440 mm was attached to the center of the water tank so that it could be rotated by a motor. Further, a cooling device for keeping the temperature of seawater constant and a pH automatic controller for keeping the pH of seawater constant were attached.

A test plate was prepared according to the following method.

First, a rust preventive coating (epoxy vinyl A/C) was applied on a titanium plate (71×100×0.5 mm) and dried to form a coating film so that the thickness of the film after drying is about 100 μm. Then, each of the coating compositions obtained in Examples and Comparative Examples was applied on the rust preventive coating film so that the thickness after drying was about 100 μm and 200 μm. Test plates were prepared by drying at 40°C for 3 days. Four identical test plates were prepared for each coating composition.

One of the prepared test plates was fixed to the rotary drum of the rotary device of the above device so that they came into contact with seawater, and the rotary drum was rotated at a speed of 20 knots. During the rotating, the temperature of seawater was kept at 25°C, the pH of seawater was kept at 8.0 to 8.2, and the seawater was replaced every two weeks.

After 3 months and 6 months of the rotary test, the test plates having a dried film thickness of about 100 μm and about 200 μm were dried, and the surface of each coating film was visually observed to evaluate the condition of the coating film. The evaluation was performed by the following method.

AA: No defects were observed.

A: Hairline cracks were observed in less than 10% of the total surface area of the coating film.

B: Hairline cracks were observed in 10 to 30% of the total surface area of the coating film.

C: Hairline cracks were observed in more than 30% of the total surface area of the coating film.

CC: Defects such as large cracks, blisters or peelings (only the surface or part of the edge of the coating film was peeled off), or peelings (the entire coating film was peeled off and no test coating film remained) were observed in the coating film.[0061]

<Test Example 2 (Adhesion test of coating film)>

The adhesion test of the coating film was conducted in accordance with JIS K-5600-5-6. Specifically, after 3 months and 6 months of the rotary test, the test plates having a dried film thickness of about 100 μm and about 200 μm were dried, and the coating film was cut into a grid pattern with six vertical and horizontal lines reaching the underlayer to form 25 squares with sides of 3 mm. A tape having a width of 24 mm (manufactured

by Nichiban Co., Ltd.) was attached to this grid pattern so that air bubbles did not enter, and the tape was rubbed firmly with the fingertips. The tape was peeled off at once by holding one end of the tape, and the condition of adhesion of the coating film was visually observed.

AA: There were 22 to 25 squares that did not peel off.

A: There were 16 to 21 squares that did not peel off.

B: There were 11 to 15 squares that did not peel off.

C: There were 0 to 10 squares that did not peel off.

[0062]

<Test Example 3 (Flexibility test of coating film)>

After 3 months and 6 months of the rotary test, the test plates having a dried film thickness of about 100 μm and about 200 μm were dried and bent at 90 degrees, and the condition of the coating film was visually observed.

AA: Almost none of cracking and peeling were observed.

A: Small cracks or peelings were observed.

B: Medium-sized cracks or peelings were observed.

C: Large cracks or peeling were observed.

[0063]

<Test results>

From the results of Test Examples 1 to 3, it was found that the crack resistance, the adhesion, and the flexibility of the coating film was improved.

We claim that:

1. An antifouling coating composition, comprising:

a polymer A;

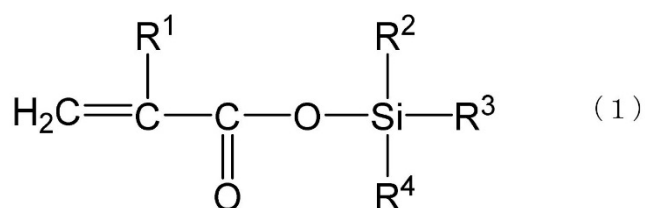
a component B; and

an antifouling agent; wherein:

the polymer A is a copolymer of a monomer (a) and an ethylenically unsaturated monomer (b) other than the monomer (a);

the monomer (a) is represented by general formula (1);

[Chem. 1]



in the general formula (1), R¹ is a hydrogen or methyl group, and R² to R⁴ are the same or different and each of R² to R⁴ represents a C3 to C8 branched alkyl group or a phenyl group; and

the component B is a paraffinic mineral oil including an aromatic hydrocarbon.