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(54) Titre : COMPOSITION DE REVETEMENT

(54) Title: COATING COMPOSITION

(57) **Abrégé/Abstract:**

There is disclosed a coating composition, capable of providing a molded plastic article with a coated film excellent in scratch resistance, surface hardness, flexibility, transparency, antistatic performance, heat resistance, moisture resistance, chemical resistance etc. and also capable of showing excellent performance such as pot life, each of use and ease of coating. The coating composition comprises an organic silicon compound represented by  $R_a^1 R_b^2 Si(OR^3)_{4-(a+b)}$  and a metal complex represented by  $M[CH_2N(CH_2COO)_2]_2Na_c$ .



1     ABSTRACT OF THE DISCLOSURE

          There is disclosed a coating composition,  
capable of providing a molded plastic article with  
a coated film excellent in scratch resistance,  
5     surface hardness, flexibility, transparency,  
antistatic performance, heat resistance, moisture  
resistance, chemical resistance etc. and also  
capable of showing excellent performance such as  
pot life, ease of use and ease of coating. The  
10    coating composition comprises an organic silicon  
compound represented by  $R_a^1 R_b^2 Si(OR^3)_{4-(a+b)}$  and  
a metal complex represented by  $M[CH_2N(CH_2COO)_2]_2Na_c$ .

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## Coating Composition

BACKGROUND OF THE INVENTIONField of the Invention

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The present invention relates to a coating composition for a molded plastic article, and more particularly a coating composition for protecting the molded plastic article.

Related Background Art

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Molded plastic articles are widely used, exploiting the advantages of light weight, ease of working, high impact strength etc. but are associated with drawbacks of insufficient hardness easily causing scratches, susceptibility to solvents, tendency of charging causing dust absorption and insufficient heat resistance, and have been inferior to molded inorganic glass articles for the use in spectacle lenses and window panes.

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For this reason it has been proposed to apply a protective coating to the molded plastic articles, and too many coating compositions have been proposed for this purpose.

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Such proposals include, for example, "a coating composition containing an organic silicon compound or a hydrolyzed product thereof as a principal component (resinous component or film forming component)" which is disclosed in the

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1 Japanese Patent Laid-Open Application No. 52-11261  
and which has expected to provide a hard coating  
similar to the inorganic coating. This composition  
is commercially utilized for spectacle lenses.

5 However, since this composition is still  
unsatisfactory in scratch resistance, there has been  
proposed, for example, a composition additionally  
containing colloidal silica sol, as disclosed in the  
Japanese Patent Laid-Open Application No. 53-111336,  
10 and this composition is also commercially used for  
the spectacle lenses.

However, such conventional coating  
compositions have been associated with a drawback of  
unsatisfactory performance of the coating film.

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#### SUMMARY OF THE INVENTION

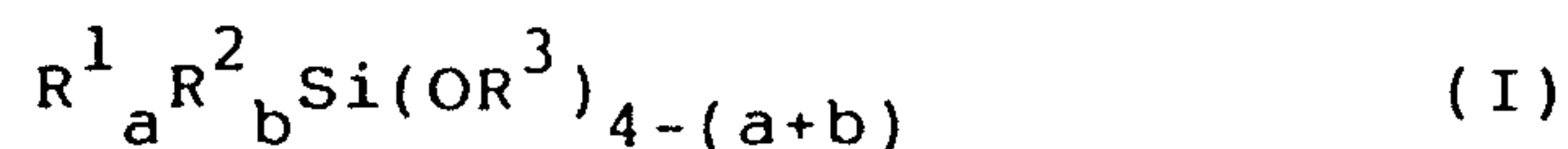
In consideration of the foregoing, the object  
of the present invention is to provide a coating  
composition, adapted for use on a molded plastic  
20 article, excellent in the performance of the coated  
film such as scratch resistance, surface hardness,  
abrasion resistance, flexibility, transparency,  
static resistance, heat resistance, moisture  
resistance, chemical resistance etc., and in the  
25 performance of the composition such as pot life, each  
of use, ease of coating etc.

The above-mentioned object can be attained,

- 3 -

according to the present invention, by a coating composition comprising:

(a) an organic silicon compound represented by a general formula:



wherein:

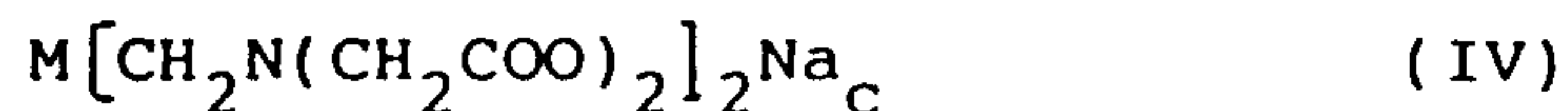
$R^1$  stands for a functional radical or an organic radical with 4 to 14 carbon atoms containing an unsaturated double bond;

$R^2$  stands for a hydrocarbon or halogenated hydrocarbon radical with 1 to 6 carbon atoms;

$R^3$  stands for an alkyl, alkoxyalkyl or acyl radical with 1 to 4 carbon atoms;

a is 0 or 1, b is 0, 1 or 2 and a+b is 1 or 2, or a hydrolyzed product thereof; and

(b) a metal complex represented by a general formula:



wherein:

