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(71) Applicant (for all designated States except US): **DOW CORNING TORAY CO., LTD.** [JP/JP]; 1-3, Marunouchi 1-chome, Chiyoda-ku, Tokyo, 1000005 (JP).

(72) Inventors; and

(75) Inventors/Applicants (for US only): **YAMADA, Shuji** [JP/JP]; c/o Dow Corning Toray Co., Ltd., 2-2, Chigusaigaigan, Ichihara-shi, Chiba, 2990108 (JP). **YAMADA, Takateru** [JP/JP]; c/o Dow Corning Toray Co., Ltd., 2-2, Chigusaigaigan, Ichihara-shi, Chiba, 2990108 (JP).

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(54) Title: CURABLE ORGANOPOLYSILOXANE COMPOSITION AND SHEET-FORM ARTICLE HAVING A CURED LAYER OBTAINED THEREFROM

(57) Abstract: A curable organopolysiloxane composition comprising (A) at least one organopolysiloxane that has a viscosity of 20 to 500 mPa. s and a content of higher alkenyl in the range of 1.0 to 5.0 mass%, (B) organopolysiloxane that has a viscosity of at least 1,000,000 mPa. s and an alkenyl content of 0.005 to 0.1 mass%, (C) an organohydrogenpolysiloxane, and (D) a platinum-type catalyst. The cured layer exhibits an inhibition of the increase in the dynamic friction coefficient, even when executed as a thick coating on a substrate.



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DESCRIPTION

Title of Invention

5 CURABLE ORGANOPOLYSILOXANE COMPOSITION AND SHEET-FORM ARTICLE HAVING A
CURED LAYER OBTAINED THEREFROM.

Technical Field

[0001] The present invention relates to a curable organopolysiloxane composition that
10 can form a cured layer that, when executed as a thick coating on a substrate,
characteristically exhibits an inhibition of the increase in the dynamic friction coefficient
of the cured layer over that for execution as a thin coating as well as a small velocity
dependence by the dynamic friction coefficient. More particularly, the present invention
relates to a curable organopolysiloxane composition that is easy to handle, that can form
15 a cured layer on the surface of a substrate, that can provide excellent releasability with
respect to pressure-sensitive adhesives and tacky substances, and that can provide the
cured layer with a smooth slipperiness. The present invention further relates to a sheet-
form article that has a cured layer provided by the cure of this composition and in
particular relates to a laminate comprising this sheet-form article and to a surface-
20 protection sheet. The present invention additionally relates to a method of producing the
sheet-form article and a method of producing the surface-protection sheet.

Background Art

[0002] The method of imparting releasability from a pressure-sensitive adhesive or
25 tacky substance by forming a cured layer from an organopolysiloxane composition on the
surface of a substrate such as, for example, various types of papers, laminated papers,

synthetic films, metal foils, and so forth, is well known. The cured release coating is often formed in this case using an addition reaction-curable organopolysiloxane composition that undergoes an addition reaction between an unsaturated hydrocarbyl-functional organopolysiloxane and an organohydrogenpolysiloxane in the presence of a hydrosilylation reaction catalyst (refer, for example, to Patent Reference 1). Solvent-free cured release coating-forming organopolysiloxane compositions have come to be required in recent years in a broad range of applications based on safety and environmental considerations.

[0003] However, the prior solvent-free cured release coating-forming

organopolysiloxane compositions have employed an organopolysiloxane base component with a low viscosity of approximately 50 to 1000 cS and have not contained a high-viscosity organopolysiloxane, and, while this has provided an excellent coatability, the resulting cured coatings have exhibited a poor slipperiness as a consequence, which has had the disadvantage of placing limitations on their application. In order to solve this problem, compositions provided by the addition of a high-viscosity, low-reactive organopolysiloxane to a cured coating-forming composition are known (refer to Patent References 2 to 4). In addition, the present inventors have proposed a solvent-free cured release coating-forming organopolysiloxane composition that has a viscosity at 25°C of 20 to 300 mPa · s and that contains (A) an alkenyl-functional organopolysiloxane having the silicon-bonded phenyl group and (B) an organopolysiloxane with a viscosity of at least 100,000 mPa · s (refer to Patent Reference 5).

[0004] It is known, on the other hand, that an organopolysiloxane containing a higher alkenyl group, e.g., hexenyl, can be used as the base component of addition reaction-curing organopolysiloxane compositions and can improve, for example, the low temperature curing characteristics and the release properties with respect to pressure-sensitive adhesives and tacky substances (refer to Patent References 6 to 9). Moreover,

Patent Reference 10 discloses a curable coating composition that contains from 0.1 to 20 weight% of a higher alkenyl-functional organopolysiloxane gum and teaches that the introduction of this gum provides a composition that cures rapidly into a coating that has a low friction coefficient and a stable releasability keeping in long-term.

5 **[0005]** This reference, however, does not disclose a curable organopolysiloxane composition that has as its base component a low-viscosity organopolysiloxane having a higher alkenyl group content in the range of 1.0 to 5.0 mass%, and that additionally contains a high-viscosity organopolysiloxane and particularly an organopolysiloxane gum that has the vinyl group only at the molecular chain terminals. Moreover, this
10 reference contains no description or suggestion whatever of the combined use of two or more low-viscosity organopolysiloxanes that have different ranges for their higher alkenyl group contents.

