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(54) Title: SURFACE MODIFIER AND ITS USE

(57) Abstract: A surface modifier comprising an organosilicone compound represented by General Formula (A) and/or General Formula (B): $F-(CF_2)_q-(OC_3F_6)_m-(OC_2F_4)_n-(OCF_2)_o(CH_2)_pXX''Si(X')_{3-a}(R')_a$ (A) and $F-(CF_2)_q-(OC_3F_6)_m-(OC_2F_4)_n-(OCF_2)_o(CH_2)_pXX''(X')_{2-a}(R')_aSiO(F-(CF_2)_q-(OC_3F_6)_m-(OC_2F_4)_n-(OCF_2)_o(CH_2)_pXX''(X')_{1-a}(R')_aSiO)_zF-(CF_2)_q-(OC_3F_6)_m-(OC_2F_4)_n-(OCF_2)_o(CH_2)_pXX''(X')_{2-a}(R')_aSi$ (B) wherein q is an integer from 1 to 3; m, n, and o are independently integers from 0 to 200; p is 0, 1 or 2; X is oxygen or a bivalent organic spacer group; X' is a bivalent organosilicone spacer group; X'' is hydrolysable group; and z is an integer from 0 to 10 when a is 0 or 1.

DESCRIPTION

SURFACE MODIFIER AND ITS USE

5 [0001]

[Technical Field]

The present invention is directed to a surface modifier for use in forming a low surface tension layer or a dirt preventive layer on the surface of various substrates, and a method for forming a treated layer using the surface modifier. Moreover, the invention relates to optical members (e.g., antireflective films, optical filters, optical lenses, eyeglass lenses, beam splitters, prisms, mirrors, etc.) wherein the surface modifier is used; antireflective optical members applied to screen surfaces of displays (e.g., liquid crystal displays, CRT displays, projection TVs, plasma displays, EL displays, etc.); optically functional members; display devices in which such an optically functional member is adhered to a display screen surface; treated glasses; treated earthenwares; etc.

[0002]

[Prior Art]

Antireflection coatings, optical filters, optical lenses, spectacle lenses, beam splitters, prisms, mirrors and

other optical elements and sanitary wares are liable to be stained with fingerprints, skin oil, sweat, cosmetics, etc., when used. Once adhering, such stains are not easily removed, and in particular, stains adhering to
5 optical members with antireflection coatings are easily noticeable and pose problems. Further, windows of automobiles and airplanes are required to have durable water repellency.

[0003] To solve such problems relating to stains and
10 water repellency, techniques using various stain-proofing agents have hitherto been proposed.

[0004] For example, Japanese Unexamined Patent Publication No. 1997-61605 has proposed a stain-resistant antireflection filter obtained by surface-treating a
15 substrate with a perfluoroalkyl group-containing compound. Japanese Examined Patent Publication No. 1994-29332 has proposed a stain-resistant, low-reflection plastic that has, on its surface, an antireflection coating comprising polyfluoroalkyl group-containing, mono- and disilane
20 compounds and halogen-, alkyl- or alkoxy silane compound. Japanese Unexamined Patent Publication No. 1995-16940 has proposed an optical member obtained by forming a copolymer of perfluoroalkyl (meth)acrylate and alkoxy silane group-containing monomer on an optical thin
25 film mainly consisting of silicon dioxide.

[0005] However, the stain-resistant coatings formed by the hitherto known processes have insufficient stain resistance, and in particular, stains such as fingerprints, skin oil, sweat and cosmetics are difficult to be removed therefrom. Further, their stain resistance greatly reduces as they are used for a longer period. Therefore, development of a stain-resistant coating with excellent stain resistance and excellent durability is desired.

10 [0006] The present invention is to solve the problems of the prior art techniques described above and to provide a surface modifier that can form a superior, low-surface-tension treated layer of high durability that prevents moisture or dirt such as finger prints, skin oil, sweat, cosmetics and the like from adhering to the surface of various substrates, especially antireflective films and like optical members and glasses, and that allows dirt and moisture, once adhered, to be easily wiped off.

20 [0007] Another object of the present invention is to provide a method for producing a surface modifier that can form a superior low surface tension layer.

[0008] A further object of the present invention is to provide a method for readily forming a superior low surface tension layer.

25

[0009] Yet another object of the present invention is to provide optical members and various substrates furnished with the superior low surface tension layer.

[0010] Yet another object of the present invention is to provide antireflective optical members furnished with the superior low surface tension layer.

[0011] Yet another object of the present invention is to provide optically functional members furnished with the antireflective member.

10 [0012] Yet another object of the present invention is to provide display devices having a display screen surface furnished with the optically functional member.

[0013] Yet another object of the present invention is to provide the application of the compound of the invention to the field of microfabrication, e.g., nanoimprinting, which has seen significant technical development in recent years, thereby enabling precise mold releasing.

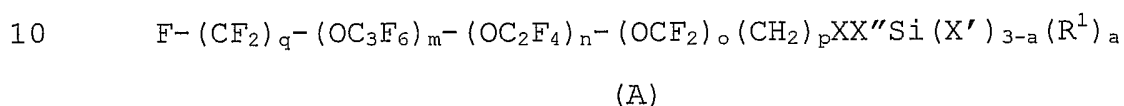
[0014] Yet another object of the present invention is to provide the application of the compound of the invention to device production to provide a material and a processing method that allow easy processing of lines having very small width due to the great repellency properties of the compound of the invention.

25 Yet another object of the present invention is to provide

the application of the compound of the invention to the treatment of stoneware such as concrete, limestone, granite or marble.

[0015] The present invention provides a dirt preventive agent comprising an organic silicone compound represented by General Formula (A) and/or a partial hydrolysis product, General Formula (B).

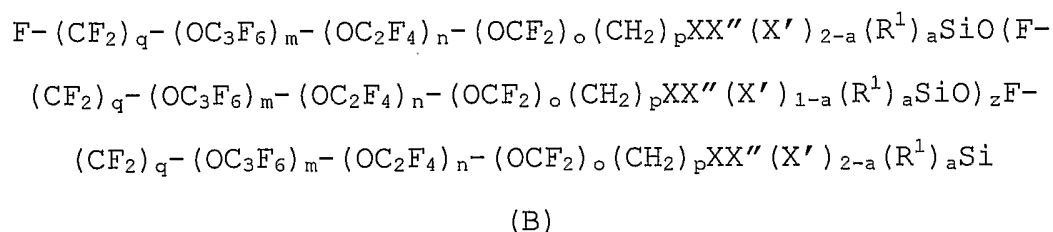
[0016]



[0017] In General Formula (A), q is an integer from 1 to 3; m, n, and o are independently integers from 0 to 200; p is 0, 1 or 2; X is oxygen or a bivalent organic spacer group; X'' is a bivalent organosilicone spacer group; R¹ is a C₁₋₂₂ linear or branched hydrocarbon group; a is an integer from 0 to 2; and X' is hydrolysable group.

[0018]

20



25

[0019] In General Formula (B), q is an integer from 1 to 3; m, n, and o are independently integers from 0 to 200; p is 0, 1 or 2; X is oxygen or a bivalent organic spacer group; X'' is a bivalent organosilicone spacer
5 group; X' is hydrolysable group and z is an integer from 0 to 10 with the proviso that a is 0 or 1.

[0020] Furthermore, the present invention provides a method for producing the aforementioned surface modifier.