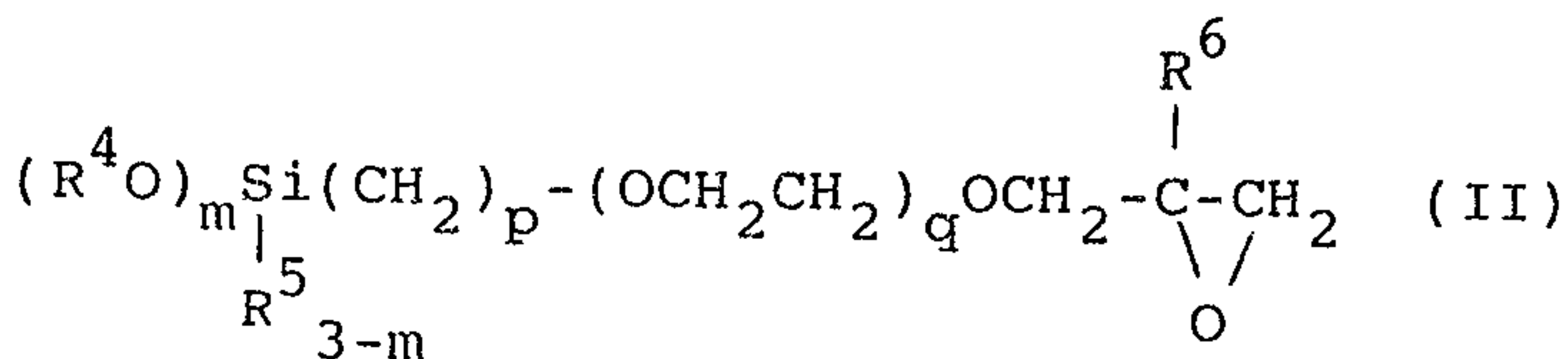
M stands for Zn, Mn, Mg, Fe, Cu, Co, Ca, Bi or Al; and

c is 0, 1 or 2.

#### Explanation of the component (a)

Among the compounds of the general formula (I), there are preferred those containing an epoxy radical as the functional radical represented by  $R^1$ , and there can be employed a compound represented,

1 for example, by the following general formula (II) or  
(III):



wherein:

$R^4$  stands for an alkyl, alkoxyalkyl or acyl radical with 1 to 4 carbon atoms;

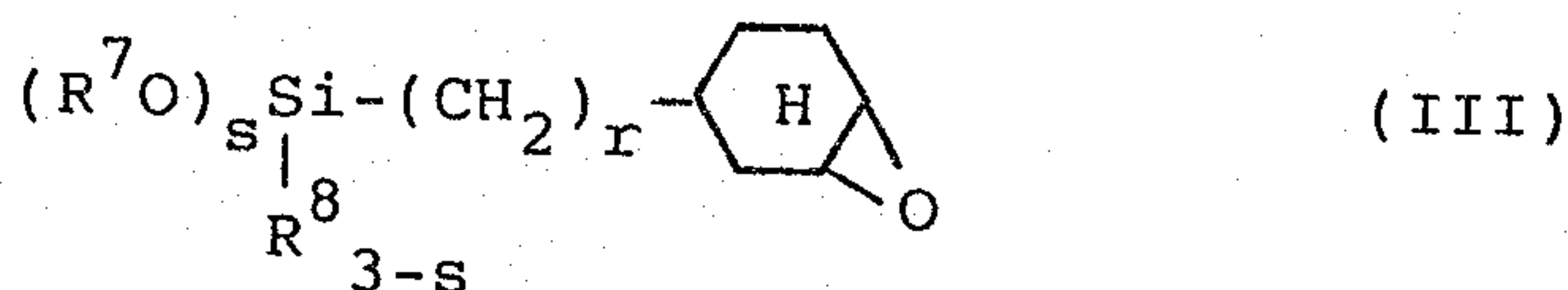
$R^5$  stands for a hydrocarbon or halogenated hydrocarbon radical with 1 to 6 carbon atoms;

$R^6$  stands for a hydrogen atom or a methyl radical;

m is 2 or 3;

p is an integer from 0 to 6; and

q is an integer from 0 to 2;



wherein:

$R^7$  stands for an alkyl, alkoxyalkyl or acyl radical with 1 to 4 carbon atoms;

$R^8$  stands for a hydrocarbon or halogenated hydrocarbon radical with 1 to 4 carbon atoms;

s is 2 or 3; and

r is an integer from 1 to 4.

The compounds represented by the foregoing general formulas, having an epoxy radical therein,

1 are called epoxysilane in general terms.

Examples of such epoxysilane include  $\gamma$ -glycidoxypropyltrimethoxysilane,  $\gamma$ -glycidoxypropyltriethoxysilane,  $\gamma$ -glycidoxypropyltrimethoxyethoxysilane,  $\gamma$ -glycidoxypropyltriacetoxysilane,  $\gamma$ -glycidoxypropylmethyldimethoxysilane,  $\gamma$ -glycidoxypropylmethyldiethoxysilane and  $\beta$ -(3,4-epoxycyclohexyl)ethyltriethoxysilane.

Also examples of the compounds of the general formula (I), other than those having an epoxy radical as the functional radical represented by  $R^1$  but including those in which  $a = 0$ , include methyltrialkoxysilanes, methyltriacyloxysilanes and vinyltrialkoxysilanes, such as methyltrimethoxysilane, methyltriethoxysilane, vinyltrimethoxysilane, vinyltriethoxysilane, vinyltriacetoxysilane, vinyltrimethoxyethoxysilane,  $\gamma$ -methacryloxypropyltrimethoxysilane, aminomethyltrimethoxysilane, 3-aminopropyltrimethoxysilane, 3-aminopropyltriethoxysilane, phenyltrimethoxysilane, phenyltriethoxysilane,  $\gamma$ -chloropropyltrimethoxysilane,  $\gamma$ -mercaptopropyltriethoxysilane, and 3,3,3-trifluoropropyltrimethoxysilane.

The above-cited examples of the compounds of the general formula (I) are all trifunctional having three  $OR^3$  combined to Si atom ( $a+b=1$ ), but corresponding bifunctional compounds having two  $OR^3$

1 radical ( $a+b=2$ ) can naturally be utilized also.  
Examples of such corresponding bifunctional compound  
include dimethyldimethoxysilane,  
diphenyldimethoxysilane, methylphenyldimethoxysilane,  
5 methylvinyl dimethoxysilane and dimethyldiethoxy-  
silane.

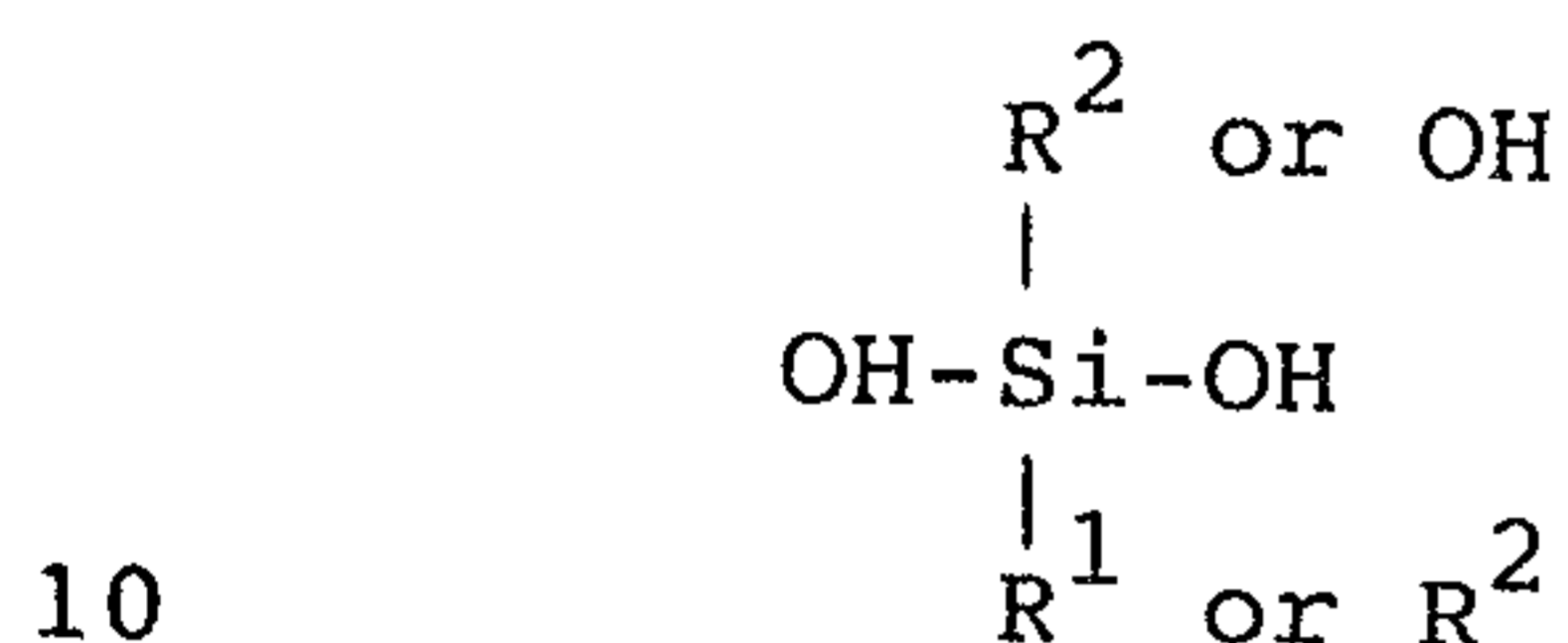
The compounds of the general formula (I) may  
be used singly, or as a mixture of at least two  
compounds according to the purpose.

10 In particular, when a bifunctional compound  
is employed, it is preferably employed in combination  
with a trifunctional compound. In such combined  
use, there is attained a relation  $2 > a + b > 1$  in  
average.

15 Furthermore, a corresponding tetrafunctional  
compound with  $a+b=0$  may also be used in combination.  
Examples of such corresponding tetrafunctional  
compound include methyl silicate, ethyl silicate,  
isopropyl silicate, n-propyl silicate, n-butyl  
20 silicate, i-butyl silicate and sec-butyl silicate.

The compound of the general formula (I) may  
be used in its original form, but is preferably used  
as the hydrolyzed product thereof, for the purpose  
of increasing the reaction rate and reducing the  
25 curing temperature. In case of combined use of at  
least two compounds with a same number of functional  
radicals among the bi- to tetra-functional compounds,

1 or in case of combined use of at least two compounds  
 with different numbers of functional radicals, such  
 compounds may be combined after respective  
 hydrolysis, or may be combined at first and then  
 5 hydrolyzed together. The hydrolysis liberates an  
 alcohol  $\text{HOR}^3$ , and the compound of the general formula  
 (I) is converted into a corresponding silanol:



Silanol shows rapid dehydrating condensation, thus  
 generating an oligomer. Consequently, the hydrolyzed  
 product may be let to stand for 1 to 24 hours after  
 hydrolysis, in order to encourage this reaction.

15 Explanation of the component (b)

The compound of the general formula (IV) has  
 a function of polymerizing the component (a), thereby  
 forming a coated film of a three-dimensional network  
 structure. Examples of said compound of the general  
 20 formula (IV) include iron ethylenediamine  
 tetraacetate (EDTA), aluminum EDTA, zinc EDTA,  
 manganese EDTA, magnesium EDTA, copper EDTA, cobalt  
 EDTA, calcium EDTA and bismuth EDTA.