[0021] The present invention provides a method for
10 creating a low surface tension using the surface modifier.

[0022] The present invention provides a surface of low surface tension obtained by using of the surface modifier.

[0023] The present invention provides an optical member furnished with a treated layer containing the
15 surface modifier.

[0024] The present invention provides an antireflective optical member furnished with a treated layer containing the surface modifier.

[0025] The present invention provides an optically
20 functional member containing the antireflective optical member.

[0026] The present invention provides a display device furnished with the optically functional member.

[0027] The present invention provides an inorganic
25 substrate, such as glass, having a surface furnished with

a treated layer containing the surface modifier.

[0028] The present invention provides an automobile and aeronautical glasses and sanitary wares having an inorganic substrate having the aforementioned surface.

5 [0029] The present invention provides an application of the surface modifier to precision mold releasing in nanoimprinting.

[0030] The present invention provides a method for readily producing a device having a microstructure using
10 the surface modifier.

[0031]

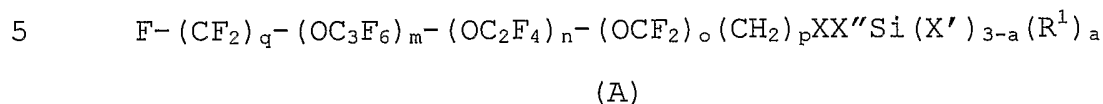
[Mode of Carrying out the Invention]

Since the surface modifier of the present invention contains a specific organic silicone compound, when a
15 treated layer is created on substrates, e.g., various optical members (antireflective films, optical filters, optical lenses, eyeglass lenses, beam splitters, prisms, mirrors, etc.), using the surface modifier, the adhesion of dirt, such as finger prints, skin oil, sweat,
20 cosmetics and the like, or moisture can be prevented without impairing the optical properties of the optical members, and dirt and moisture, once adhered, can be easily wiped off, thereby giving high durability to the treated layer.

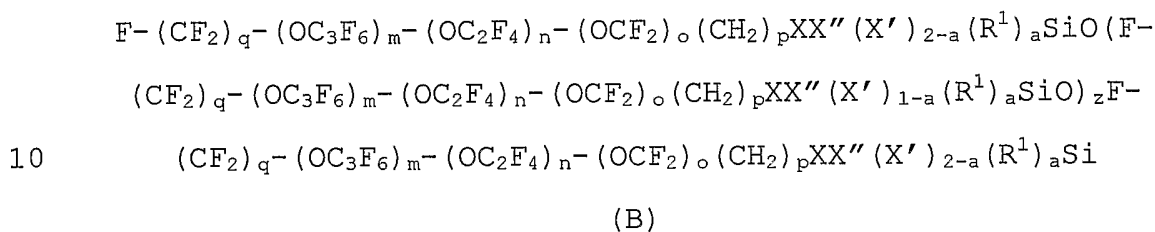
25 [0032] The dirt preventive agent of the present

invention contains an organic silicone compound represented by General Formula (A) and/or General Formula (B).

[0033]



[0034]



[0035] In General Formula (A), q is an integer from 1 to 3; m , n , and o are independently integers from 0 to 200; p is 0, 1 or 2; X is oxygen or a bivalent organic
15 spacer group; X'' is a bivalent organosilicone spacer group; R^1 is a C_{1-22} linear or branched hydrocarbon group; a is an integer from 0 to 2; and X' is hydrolysable group.

[0036] In General Formula (B), q is an integer from 1 to 3; m , n , and o are independently integers from 0 to
20 200; p is 0, 1 or 2; X and X'' are a spacer groups; X' is hydrolysable group and z is an integer from 0 to 10 with the proviso that a is 0 or 1.

Preferably, in General Formulas (A) and (B),
 X is an oxygen atom or a bivalent organic group such as
25 C_{1-22} linear or branched alkylene group;

R^1 is a C_{1-22} alkyl group, more preferably a C_{1-12} alkyl group;

X'' is a group having at least one siloxane group and at least one methylene group; and

5 X' is chlorine, an alkoxy ($-OR$) group or $-O-N=CR_2$ wherein R is a C_{1-22} linear or branched hydrocarbon group, particularly a linear or branched alkyl group.

[0037] The hydrolysable group, X' , of General Formula (A) or (B) are exemplified by groups of the following
10 formulas: alkoxy or alkoxy substituted alkoxy groups such as methoxy, ethoxy, propoxy and methoxyethoxy groups, acyloxy groups such as acetoxy, propionyloxy and benzoyloxy groups, alkenyloxy groups such as isopropenyloxy and isobutenyloxy groups, iminoxy groups
15 such as dimethyl ketoxime, methyl ethyl ketoxime, diethyl ketoxime, cyclohexanoxime groups, substituted amino groups such as methylamino, ethylamino, dimethylamino and diethylamino groups, amido groups such as N-methyl acetamido and N-ethylamido groups, substituted aminoxy
20 groups such as dimethyl aminoxy and diethyl aminoxy groups, halogen, such as chlorine and so on. Among such hydrolysable groups, $-OCH_3$, $-OC_2H_5$, and $-O-N=C(CH_3)_2$ are particularly preferable. The various X' groups can be exchanged as desired by equilibration, e.g. $\text{=Si(OMe)} +$
25 methyl ethyl ketoxime $\rightarrow \text{=Si(Ketoxime)} + \text{MeOH}$, or reaction,

e.g. $\text{=Si(OMe)} + \text{AcCl} \rightarrow \text{=SiCl} + \text{AcOMe}$. Such hydrolysable groups can be contained in the organic silicone compound of the dirt preventive agent of the present invention as one species or as a combination of two or more species.

5 [0038] The spacer groups, X and X'', of General Formula (A) or (B) are needed to facilitate the attachment of the hydrolysable silicon functionality, $\text{Si(X')}_{3-a}(\text{R}^1)_a$, by hydrosilation to the perfluoropolyether. X can be exemplified by groups of the following formulas: oxygen,
10 a bivalent organic groups such as amide, N-methyl amide, N-ethyl amide, ester, ether, in combination with X'', independently a bivalent organosilicone group such as $-\text{R}^3\text{Si(R}^2)_2(\text{OSi(R}^2)_2)_b\text{O}-$ or $-\text{R}^3\text{Si(R}^2)_2(\text{OSi(R}^2)_2)_b\text{R}^3-$ where R^2 can be independently a C_{1-22} linear or branched optionally
15 substituted alkyl, a C_{6-20} unsubstituted or substituted aryl, R^3 is independently a bivalent organic group such as a C_{1-22} linear or branched optionally substituted alkyl group and b is an integer from 1 to 100.

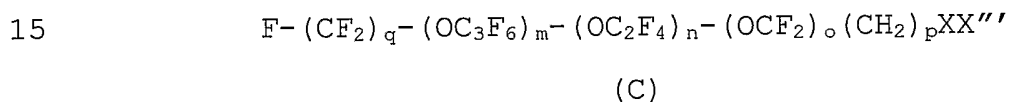
[0039] In General Formulas (A) and (B), the sum of m, n, and o is preferably 5 or greater, and particularly
20 preferably 10 or greater. X is preferably oxygen or amide, where X'' is preferably $-\text{CH}_2\text{CH}_2\text{CH}_2\text{Si(Me}_2)_2\text{OSi(Me}_2)_2\text{O}-$ or $-\text{CH}_2\text{CH}_2\text{CH}_2\text{Si(Me}_2)_2\text{OSi(Me}_2)_2\text{C}_2\text{H}_4-$. In General Formula (A), a is preferably 0.