25 The component (b) may be used not only singly  
 but also as a mixture of at least two compounds.

The composition of the present invention may  
 also contain sol (c) as will be explained later for

1 the purpose of increasing the hardness, and a solvent  
(d) as will be explained later for the purpose of  
improving the flowability at the coating and the  
smoothness of the cured film.

5 Explanation of the component (c)

There may be employed sol of inorganic  
particles such as of zinc oxide, silicon oxide,  
aluminum oxide, titanium oxide, zirconium oxide,  
tin oxide, beryllium oxide, antimony oxide, tungsten  
10 oxide, cellium oxide or tin oxide-tungsten oxide  
complex.

Such sols may be used singly, or as a mixture  
of at least two, if required.

In particular, titanium oxide, antimony  
15 oxide, tungsten oxide, cellium oxide, zirconium oxide  
or tin oxide can increase the refractive index of the  
composition, and the present invention provides a  
particularly excellent effect when such high  
refractive index component is employed.

20 The dispersion medium can be water or an  
organic solvent such as alcohol. The sol is  
preferably added with a stabilizer such as an organic  
amine.

The sol preferably has a particle size in a  
25 range of 1 - 200 nm, particularly 5 - 100 nm. A  
smaller particle size renders the manufacture  
difficult, also deteriorates the stability of the

1 sol itself and is not effective enough, while a  
larger particle size deteriorates the stability of  
the coating composition, and transparency and  
smoothness of the coated film.

5 Such sols are partly already known and partly  
available commercially.

There may also be employed modified sol in  
which tin oxide particles are coated with tin oxide-  
tungsten oxide complex sol.

10 Said modified sol is a colloidal dispersion,  
in a dispersion medium, of "double-structured colloid  
particles consisting of nuclei of (1) colloid  
particles of tin oxide (sol), surrounded perfectly  
or imperfectly by (2) colloid particles of tin oxide-  
15 tungsten oxide complex (sol)". The tin oxide colloid  
particles (1) constituting nuclei generally have a  
particle size of 4 to 50 nm. The surrounding complex  
colloid particles (2) generally have a particle size  
of 2 to 7 nm. The tin oxide particles (1)  
20 constituting nuclei are positively charged. For this  
reason, they show coagulation (gelation) if they are  
mixed with the component (a), of which molecule has  
a negative charge because of  $-\text{SiO}^-\text{H}^+$  structure.  
On the other hand, the complex particles (2) are  
25 negatively charged, and do not show such coagulation  
when mixed with the component (a).

The tin oxide-tungsten oxide complex sol is

1 generally prepared by adding aqueous solution of  
sodium stannate, under strong agitation at room  
temperature, to aqueous solution of tungstic acid,  
obtained by ion exchange of aqueous solution of  
5 sodium tungstate.

The weight ratio  $WO_3/SnO_2$  in the complex sol  
is generally with a range from 0.5 to 100. A ratio  
below 0.5 or above 100 provides a coated film of  
interior performance when the coating composition  
10 of the present invention is prepared and coated.

The modified sol can be prepared by adding,  
to aqueous sol of tin oxide (1) in an amount of 100  
parts by weight of  $SnO_2$ , aqueous sol of the complex  
(2) in an amount of 2 to 100 parts by combined weight  
15 of  $WO_3$  and  $SnO_2$  under strong agitation at room  
temperature. Also in this case, an amount below 2  
parts or above 100 parts provides a film of inferior  
performance when the coating composition of the  
present invention is prepared and coated. The  
20 double-structured colloid particles of the modified  
sol generally have a particle size of 4.5 to 60 nm.  
The mixing of the aqueous sol of the oxide (1) and  
the aqueous sol of the complex (2) is estimated to  
cause chemical bonding of the two, and the obtained  
25 modified sol is estimated to exist stably for this  
reason. Such modified sol itself is already known  
as disclosed in the Japanese Patent Laid-Open

1 Application No. 3-217230.

Explanation of the component (d)

5 The solvent (d) is employed when required, for maintaining the coating composition in liquid state or reducing the viscosity thereof, and can for example be water, a lower alcohol, acetone, an ether, a ketone or an ester.

10 In the coating composition of the present invention, per 100 parts by weight (solid) of the component (a), there is employed the component (b) in an amount of 10 to 400 parts by weight, preferably 50 to 250 parts by weight, and, per 100 parts by combined weight of the components (a) and (b), the component (c) is employed in an amount of 0.0001 to 15 20 parts by weight.

The component (d) is employed in a suitable amount, according to the viscosity of the composition.

20 In addition to the foregoing components (a) to (d), there may be employed, if required, various additive materials for the purpose for example of improving the adhesion to the substrate (molded article) or improving the weather resistance, or improving the stability of the coating composition.

25 Examples of such additive material include pH regulating agent, viscosity regulating material, levelling agent, matting agent, dye, pigment,

1 stabilizer, ultraviolet absorbing agent and  
antioxidant.

Furthermore, there may be employed in  
combination epoxy resin or other organic polymers  
5 for the purpose of improving the dyeability of the  
coated film. Examples of such epoxy resin include  
polyolefinic epoxy utilized for paints and for  
molding, alicyclic epoxy resin such as  
cyclopentadieneoxide, cyclohexeneoxide or  
10 polyglycidyl ester, polyglycidylether, epoxylated  
vegetable oil, epoxynovolac composed of novolac  
phenolic resin and epichlorhydrine, and glycidyl  
methacrylate-methylmethacrylate copolymer.

Examples of other organic polymers include  
15 polyol, cellulose resins, and melamine resin.