25 [0040] Among the compounds represented by General

Formula (A), a particularly preferable compound, which is represented by General Formula (A) wherein X is oxygen, X'' is $-\text{CH}_2\text{CH}_2\text{CH}_2\text{Si}(\text{Me}_2)_2\text{OSi}(\text{Me}_2)_2\text{C}_2\text{H}_4-$, a is 0, and X' is $-\text{OCH}_3$, can be synthesized by a hydrosilylation reaction
 5 between $\text{HSi}(\text{Me}_2)_2\text{OSi}(\text{Me}_2)_2\text{C}_2\text{H}_4\text{Si}(\text{OMe})_3$ and a compound represented by General Formula (C) below in the presence of a transition metal.

[0041] The catalytic Group VIII transition metals usable in hydrosilylation are preferably Platinum or
 10 Rhodium. It is preferred to supply Platinum as chloroplatinic acid or as a Platinum complex with 1,3-divinyl-1,1,3,3-tetramethyldisiloxane or Rhodium as tris(triphenylphosphino) Rh^+Cl .

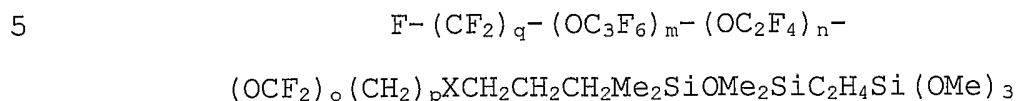
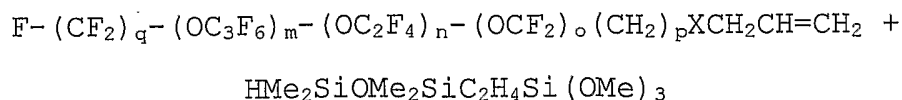
[0042]



In General Formula (C), q is an integer from 1 to 3; m, n, and o are independently integers from 0 to 200; p is 0, 1 or 2; X is oxygen, or a bivalent organic group and X''' is
 20 a monovalent organic group having terminal ethylenic unsaturation such as $-\text{CH}_2\text{CH}=\text{CH}_2$, $-(\text{CH}_2)_9\text{CH}=\text{CH}_2$, $-\text{CH}_2\text{CMe}=\text{CH}_2$ and so on. Upon hydrosilation X''' is a component of X''.

[0043] Specifically, a particularly preferable compound can be produced according to the following
 25 reaction scheme.

[0044]



[0045] In the reaction scheme above, q is an integer from 1 to 3; m , n , and o are independently integers from 0 to 200; p is 1 or 2; X is oxygen, or a bivalent organic group and X''' of structure $\text{CH}_2\text{CH}=\text{CH}_2$ is converted to a component of X'' of structure $-\text{CH}_2\text{CH}_2\text{CH}_2-$.

Other preferable compounds can be prepared by substituting $\text{HMe}_2\text{Si}(\text{OSiMe}_2)_3\text{OSi}(\text{OMe})_3$ or larger oligomers for $\text{HMe}_2\text{SiOMe}_2\text{SiC}_2\text{H}_4\text{Si}(\text{OMe})_3$ in the above reaction.

[0046] The hydrosilation reaction is proceeded by reacting for an appropriate time interval and temperature with an excess of silicon hydride to drive the reaction to completion. Various instrumental methods such as Nuclear Magnetic Resonance or Infrared spectroscopy can be used to monitor reaction progress. For example, preferred conditions are 30-90°C for 1-10 hours with 1.05-3 mol of HSi per mol of fluorine compound using 0.01-10 mmol of Pt supplied as a Platinum complex with 1,3-divinyl-1,1,3,3-tetramethyldisiloxane catalyst, i.e., a

group VIII transition metal. Any excess of silicon
hydride can be removed from the reaction product by
vacuum distillation if it has sufficient volatility. A
solvent can also be used for the hydrosilation reaction
5 to facilitate component compatibilization.

[0047] Among the fluorine compounds represented by
General Formula (C) given above, particularly preferable
are those represented by General Formula (C) wherein q is
3, m is 10 to 200, n is 1, o is 0, p is 1, X is oxygen or
10 bivalent organic group such as amide, N-substituted amide
or ester and X''' is $-\text{CH}_2\text{CH}=\text{CH}_2$.

[0048] Other compounds represented by General Formula
(A) can be similarly synthesized according to the
reaction scheme above.

15 [0049] Compounds represented by General Formula (B)
can be synthesized by a partial hydrolysis and
condensation reaction of compounds represented by General
Formula (A).

[0050] Organic silicone compounds represented by
20 General Formula (A) and/or (B) can be used alone or as a
combination of two or more species to form the surface
modifier of the present invention.

An optional catalyst can be used, if needed, to promote
surface modification by the organic silicone compounds
25 represented by General Formula (A) and/or (B). They can

be used alone or as a combination of two or more species to form the surface modifier of the present invention. Examples of suitable catalytic compounds include metal salts of organic acids such as dibutyl tin dioctoate, iron stearate, lead octoate and others, titanate esters such as tetraisopropyl titanate, tetrabutyl titanate, chelate compounds such as acetylacetonato titanium, aluminum, or zirconium and the like. It is preferred to use an amount of the optional catalyst in the range of 0 to 5 parts by weight, more preferably 0.01 to 2 parts by weight based on 100 parts by weight of the organic silicone compound represented by General Formula (A) and/or (B).

[0051] The organic silicone compound of General Formula (A) and/or (B) is an active component of the surface modifier. The surface modifier may consist of the organic silicone compound of General Formula (A) and/or (B). The surface modifier may comprise the organic silicone compound of General Formula (A) and/or (B) and a liquid medium such as an organic solvent. The concentration of the organic silicone compound in the surface modifier is preferably 0.01 to 80 % by weight based on the surface modifier.

The organic solvent may be various solvents which preferably dissolve the organic silicone compound

provided that the organic solvent does not react with components (particularly, the organic silicone compound) contained in the composition of the present invention. Examples of the organic solvent include a fluorine-
5 containing solvent such as a fluorine-containing alkane, a fluorine-containing haloalkane, a fluorine-containing aromatics and a fluorine-containing ether (for example, hydrofluoroether (HFE)).

[0052] The substrate to be treated with the surface
10 modifier of the invention to form a surface-treated layer is not particularly limited. Examples thereof include optical members comprising: inorganic substrates such as glass plates, glass plates comprising an inorganic layer, ceramics, and the like; and organic substrates such as
15 transparent plastic substrates and transparent plastic substrates comprising an inorganic layer; etc.

[0053] Examples of inorganic substrates include glass plates. Examples of inorganic compounds for forming glass plates comprising an inorganic layer include metal oxides
20 (silicon oxides (silicon dioxide, silicon monoxide, etc.), aluminum oxide, magnesium oxide, titanium oxide, tin oxide, zirconium oxide, sodium oxide, antimony oxide, indium oxide, bismuth oxide, yttrium oxide, cerium oxide, zinc oxide, ITO (indium tin oxide) and the like; and
25 metal halides (magnesium fluoride, calcium fluoride,

sodium fluoride, lanthanum fluoride, cerium fluoride, lithium fluoride, thorium fluoride, etc.).