Furthermore, various surfactants may be  
employed in the coating composition, for the purpose  
of improving the flowability at coating and also  
improving the smoothness of the coated film thereby  
20 reducing the friction coefficient of the coated  
surface. For these purposes particularly effective  
is block or graft copolymers of dimethylsiloxane  
and alkyleneoxide, or a fluorinated surfactant.

Also in certain cases, there may be added  
25 inorganic filler such as silica sol, antimony oxide  
sol or fine diamond particles within an extent not  
contrary to the object of the present invention.

1           The composition of the present invention is  
coated particularly on a molded plastic article.  
In terms of the material constituting such molded  
article, the composition of the present invention  
5   may be coated, for example, on polymethyl  
methacrylate or a copolymer thereof, acrylonitrile-  
styrene copolymer, polycarbonate, cellulose acetate,  
polyvinyl chloride, polyethylene terephthalate,  
epoxy resin, unsaturated polyester resin,  
10   polyurethane resin, CR-39 polymer, or a plastic  
substrate obtained by polymerizing a monomer mixture  
containing at least a polyisocyanate and at least  
a polyol and/or at least a polythiol.

          In terms of the form of the molded article,  
15   the composition of the present invention may be  
coated on an ingot, a wire or a film.

          In terms of the function of the molded  
article, the composition of the present invention  
may be coated on optical products, particularly a  
20   lens for camera, a spectacle lens, a mirror or a  
prism.

          The composition of the present invention is  
particularly useful as an antiscratch film for  
spectacle lens molded with resin of a high refractive  
25   index at least equal to  $n_d = 1.53$ .

          In addition to the molded plastic articles,  
the composition of the present invention may be

1 coated on inorganic glass, timber or metallic  
articles.

Coating may be achieved by ordinary coating  
means such as brush coating, dipping, roller coating,  
5 spin coating, spray coating or flow coating.

It is furthermore possible to coat the  
composition of the present invention on a mold and  
to pour and polymerize the material for the substrate  
thereby forming the molded plastic article, or to  
10 coat the composition of the present invention on a  
molded article, then to bring the surface of the  
uncured coated film in contact with a mold and to  
cure said coated film.

The coating composition of the present  
15 invention is turned, after coating, into a hard  
coated film by a heating treatment in most cases.  
A heating temperature of ca. 50 to 200°C, preferably  
80 to 140°C is sufficient for this purpose.

The thickness of the coated film, after  
20 drying, is generally in a range of 0.3 to 30  $\mu\text{m}$ ,  
preferably 0.5 to 10  $\mu\text{m}$ .

The coated film is transparent and is  
excellent in hardness, particularly in the scratch  
resistance. Thus it can prevent the deterioration  
25 of appearance and lens performance resulting from the  
scratches which have been the inherent drawback of  
the molded plastic articles, and there can be

1     obtained molded articles of extremely high value of  
merchandise.

      In the following the present invention will  
be clarified in more details by embodiments thereof,  
5     but the present invention is by no means limited by  
such embodiments.

      As explained in the foregoing, the present  
invention provides a coating composition which has  
following features:

10           (1) The coated film is excellent in scratch  
resistance, surface hardness, abrasion resistance,  
flexibility, transparency, heat resistance, moisture  
resistance etc.;

          (2) The coated film is extendable and shows  
15     little crack formation on the film surface even when  
the substrate is bent;

          (3) The coated film shows little contraction  
by the curing, thus being capable of avoiding the  
curling trouble when coated on a thin film;

20           (4) The coated film is excellent in  
antistatic ability, thus being relatively free from  
smearing;

          (5) The coated film has a high surface  
reflectance;

25           (6) The coated film shows satisfactory  
adhesion to an antireflective film or an metallic  
vapor deposition film;

1           (7) The coated film shows satisfactory  
sliding characteristic (low friction coefficient);

          (8) The composition of the present invention  
has a shortened curing time;

5           (9) The composition of the present invention  
has a longer pot life;

          (10) The composition of the present  
invention is easy to coat; and

          (11) The composition of the present  
10 invention is easier for use.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

[Example 1]

(1) Preparation of preliminary composition A

15           170 parts by weight of  $\gamma$ -glycidoxypentyl-  
trimethoxysilane were charged in a reaction vessel  
provided with a rotor, and the interior of the  
vessel was maintained at 10°C. Under vigorous  
agitation with a magnetic stirrer, 40 parts by weight  
20 of 0.01 N aqueous solution of hydrochloric acid were  
dropwise added. The cooling was terminated  
immediately after the end of dropwise addition,  
whereby a hydrolyzed product corresponding to the  
component (a) was obtained as homogeneous,  
25 colorless and transparent solution.

          Thus obtained hydrolyzed product was  
subjected to the addition of 60 parts by weight of

1 2-propanol as the component (d), and the preliminary  
composition A was obtained by sufficient dissolving  
by mixing.

(2) Preparation of coating composition

5 The preliminary composition A prepared in (1)  
was charged in a glass container, and was subjected  
to the addition of 630 parts by weight (not solid  
content) of commercially available tin oxide-tungsten  
oxide complex sol (dispersed in methanol, average  
10 particle size 10 - 15 nm, tin oxide/tungsten oxide  
ratio = 100/40 parts by weight, solid content 20 %),  
4 parts by weight of aluminum ethylenediamine  
tetraacetate as the component (c) and 0.5 parts by  
weight of a silicone surfactant, followed by  
15 sufficient agitation, to obtain a coating composition  
in the form of homogeneous, colorless and transparent  
solution.

(3) Coating

The above-mentioned coating composition was  
20 coated by dipping (pull-up speed of 10 cm/min) on a  
commercially available polyurethane spectacle lens  
with a refractive index of  $n_d = 1.59$ , and was cured  
by heating for 2 hours at 100°C.

(4) Evaluation

25 The lens with the cured coated film obtained  
in (3) was subjected to the following tests, for  
evaluating the performance of the coated film:

1     (i) Scratch resistance test

Scratch resistance was tested by rubbing the film surface with steel wool #0000, and was evaluated as follows:

- 5           ++ no scratch even with strong rubbing;  
          + slight scratches by considerably strong rubbing;  
          - scratched even with weak rubbing.

10          The lens without the coated film was evaluated as (-).

(ii) Appearance

On the cured coated film obtained in (3), an ordinary antireflection coating was formed by vacuum vapor deposition method and evaluated as follows by  
15 visual observation of the reflected color:

- ++ no unevenness in the reflected color;  
          + some unevenness in the reflected color;  
          - significant unevenness in the reflected color.

20     (iii) Adhesion

The lens with cured coated film was immersed in hot water of 90°C for 2 hours. Then the coated film was cut with a knife with a pitch of 1 mm in vertical and horizontal directions to form checker  
25 board squares. Then a cellophane adhesive tape "Cellotape (trade name)" supplied by Nichiban Co., Ltd. was applied firmly, and then was rapidly peeled

1 off in a direction perpendicular to the coated film,  
and the number of the checker board squares in which  
the coated film was peeled off was counted. The  
number X of such peeled squares is represented as a  
5 ratio X/100. A smaller value of X indicates better  
adhesion.

The results of the foregoing evaluations are  
shown in Table 1.

[Example 2]

10 A coating composition was prepared and  
evaluated in the same manner as in the example 1,  
except that aluminum ethylenediamine tetraacetate  
was replaced by iron ethylenediamine tetraacetate.

[Reference example 1]

15 A coating composition was prepared and  
evaluated in the same manner as in the example 1,  
except that tin oxide-tungsten oxide complex sol was  
replaced by commercially available silica sol  
(dispersed in methanol, average particle size  $13 \pm 1$   
20 nm solid content 20 %).

[Reference example 2]

A coating composition was prepared and  
evaluated in the same manner as in the example 1,  
except that aluminum ethylenediamine tetraacetate was  
25 not added.

The results of the evaluations on these  
examples are also shown in Table 1.

1

Table 1

		Scrach resistance	Appearance	Adhesion
5	Example 1	++	++	0/100
	2	++	++	0/100
	Refer- ence Example 1	+	-	0/100
	2	+	++	0/100

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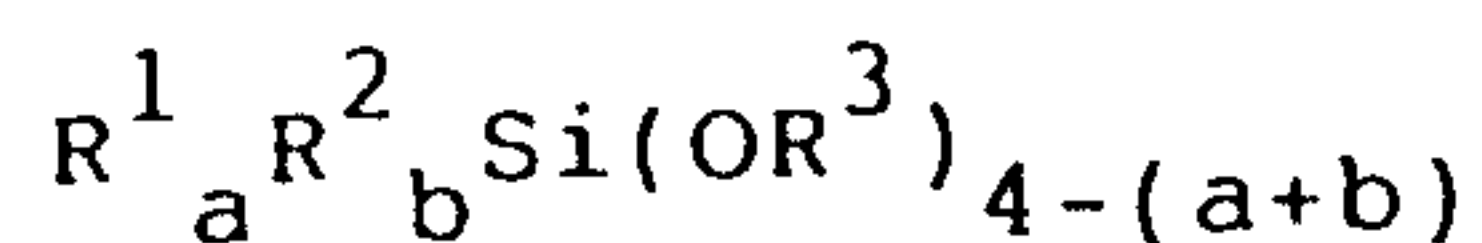
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WHAT IS CLAIMED IS:

1. A coating composition comprising:

(a) an organic silicon compound represented by a general formula:



wherein:

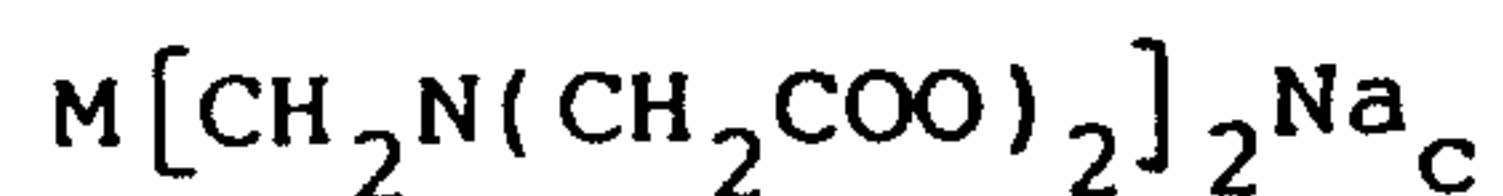
$R^1$  stands for a functional radical or an organic radical with 4 to 14 carbon atoms containing an unsaturated double bond;

$R^2$  stands for a hydrocarbon or halogenated hydrocarbon radical with 1 to 6 carbon atoms;

$R^3$  stands for an alkyl, alkoxyalkyl or acyl radical with 1 to 4 carbon atoms;

a is 0 or 1, b is 0, 1 or 2, and a+b is 1 or 2;

(b) a metal complex represented by a general formula:



wherein:

M stands for a metal selected from the group consisting of Zn, Mn, Mg, Fe, Cu, Co, Ca, Bi and Al, c is 0, 1 or 2 in an amount of 10 to 400 parts by weight per 100 parts by weight of component (a); and