[0054] The inorganic layer or inorganic substrate comprising such an inorganic compound may be single- or
5 multi-layered. The inorganic layer acts as an antireflective layer, and can be formed by known methods such as wet coating, PVD (Physical Vapor Deposition), CVD (Chemical Vapor Deposition), and like methods. Examples of wet coating methods include dip coating, spin coating,
10 flow coating, spray coating, roll coating, gravure coating, and like methods. Examples of PVD methods include vacuum evaporation, reactive deposition, ion beam assisted deposition, sputtering, ion plating, and like methods.

15 [0055] Among usable organic substrates, examples of transparent plastic substrates include substrates comprising various organic polymers. From the view point of transparency, refractive index, dispersibility and like optical properties, and various other properties
20 such as shock resistance, heat resistance and durability, substrates used as optical members usually comprise polyolefins (polyethylene, polypropylene, etc.), polyesters (polyethyleneterephthalate, polyethylenenaphthalate, etc.), polyamides (nylon 6,
25 nylon 66, etc.), polystyrene, polyvinyl chloride,

polyimides, polyvinyl alcohol, ethylene vinyl alcohol, acrylics, celluloses (triacetylcellulose, diacetylcellulose, cellophane, etc.), or copolymers of such organic polymers. These substrates can be mentioned
5 as examples of transparent plastic substrates to be treated in the invention.

[0056] Examples of usable materials include those prepared by adding known additives such as antistatic agents, UV absorbers, plasticizers, lubricants, coloring
10 agents, antioxidants, flame retardants, etc. to the organic polymers of these organic substrates.

[0057] It is also possible to use as the substrate of the invention a substrate prepared by forming an inorganic layer on an organic substrate. In this case,
15 the inorganic layer acts as an antireflective layer and can be formed on an organic substrate by methods as mentioned above.

[0058] The inorganic substrate or organic substrate to be treated is not particularly limited. Transparent
20 plastic substrates used as optical members are usually in the form of films or sheets. Such substrates in the form of films or sheets may also be used as the substrate of the invention. A substrate in the form of a film or sheet may be a monolayer or a laminate of a plurality of
25 organic polymers. The thickness is not particularly

limited but is preferably 0.01 to 5 mm.

[0059] The hard coat layer may be formed between the transparent plastic substrate and the inorganic layer.

The hard coat layer improves the hardness of the

5 substrate surface and also flattens and smoothens the surface of the substrate, thus improving the adhesion between the transparent plastic substrate and the inorganic layer. Therefore, scratching caused by pencils or like loads can be prevented. Moreover, the hard coat
10 layer can inhibit cracking in the inorganic layer caused by the bending of the transparent plastic substrate, thus improving the mechanical strength of the optical member.

[0060] The material of the hard coat layer is not particularly limited so long as it has transparency,

15 appropriate hardness, and mechanical strength. For example, thermosetting resins and resins cured by ionizing radiation or ultraviolet radiation are usable. UV-curing acrylic resins, organic silicon resins, and thermosetting polysiloxane resins are particularly
20 preferable. The refractive index of such resins is preferably equivalent to or close to that of the transparent plastic substrate.

[0061] The coating method for forming such a hard coat layer is not particularly limited. Any method capable of
25 achieving a uniform coating can be used. When the hard

coat layer has a thickness of 3 μm or more, sufficient strength can be imparted. A range of 5 to 7 μm is, however, preferable in view of transparency, coating accuracy, and ease of handling.

5 [0062] Furthermore, by mixing and dispersing inorganic or organic particles with a mean particle diameter of 0.01 to 3 μm in the hard coat layer, the optical diffusion treatment generally called "antiglare" can be performed. Although any transparent particles may be used
10 as such particles, low refractive index materials are preferable. Silicon oxides and magnesium fluoride are particularly preferable in terms of stability, heat resistance, etc. Optical diffusion treatment can also be achieved by providing the hard coat layer with an
15 indented surface.

[0063] Substrates as mentioned above can be used as the transparent substrate of the antireflective optical member of the invention. In particular, such substrates comprising an antireflective layer on the surface can be
20 transparent substrates comprising an antireflective layer. An antireflective optical member of the invention can be obtained by forming a dirt preventive layer on the surface of such a substrate.

[0064] In addition to such optical members, the
25 surface modifier of the invention can be applied to

window members for automobiles or airplanes, thus providing advanced functionality. To further improve surface hardness, it is also possible to perform surface modification by a so-called sol-gel process using a
5 combination of the surface modifier of the invention and TEOS (tetraethoxysilane).

[0065] By using the surface modifier of the invention as a mold release agent in a nanoimprinting process, precise mold release can be easily achieved. When the
10 surface is treated with the surface modifier of the invention, the modifier diffuses almost to the state of a monolayer, so that the resulting layer has a thickness of only several nanometers. In spite of such a thickness, it is possible to form a surface with a water contact angle
15 of 110° or more and a water drop angle of 5° or less as shown later in the Examples.

[0066] The surface modifier of the invention has excellent liquid repellency and thus can be applied to lithography and device formation.

20 [0067] Furthermore, by treating the surface of ceramic materials, it is also possible to produce easily maintained sanitary wares and exterior walls.

[0068] The method of forming a treated layer is not particularly limited. For example, wet coating methods
25 and dry coating methods can be used.

[0069] Examples of wet coating methods include dip coating, spin coating, flow coating, spray coating, roll coating, gravure coating, and like methods.

[0070] Examples of dry coating methods include vacuum
5 evaporation, sputtering, CVD, and like methods. Specific examples of vacuum evaporation methods include resistive heating, electron beam, high-frequency heating, ion beam and like methods. Examples of CVD methods include plasma-CVD, optical CVD, heat CVD, and like methods.

10 [0071] Moreover, coating by atmospheric pressure plasma methods is also possible.

[0072] When using wet coating methods, usable diluent solvents are not particularly limited. In view of stability and volatility of the composition, the
15 following compounds are preferable: perfluoroaliphatic hydrocarbons having 5 to 12 carbon atoms, such as perfluorohexane, perfluoromethylcyclohexane, and perfluoro-1,3-dimethylcyclohexane; polyfluorinated aromatic hydrocarbons such as
20 bis(trifluoromethyl)benzene; polyfluorinated aliphatic hydrocarbons, perfluorobutyl methyl ether and like HFEs, etc. Such a solvent can be used singly or as a mixture of two or more.

[0073] A wet coating method is preferably used for
25 substrates having complicated shapes and/or large areas.

[0074] On the other hand, in consideration of the work environment at the time of forming a dirt preventive layer, dry coating methods, which do not require diluent solvents, are preferable. Vacuum evaporation methods are particularly preferable.

[0075] After forming a dirt preventive layer on the substrate by a dry or wet coating method, if necessary, heating, humidification, photoirradiation, electron beam irradiation, etc. may be performed.

10 [0076] The thickness of the dirt preventive layer formed by using the dirt preventive agent of the invention is not particularly limited. A range of 1 to 10 nm is preferable in terms of dirt preventive properties, anti-scratching properties and optical performance of the optical member.

[0077]

[Examples]

The following Examples are intended to illustrate the present invention in detail, and not to limit the scope of the invention.