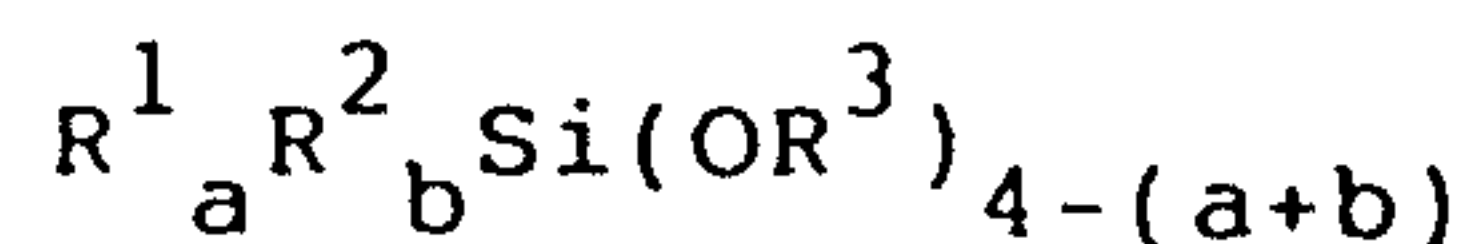
(c) an inorganic particle sol of at least one of titanium oxide, antimony

- 21a -

oxide, tungsten oxide, cellium oxide, zirconium oxide or tin oxide or modified double-structured colloid particles consisting of nuclei of colloid particles of tin oxide, surrounded by colloid particles of tin oxide-tungsten oxide complex, in an amount of 0.0001 to 20 parts by weight per 100 parts by weight of components (a) and (b) together.

2. A coating composition comprising:

- (a) a hydrolyzed product of an organic silicon compound represented by a general formula:



wherein:

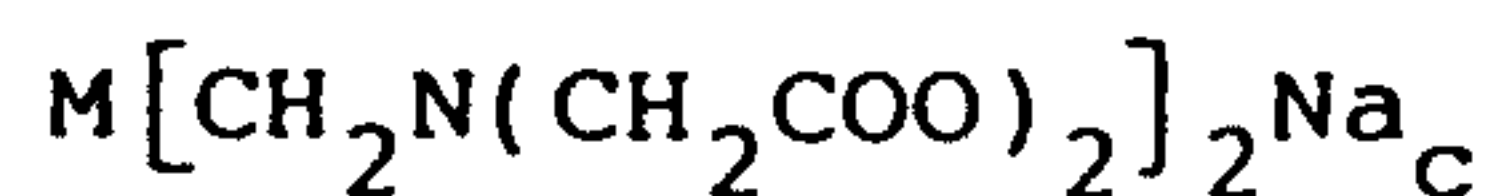
$R^1$  stands for a functional radical or an organic radical with 4 to 14 carbon atoms containing an unsaturated double bond;

$R^2$  stands for a hydrocarbon or halogenated hydrocarbon radical with 1 to 6 carbon atoms;

$R^3$  stands for an alkyl, alkoxyalkyl or acyl radical with 1 to 4 carbon atoms;

a is 0 or 1, b is 0, 1 or 2 and a+b is 1 or 2;

- (b) a metal complex represented by a general formula:



wherein:

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M stands for a metal selected from the group consisting of Zn, Mn, Mg, Fe, Cu, Co, Ca, Bi and Al, c is 0, 1 or 2 in an amount of 10 to 400 parts by weight per 100 parts by weight of component (a); and

(c) an inorganic particle sol of at least one of titanium oxide, antimony oxide, tungsten oxide, cellium oxide, zirconium oxide or tin oxide or

modified double-structured colloid particles

consisting of nuclei of colloid particles of

tin oxide, surrounded by colloid particles of tin

oxide-tungsten oxide complex, in an amount of 0.0001 to 20 parts by weight per 100 parts by weight of components (a) and (b) together.

3. A coating composition according to claim

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1, wherein c is 1 or 2.

4. A coating composition according to claim 2, wherein c is 1 or 2.

5. A coating composition according to claim 1, wherein  $R^1$  is a functional radical containing an epoxy radical.

6. A coating composition according to claim 2, wherein  $R^1$  is a functional radical containing an epoxy radical.

7. A coating composition according to claim 3, wherein  $R^1$  is a functional radical containing an epoxy radical.

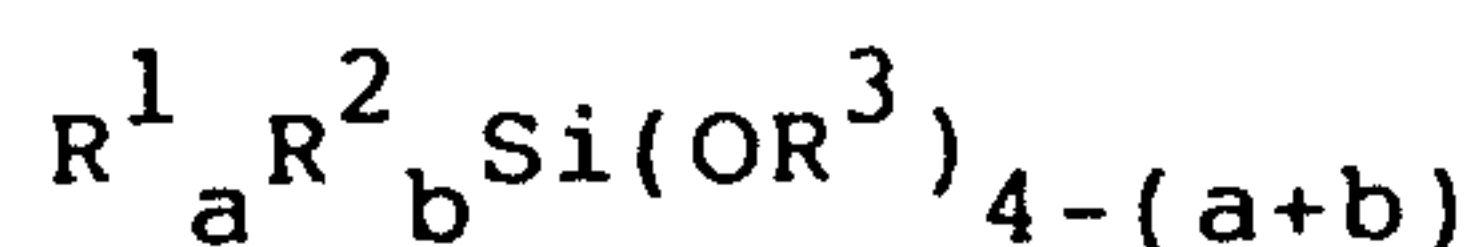
8. A coating composition according to claim 4, wherein  $R^1$  is a functional radical containing an epoxy radical.

9. A coating composition according to claim 3, wherein said inorganic particles sol has a particle size within a range from 1 to 200 nm.