[0078]

Synthesis Example 1:

To a 250 mL 3 neck flask equipped with magnetic stir bar, reflux condenser, temperature control and dry nitrogen headspace purge was added 61.17 g of

(F₃CCF₂CF₂(OCF₂CF₂CF₂)₁₁OCF₂CF₂CH₂OCH₂CH=CH₂), 48.88g of 1,3-bis(trifluoromethyl)benzene and 7.46g of a 2:1 mixture of HMe₂SiOMe₂SiCH₂CH₂Si(OMe)₃ and HMe₂SiOMe₂SiCHMeSi(OMe)₃. The contents were heated to 80°C before the dropwise addition
5 over 5 hours of 0.016 g of Pt metal complexed with 1,3-divinyl-1,1,3,3-tetramethyldisiloxane, dissolved in 3g of 1,3-bis(trifluoromethyl)benzene. The contents maintained at 80°C for an additional 12 hours to make a 2:1 mixture of
10 F₃CCF₂CF₂(OCF₂CF₂CF₂)₁₁OCF₂CF₂CH₂OCH₂CH₂CH₂Me₂SiOMe₂SiC₂H₄Si(OMe)₃. The residual silane and solvent was vacuum stripped from the reaction mixture before addition of 1g of activated carbon. The product was filtered through a bed of Celite filter aid on a 0.5 micron membrane. Analysis
15 by infrared and nuclear magnetic resonance spectroscopy showed the complete disappearance of CH₂=CHCH₂O and HSi functionalities.

[0079]

Synthesis Examples 2-7:

20 By the same method described in Synthesis Example 1, the following compound was synthesized.

Synthesized Compound 2;

F₃CCF₂CF₂(OCF₂CF₂CF₂)₁₁OCF₂CF₂CH₂OCH₂CH₂CH₂Me₂SiOMe₂SiC₂H₄Si(OMe)₃

25 Synthesized Compound 3;

$\text{F}_3\text{CCF}_2\text{CF}_2(\text{OCF}_2\text{CF}_2\text{CF}_2)_{11}\text{OCF}_2\text{CF}_2\text{CONHCH}_2\text{CH}_2\text{CH}_2\text{Me}_2\text{SiOMe}_2\text{SiC}_2\text{H}_4\text{Si}(\text{OMe})_3$

Synthesized Compound 4;

$\text{F}_3\text{CCF}_2\text{CF}_2\text{O}[\text{CF}(\text{CF}_3)\text{CF}_2\text{O}]_3\text{CF}(\text{CF}_3)\text{CH}_2\text{OCH}_2\text{CH}_2\text{CH}_2\text{Me}_2\text{SiOMe}_2\text{SiC}_2\text{H}_4\text{Si}(\text{OMe})_3$

Synthesized Compound 5;

$\text{F}_3\text{CCF}_2\text{CF}_2\text{O}[\text{CF}(\text{CF}_3)\text{CF}_2\text{O}]_3\text{CF}(\text{CF}_3)\text{CONHCH}_2\text{CH}_2\text{CH}_2\text{Me}_2\text{SiOMe}_2\text{SiC}_2\text{H}_4\text{Si}(\text{OMe})_3$

Synthesized Compound 6;

$\text{F}_3\text{CCF}_2\text{CF}_2\text{O}[\text{CF}(\text{CF}_3)\text{CF}_2\text{O}]_4\text{CF}(\text{CF}_3)\text{CH}_2\text{OCH}_2\text{CH}_2\text{CH}_2\text{Me}_2\text{SiOMe}_2\text{SiC}_2\text{H}_4\text{Si}(\text{OMe})_3$

Synthesized Compound 7;

$\text{F}_3\text{CCF}_2\text{CF}_2\text{O}[\text{CF}(\text{CF}_3)\text{CF}_2\text{O}]_5\text{CF}(\text{CF}_3)\text{CH}_2\text{OCH}_2\text{CH}_2\text{CH}_2\text{Me}_2\text{SiOMe}_2\text{SiC}_2\text{H}_4\text{Si}(\text{OMe})_3$

[0080]

Comparative Compound a

Optool DSX (produced by Daikin Industries, Ltd.) was purchased, which is called Comparative Compound a.

[0081]

Example 1

Pretreatment of silicon wafer substrates:

Silicon wafers (2 cm x 4 cm x 0.7 mm) were ultrasonically treated in acetone at 25°C for 10 minutes, and washed in sulfuric acid/30 mass% hydrogen peroxide solution = 70/30

(V/V) at 100°C for 1 hour. The wafers were then washed

with methanol and ethanol in that order, and dried under reduced pressure at room temperature. Further, UV/ozonization treatment was performed at 70 Pa for 10 minutes, thereby confirming that the water contact angle
5 was 0°C.

[0082]

Wet coating with surface modifier:

Each of the Synthesized Compounds and Comparative Compound a was diluted with HFE-7200 (manufactured by 3M)
10 to concentrations of 0.05 mass%, 0.10 mass% and 0.50 mass%. The silicon wafers pretreated as above were dipped in the diluted compounds at 25°C for 30 minutes, and dried at 25°C for 24 hours. The wafers were then ultrasonically cleaned in HFE-7200 at 25°C for 10 minutes,
15 and dried under reduced pressure at 25°C for 1 hour.

[0083]

Measurement of contact angle and sliding angle:

The water contact angle and water sliding angle of the treated samples were measured with Model CA-X: Kyowa
20 Interface Science Co., Ltd. The measurement was carried out using droplets of 20 µl of distilled water under the conditions of 20°C and 65% RH.

[0084]

Fingerprint adherence:

25 The finger was pressed onto the surface of the treated

samples to make a fingerprint adhere, and the adherence and noticeability of the fingerprint was visually evaluated according to the following criteria.

[0085]

- 5 A: Fingerprint adhered only slightly and, even if it adhered, was not easily noticeable.

B: Adhesion of fingerprint is noticeable.

[0086]

Ease of removing fingerprint by wiping:

- 10 The fingerprint adhering to the sample surface was wiped with nonwoven cellulose fabric (Bemcot M-3, manufactured by Asahi Chemical Co., Ltd.) to visually evaluate the removability of the fingerprint according to the following criteria.

15 [0087]

A: Fingerprint can be completely wiped off.

B: Trace of fingerprint remains after wiping.

C: Fingerprint cannot be wiped off.

[0088]

- 20 Abrasion resistance: The sample surface was rubbed 100 times with unwoven cellulose fabric (Bencot M-3, manufactured by Asahi Chemical Co., Ltd.) at a load of 500 gf, and subjected to the above tests.

[0089]

[Table 1]

	Synthesized Compound 1			Comparative Example a		
	0.05 mass%	0.10 mass%	0.50 mass%	0.05 mass%	0.10 mass%	0.50 mass%
Contact angle	115 (114)	116 (116)	120 (118)	114 (112)	115 (113)	120 (119)
Sliding angle	3 (3)	3 (3)	3 (3)	40 (45)	39 (41)	22 (25)
Fingerprint adherence	A (A)	A (A)	A (A)	A (A)	A (A)	A (A)
Ease of removing fingerprint	A (A)	A (A)	A (A)	A (B)	A (B)	A (A)

[0090] In Table 1, the parenthesized values are those of the abrasion resistance tests.

5 [0091] Table 1 reveals that the treated layer formed using the surface modifier of the present invention has a water contact angle similar to that of the treated layer of Comparative Example, but has a much smaller water sliding angle, and thus is difficult to wet with water
10 and enables fingerprints to be wiped off easily. The table also shows that these excellent properties are durable.