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10. A coating composition according to claim 4, wherein said inorganic particle sol has a particle size within a range from 1 to 200 nm.

11. A coating composition comprising:  
an organic silicon compound represented by  
a general formula:



wherein:

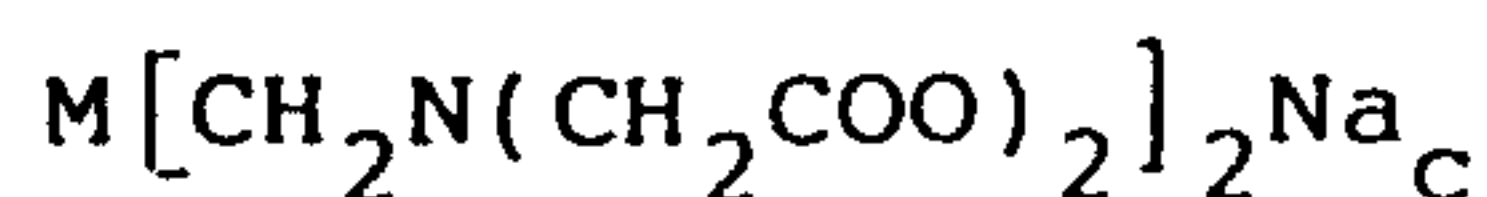
$R^1$  stands for a functional radical or an organic radical with 4 to 14 carbon atoms containing an unsaturated double bond;

$R^2$  stands for a hydrocarbon or halogenated hydrocarbon radical with 1 to 6 carbon atoms;

$R^3$  stands for an alkyl, alkoxyalkyl or acyl radical with 1 to 4 carbon atoms;

a is 0 or 1, b is 0, 1 or 2, and a+b is 1 or 2; and

a metal complex represented by a general formula:



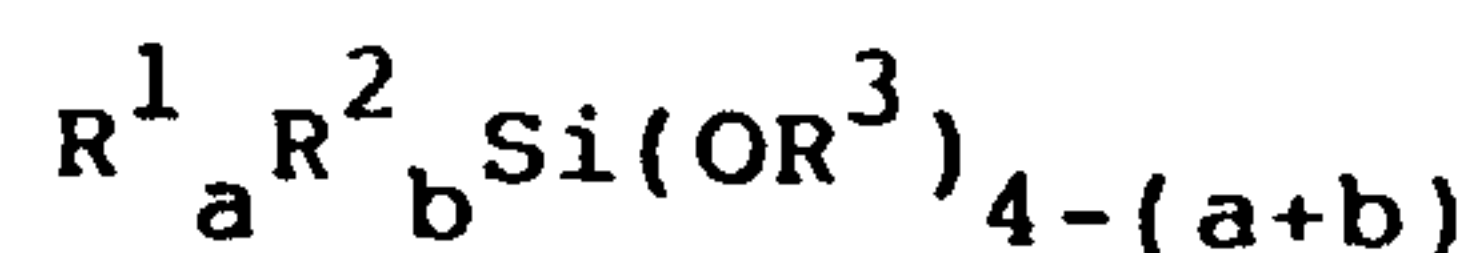
wherein:

M includes Zn, Mn, Mg, Cu, Co, Ca, Bi or Al and c is 1 or 2 in an amount of 10 to 400 parts by weight per 100 parts by weight of component (a).

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12. A coating composition comprising:

a hydrolyzed product of an organic silicon compound represented by a general formula:



wherein:

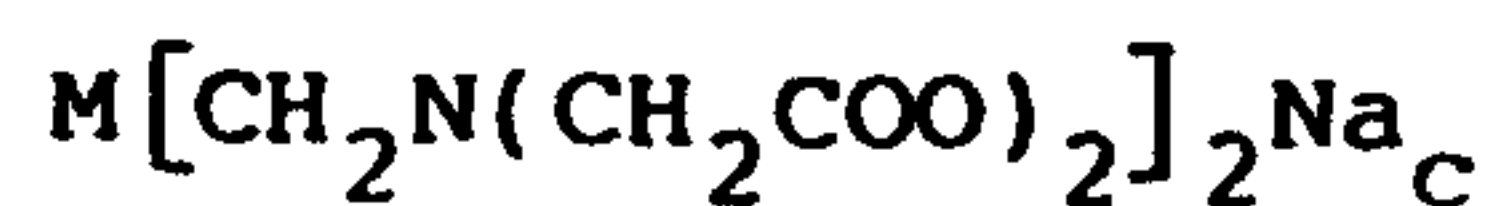
$R^1$  stands for a functional radical or an organic radical with 4 to 14 carbon atoms containing an unsaturated double bond;

$R^2$  stands for a hydrocarbon or halogenated hydrocarbon radical with 1 to 6 carbon atoms;

$R^3$  stands for an alkyl, alkoxyalkyl or acyl radical with 1 to 4 carbon atoms;

a is 0 or 1, b is 0, 1 or 2 and a+b is 1 or 2; and

a metal complex represented by a general formula:



wherein:

M includes Zn, Mn, Mg, Cu, Co, Ca, Bi or Al and c is 1 or 2 in an amount of 10 to 400 parts by weight per 100 parts by weight of component (a).

13. A coating composition according to claim 11, wherein  $R^1$  is a functional radical containing an epoxy radical.

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14. A coating composition according to claim 12, wherein R<sup>1</sup> is a functional radical containing an epoxy radical.

5 15. A coating composition according to claim 5, wherein said inorganic particle sol has a particle size within a range from 1 to 200 nm.

16. A coating composition according to claim 6, wherein said inorganic particle sol has a particle size within a range from 1 to 200 nm.