[0092]

Example 2

15 In the same manner as in Example 1, various properties of Synthesized Compounds 2-7 were measured. The results are shown in Tables 2-4.

[0093]

[Table 2]

	Synthesized Compound <u>2</u>			Synthesized Compound <u>3</u>		
	0.05 mass%	0.10 mass%	0.50 mass%	0.05 mass%	0.10 mass%	0.50 mass%
Contact angle	114 (113)	116 (116)	119 (117)	115 (114)	116 (115)	118 (116)
Sliding angle	4 (4)	3 (4)	3 (3)	4 (5)	3 (4)	3 (3)
Fingerprint adherence	A (A)	A (A)	A (A)	A (A)	A (A)	A (A)
Ease of removing fingerprint	A (A)	A (A)	A (A)	A (A)	A (A)	A (A)

5 [0094]

[Table 3]

	Synthesized Compound <u>4</u>			Synthesized Compound <u>5</u>		
	0.05 mass%	0.10 mass%	0.50 mass%	0.05 mass%	0.10 mass%	0.50 mass%
Contact angle	112 (111)	114 (113)	115 (113)	113 (110)	114 (113)	116 (114)
Sliding angle	4 (5)	4 (4)	3 (4)	4 (5)	3 (4)	3 (4)
Fingerprint adherence	A (A)	A (A)	A (A)	A (A)	A (A)	A (A)
Ease of removing fingerprint	A (A)	A (A)	A (A)	A (A)	A (A)	A (A)

[0095]

[Table 4]

	Synthesized Compound <u>6</u>			Synthesized Compound <u>7</u>		
	0.05 mass%	0.10 mass%	0.50 mass%	0.05 mass%	0.10 mass%	0.50 mass%
Contact angle	115 (114)	116 (115)	118 (117)	115 (114)	115 (114)	117 (115)
Sliding angle	4 (5)	4 (4)	4 (3)	4 (4)	3 (4)	3 (3)
Fingerprint adherence	A (A)	A (A)	A (A)	A (A)	A (A)	A (A)
Ease of removing fingerprint	A (A)	A (A)	A (A)	A (A)	A (A)	A (A)

[0096] Table 2, Table 3 and Table 4 show the same
 5 results as described in Table 1.

[0097]

[Effects of the Invention]

The treated layer formed on a substrate surface using the
 surface modifier of the present invention has a much
 10 smaller sliding angle than the treated layer formed using
 a hitherto known treatment agent, and thus is more
 resistant to stains such as fingerprints, skin oil, sweat
 and cosmetics. Further, even if such stains adhere to the
 treated layer of the surface modifier of the invention,
 15 they are readily wiped off. Furthermore, such properties

are stably exhibited.

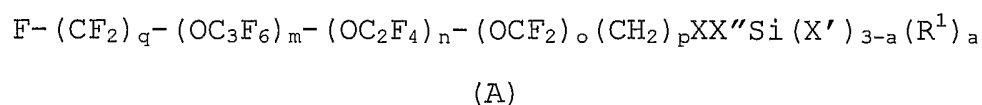
[0098] Moreover, the optically functional member obtained by bonding the optical element or antireflection optical member of the present invention to an optical
5 functional member, such as a deflection plate, has a treated layer with the above-mentioned excellent functionality and high durability formed on its surface, and therefore provides the display device with high image recognition of the present invention, when bonded to, for
10 example, the front panel of the display screen of various displays (liquid crystal displays, CRT displays, projection displays, plasma displays, EL displays, etc.).

[0099] Furthermore, the treated layer formed on a substrate surface using the surface modifier of the
15 present invention is extremely thin and thus has highly precise processability and excellent micromachining properties.

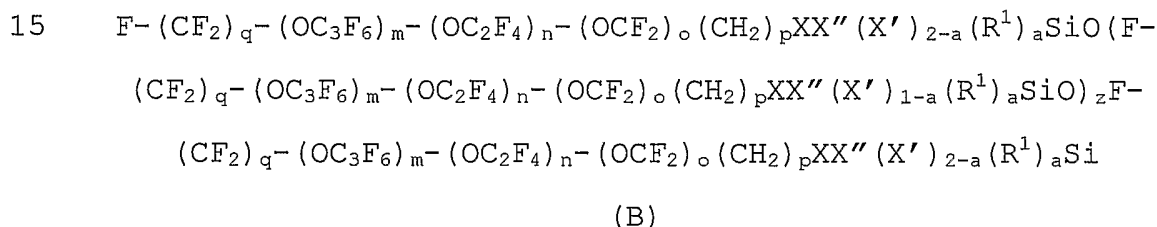
CLAIMS

[Claim 1] A surface modifier comprising an organosilicone compound represented by General Formula (A) and/or

5 General Formula (B):



wherein q is an integer from 1 to 3; m, n, and o are independently integers from 0 to 200; p is 0, 1 or 2; X
 10 is oxygen or a bivalent organic spacer group; X'' is a bivalent organosilicone spacer group; R¹ is a C₁₋₂₂ linear or branched hydrocarbon group; a is an integer from 0 to 2; and X' is hydrolysable group; and



wherein q is an integer from 1 to 3; m, n, and o are
 20 independently integers from 0 to 200; p is 0, 1 or 2; X is oxygen or a bivalent organic spacer group; X'' is a bivalent organosilicone spacer group; X' is hydrolysable group; and z is an integer from 0 to 10 when a is 0 or 1.

25 [Claim 2] The surface modifier according to Claim 1,

wherein in General Formula (A) and/or General Formula (B),
q is 3, m is an integer from 10 to 200, n is 1, o is 0, p
is 1, X is O, X'' is a bivalent organosilicone group, and
a is 0 or 1.

5

[Claim 3] The surface modifier according to Claim 1,
wherein in General Formula (A) and/or General Formula (B),
q is 3, m is an integer from 10 to 200, n is 1, o is 0, p
is 1, X is oxygen, X'' is $-R^3Si(R^2)_2(O(R^2)_2Si)_bR^3-$ where R^2
10 is independently C_1 to C_{22} hydrocarbon group, R^3 is
independently a bivalent organic group, b is 1-100, and a
is 0 or 1.

[Claim 4] The surface modifier according to Claim 1,
15 wherein in General Formula (A) and/or General Formula (B),
q is 3, m is an integer from 10 to 200, n is 1, o is 0, p
is 1, X is oxygen, X' is alkoxy, X'' is -
 $R^3Si(R^2)_2(O(R^2)_2Si)_bR^3-$ where R^2 is independently C_1 to C_{22}
hydrocarbon group, R^3 is independently a bivalent organic
20 group, b is 1-100, and a is 0 or 1.

[Claim 5] The surface modifier according to Claim 1,
wherein in General Formula (A) and/or General Formula (B),
q is 3, m is an integer from 10 to 200, n is 1, o is 0, p
25 is 0, X is oxygen, X'' is $-R^3Si(R^2)_2(O(R^2)_2Si)_bO-$ where R^2

is independently C_1 to C_{22} hydrocarbon group, R^3 is a bivalent organic group, b is 1-100, and a is 0 or 1.

[Claim 6] The surface modifier according to Claim 1,
5 wherein in General Formula (A) and/or General Formula (B),
 q is 3, m is an integer from 10 to 200, n is 1, o is 0, p
is 0, X is oxygen, X' is alkoxy, X'' is -
 $R^3Si(R^2)_2(O(R^2)_2Si)_bO-$ where R^2 is independently C_1 to C_{22}
hydrocarbon group, R^3 is a bivalent organic group, b is 1-
10 100, and a is 0 or 1.

[Claim 7] The surface modifier according to Claim 1,
wherein in General Formula (A) and/or General Formula (B),
 q is 3, m is an integer from 10 to 200, n is 1, o is 0, p
15 is 0, X is amide or N-substituted amide, X'' is -a
bivalent organosilicone group, and a is 0 or 1.

[Claim 8] The surface modifier according to Claim 1,
wherein in General Formula (A) and/or General Formula (B),
20 q is 3, m is an integer from 10 to 200, n is 1, o is 0, p
is 0, X is amide or N-substituted amide, X'' is -
 $R^3Si(R^2)_2(O(R^2)_2Si)_bR^3-$ where R^2 is independently C_1 to C_{22}
hydrocarbon group, R^3 is a bivalent organic group, b is 1-
100, and a is 0 or 1.

[Claim 9] The surface modifier according to Claim 1,
wherein in General Formula (A) and/or General Formula (B),
q is 3, m is an integer from 10 to 200, n is 1, o is 0, p
is 0, X is amide or N-substituted amide, X' is alkoxy, X"
5 is $-R^3Si(R^2)_2(O(R^2)_2Si)_bR^3-$ where R^2 is independently C_1 to
 C_{22} hydrocarbon group, R^3 is a bivalent organic group, b is
1-100, and a is 0 or 1.

[Claim 10] The surface modifier according to Claim 1,
10 wherein in General Formula (A) and/or General Formula (B),
q is 3, m is an integer from 10 to 200, n is 1, o is 0, p
is 0, X is amide or N-substituted amide, X" is $-$
 $R^3Si(R^2)_2(O(R^2)_2Si)_bO-$ where R^2 is independently C_1 to C_{22}
hydrocarbon group, R^3 is a bivalent organic group, b is 1-
15 100, and a is 0 or 1.

[Claim 11] The surface modifier according to Claim 1,
wherein in General Formula (A) and/or General Formula (B),
q is 3, m is an integer from 10 to 200, n is 1, o is 0, p
20 is 0, X is amide or N-substituted amide, X' is alkoxy, X"
is $-R^3Si(R^2)_2(O(R^2)Si)_bO-$ where R^2 is independently C_1 to
 C_{22} hydrocarbon group, R^3 is a bivalent organic group, b is
1-100, and a is 0 or 1.

25 [Claim 12] The surface modifier according to Claim 1,

wherein in General Formula (A) and/or General Formula (B),
q is 3, m is an integer from 10 to 200, n is 1, o is 0, p
is 0, X is an ester, X'' is -a bivalent organosilicone
group, and a is 0 or 1.

5

[Claim 13] The surface modifier according to Claim 1,
wherein in General Formula (A) and/or General Formula (B),
q is 3, m is an integer from 10 to 200, n is 1, o is 0, p
is 0, X is an ester, X'' is $-R^3Si(R^2)_2(O(R^2)_2Si)_bR^3-$ where
10 R^2 is independently C_1 to C_{22} hydrocarbon group, R^3 is a
bivalent organic group, b is 1-100, and a is 0 or 1.

[Claim 14] The surface modifier according to Claim 1,
wherein in General Formula (A) and/or General Formula (B),
15 q is 3, m is an integer from 10 to 200, n is 1, o is 0, p
is 0, X is an ester, X' is alkoxy, X'' is -
 $R^3Si(R^2)_2(O(R^2)_2Si)_bR^3-$ where R^2 is independently C_1 to C_{22}
hydrocarbon group, R^3 is a bivalent organic group, b is 1-
100, and a is 0 or 1.

20

[Claim 15] The surface modifier according to Claim 1,
wherein in General Formula (A) and/or General Formula (B),
q is 3, m is an integer from 10 to 200, n is 1, o is 0, p
is 0, X is an ester, X'' is $-R^3Si(R^2)_2(O(R^2)_2Si)_bO-$ where R^2 ,
25 is independently C_1 to C_{22} hydrocarbon group, R^3 is a

bivalent organic group, b is 1-100, and a is 0 or 1.

[Claim 16] The surface modifier according to Claim 1,
wherein in General Formula (A) and/or General Formula (B),
5 q is 3, m is an integer from 10 to 200, n is 1, o is 0, p
is 0, X is an ester, X' is alkoxy, X'' is -
 $R^3Si(R^2)_2(O(R^2)_2Si)_bO-$ where R^2 is independently C_1 to C_{22}
hydrocarbon group, R^3 is a bivalent organic group, b is 1-
100, and a is 0 or 1.

10

[Claim 17] The surface modifier according to Claim 1,
wherein the proportion of compound represented by General
Formula (A) and/or General Formula (B) is not limited.

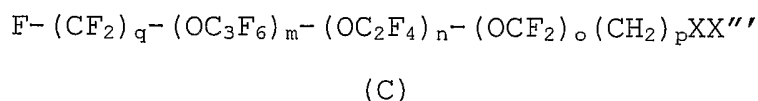
15 [Claim 18] The surface modifier according to any one of
Claims 1 to 17, with the addition of a catalyst to
promote surface modification wherein the proportion of
compound represented by General Formula (A) and/or
General Formula (B) and catalyst is not limited.

20

[Claim 19] The surface modifier according to any one of
Claims 1 to 17, with the addition of a catalyst to
promote surface modification wherein the proportion of
compound represented by General Formula (A) and/or
25 General Formula (B) and catalyst is 0.001 to 2.

[Claim 20] A method for producing an organosilicone compound represented by General Formula (A) wherein X'' is a bivalent organosilicone group, X' is hydrolyzable, and a is 0,

5 the method using a hydrosilylation reaction between $\text{HMe}_2\text{Si}(\text{OMe}_2\text{Si})_b\text{R}^3\text{Si}(\text{X}')_{3-a}(\text{R}^1)_a$ where R^1 is a C_{1-22} linear or branched hydrocarbon group, R^3 is a bivalent organic group, a is either 0 or 1, b is an integer from 1-100 and a compound represented by General Formula (C) below in the presence of a transition metal:



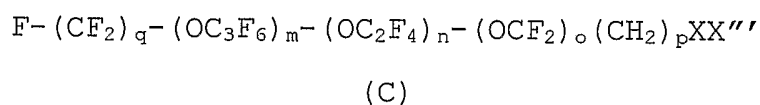
wherein q is an integer from 1 to 3; m, n, and o are independently integers from 0 to 200; p is 0, 1 or 2; and X is oxygen or a bivalent organic group and X''' is a monovalent organic group having terminal ethylenic unsaturation.

20 [Claim 21] A method for producing an organosilicone compound represented by General Formula (A) wherein X'' is a bivalent organosilicone group, X' is hydrolyzable, and a is 0,

the method using a hydrosilylation reaction between $\text{HMe}_2\text{Si}(\text{OMe}_2\text{Si})_b\text{OSi}(\text{X}')_{3-a}(\text{R}^1)_a$ where R^1 is a C_{1-22}

linear or branched hydrocarbon group, R^3 is a bivalent organic group, a is either 0 or 1, b is an integer from 0-100 and a compound represented by General Formula (C) below in the presence of a transition metal:

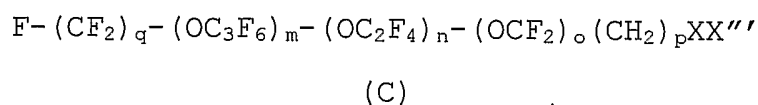
5



wherein q is an integer from 1 to 3; m , n , and o are independently integers from 0 to 200; p is 0, 1 or 2; and
 10 X is oxygen or a bivalent organic group and X''' is a monovalent organic group having terminal ethylenic unsaturation.

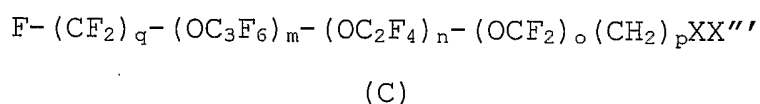
[Claim 22] A method for producing an organosilicone
 15 compound represented by General Formula (A) wherein X'' is a bivalent organosilicone group, X' is alkoxy, and a is 0, the method using a hydrosilylation reaction between $HMe_2Si(OMe_2Si)_bR^3Si(X')_{3-a}(R^1)_a$ where R^1 is a C_{1-22} linear or branched hydrocarbon group, R^3 is a bivalent
 20 organic group, a is either 0 or 1, b is an integer from 1-100 and a compound represented by General Formula (C) below in the presence of a transition metal:

25



wherein q is an integer from 1 to 3; m, n, and o are independently integers from 0 to 200; p is 0, 1 or 2; and X is oxygen or a bivalent organic group and X''' is a monovalent organic group having terminal ethylenic unsaturation.

[Claim 23] A method for producing an organosilicone compound represented by General Formula (A) wherein X'' is a bivalent organosilicone group, X' is alkoxy, and a is 0, the method using a hydrosilylation reaction between $\text{HMe}_2\text{Si}(\text{OMe}_2\text{Si})_b\text{OSi}(\text{X}')_{3-a}(\text{R}^1)_a$ where R^1 is a C_{1-22} linear or branched hydrocarbon group, R^3 is a bivalent organic group, a is either 0 or 1, b is an integer from 0-100 and a compound represented by General Formula (C) below in the presence of a transition metal:



wherein q is an integer from 1 to 3; m, n, and o are independently integers from 0 to 200; p is 0, 1 or 2; and X is oxygen or a bivalent organic group and X''' is a monovalent organic group having terminal ethylenic unsaturation.

[Claim 24] The method for producing an organosilicone

compound according to any one of Claims 20 to 23, wherein the transition metal is platinum or rhodium.

[Claim 25] The method for producing an organosilicone
5 compound according to any one of Claims 20 to 24, wherein in General Formula (C), q is 3, m is an integer from 10 to 200, n is 1, o is 0, p is 1, and X is O.

[Claim 26] The method for producing an organosilicone
10 compound according to any one of Claims 20 to 24, wherein in General Formula (C), q is 3, m is an integer from 10 to 200, n is 1, o is 0, p is 0, and X is amide or N-substituted amide.

15 [Claim 27] The method for producing an organosilicone compound according to any one of Claims 20 to 24, wherein in General Formula (C), q is 3, m is an integer from 10 to 200, n is 1, o is 0, p is 0, and X is an ester.

20 [Claim 28] A method for producing an organosilicone compound represented by General Formula (B),
the method using a partial hydrolysis and
condensation reaction of a compound represented by
General Formula (A) that is obtained according to the
25 method recited in any one of Claims 20 to 27.

[Claim 29] A treated surface obtained by using the surface modifier recited in any one of Claims 1 to 19, the treated surface having a water contact angle of at least 110° and a water sliding angel of no more than 5° .

[Claim 30] A treated surface obtained by using the surface modifier recited in any one of Claims 1 to 19, the treated surface comprising a perfluoropolyether in the form of a monomolecular film.

[Claim 31] A method for producing the surface recited in Claim 29 comprising the step of forming on a substrate a film of the surface modifier recited in any one of Claims 1 to 19 according to a wet coating method.

[Claim 32] A method for producing the surface recited in Claim 30 comprising the step of forming on a substrate according to a dry coating method a film of the surface modifier recited in any one of Claims 1 to 19 according to a wet coating method.

[Claim 33] A method for forming a surface comprising the steps of impregnating a porous article with the surface

modifier recited in any one of Claims 1 to 19, and forming a treated layer on a substrate by heating in a vacuum the porous article, in which the surface modifier has been impregnated, to evaporate the surface modifier.

5

[Claim 34] The method for forming a surface according to Claim 33, wherein the porous article comprises at least one species selected from the group consisting of SiO_2 , TiO_2 , ZrO_2 , MgO , Al_2O_3 , CaSO_4 , Cu, Fe, Al, stainless steel, and carbon.

10

[Claim 35] The method for forming a surface according to Claim 33 or 34, wherein the surface modifier impregnated in a porous article is evaporated according to at least one heating method selected from resistive heating, electron beam heating, ion beam heating, high-frequency heating, and optical heating.

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[Claim 36] A method for forming the surface recited in Claim 29 comprising the step of forming a film on a substrate by nozzle-spraying the surface modifier recited in any one of Claims 1 to 19 in the presence of a plasma.

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[Claim 37] The method according to Claim 36, wherein the plasma is an atmospheric-pressure plasma of argon or

25

helium.

[Claim 38] An antireflective optical member comprising a transparent substrate, an antireflective film formed on
5 at least one side of the transparent substrate, and a treated layer formed on the outer most surface,
the treated layer comprising the surface modifier recited in any one of Claims 1 to 19.

10 [Claim 39] The antireflective optical member according to Member 389, wherein the transparent substrate is an organic substrate, e.g., a transparent plastic substrate, or an inorganic substrate, e.g., a glass substrate.

15 [Claim 40] An optically functional member comprising the antireflective optical member recited in Claim 38 or 39 and a functional optical member adhered to the antireflective optical member.

20 [Claim 41] The optically functional member according to Claim 40, wherein the functional member is a polarizing plate.

[Claim 42] A display device comprising a coating member
25 adhered with an adhesive to the front side a front panel

of a display screen surface,

the coating member being the optically functional member recited in Claim 40 or 41.

- 5 [Claim 43] The display device according to Claim 42, wherein the display is a liquid crystal display, CRT display, projection display, plasma display, or EL display.
- 10 [Claim 44] A glass having a surface obtained using the surface modifier recited in any one of Claims 1 to 19.
- [Claim 45] The glass according to Claim 44 for automobile use or aeronautical use.
- 15 [Claim 46] An eyeglass lens or optical lens having a surface obtained using the surface modifier recited in any one of Claims 1 to 19.
- 20 [Claim 47] A sanitary ware having a surface obtained using the surface modifier recited in any one of Claims 1 to 19.
- [Claim 48] A mold-releasing method using the surface
- 25 modifier recited in any one of Claims 1 to 19 as a

release agent.

[Claim 49] A mold-releasing method using the surface
modifier recited in any one of Claims 1 to 19 for
5 nanoimprinting.

[Claim 50] A method for creating a microstructure using
the surface modifier recited in any one of Claim 1 to 19.

10 [Claim 51] Use of the microstructure recited in Claim 49
in lithography or device production.

[Claim 52] Stoneware having a surface obtained using the
surface modifier recited in any one of Claims 1 to 19.