[0006]

[Patent Reference 1] JP 47-32072 A

15 [Patent Reference 2] JP 61-159480 A

[Patent Reference 3] JP 2006-206884 A

[Patent Reference 4] JP 2008-169322 A

[Patent Reference 5] WO 2006/070947

[Patent Reference 6] JP 02-145650 A

20 [Patent Reference 7] JP 04-020570 A

[Patent Reference 8] JP 05-171047 A

[Patent Reference 9] JP 06-049413 A

[Patent Reference 10] JP 09-507523 A

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Disclosure of Invention

Technical Problems to be Solved

[0007] The present invention was pursued in order to solve the problems identified above and provides a curable organopolysiloxane composition that is easy to handle, that can form a cured layer on the surface of a substrate, that can provide excellent releasability with respect to pressure-sensitive adhesives and tacky substances, and that can provide the cured layer with a smooth slipperiness.

[0008] The present inventors also discovered new technical problems for the present invention to solve. The cured layers provided by the known curable organopolysiloxane compositions can be selected as appropriate in accordance with the application of the cured layer-bearing sheet-form substrate, and it may be necessary not only to form a cured layer by executing a thin coating of less than 1.0 g/m^2 on the substrate, but in some cases to form a cured layer by executing a thick coating of 1.0 to 10.0 g/m^2 on the substrate. However, it was discovered that the dynamic friction coefficient of the cured layer increases as the thickness of the cured layer increases and that the slipperiness of the cured layer is lost as the thickness of the cured layer increases. These problems are quite substantial in applications where the adhesive characteristics and release characteristics of the cured layer are both important, as in the case of protective films for optical displays and glass surfaces. The present inventors further discovered that when a thick cured layer is formed on the aforementioned substrate, the trend of an increase in the peeling force relative to the peeling force for lower-velocity peeling is very substantial in particular when high-speed peeling at 100 mm/min or more is carried out.

[0009] Therefore, the present invention provides a curable organopolysiloxane composition that can form a cured layer that, when executed as a thick coating on a substrate, characteristically exhibits an inhibition of the increase in the dynamic friction coefficient of the cured layer over that for execution as a thin coating as well as a small velocity dependence by the dynamic friction coefficient. The present invention also provides a sheet-form article provided with a cured layer formed by the cure of this

composition and in particular provides a laminate comprising this sheet-form article and provides a surface-protection sheet. The present invention further provides a method of producing this sheet-form article and a method of producing this surface-protection sheet.

Solution to Problems

5 [0010] The preceding objects are achieved by a curable organopolysiloxane composition comprising

(A) 100 mass parts of at least one organopolysiloxane that has a viscosity at 25°C of 20 to 500 mPa · s and a content of C₄₋₁₂ higher alkenyl groups in the range of 1.0 to 5.0 mass%,

10 (B) 0.5 to 15 mass parts of an organopolysiloxane that ranges from a gum to a fluid with a viscosity at 25°C of at least 1,000,000 mPa · s and that has a content of C₂₋₁₂ alkenyl groups of 0.005 to 0.100 mass%,

(C) an organohydrogenpolysiloxane that has at least two silicon-bonded hydrogen atoms (Si-H) in each molecule, in an amount that provides a value of 0.5 to 5 for
15 the molar ratio of the SiH group in component (C) to the alkenyl groups in components (A) and (B), and

(D) a platinum-type catalyst in a catalytic amount.

[0011] That is, the preceding objects are achieved by

“[1] A curable organopolysiloxane composition comprising

20 (A) 100 mass parts of at least one organopolysiloxane that has a viscosity at 25°C of 20 to 500 mPa · s and a content of C₄₋₁₂ higher alkenyl groups in the range of 1.0 to 5.0 mass%,

(B) 0.5 to 15 mass parts of an organopolysiloxane that ranges from a gum-state to a fluid with a viscosity at 25°C of at least 1,000,000 mPa · s and that has a content
25 of C₂₋₁₂ alkenyl groups of 0.005 to 0.100 mass%,

- (C) an organohydrogenpolysiloxane that has at least two silicon-bonded hydrogen atoms (Si-H) in each molecule, in an amount that provides a value of 0.5 to 5 for the molar ratio of the SiH group in component (C) to the alkenyl groups in components (A) and (B), and
- 5 (D) a platinum-type catalyst in a catalytic amount.
- [2] The curable organopolysiloxane composition according to [1], wherein component (A) is a mixture of at least two organopolysiloxanes, in which
- (A1) an organopolysiloxane having a content of C₄₋₁₂ higher alkenyl groups in the range of 0.5 to 2.0 mass% and
- 10 (A2) an organopolysiloxane having a content of C₄₋₁₂ higher alkenyl groups in the range of 2.5 to 5.0 mass%
- are mixed at a mass ratio of 1/4 to 4/1.
- [3] The curable organopolysiloxane composition according to [1] or [2], wherein the higher alkenyl group in component (A) is the hexenyl group.
- 15 [4] The curable organopolysiloxane composition according to [1], wherein component (B) is a dimethylpolysiloxane endblocked by the dimethylvinylsiloxy group at both molecular chain terminals.
- [5] The curable organopolysiloxane composition according to any of [1] to [4], characterized in that the composition is solvent free and the viscosity of the composition
- 20 as a whole is 100 to 5,000 mPa · s at 25°C.
- [6] The curable organopolysiloxane composition according to any of [1] to [5], characterized in that, when the coefficient of dynamic friction is measured according to Japanese Industrial Standard P8147 at a displacement velocity of 10 mm/minute on cured layers provided by coating the curable organopolysiloxane composition on a sheet-form
- 25 substrate at 0.6 g/m² and at 1.6 g/m² and curing in each instance by heating at 130°C for

30 seconds, the % increase (Δ) in the coefficient of dynamic friction calculated with the following formula is not more than 10%.

$$\begin{aligned} \text{\% increase } (\Delta) \text{ in the coefficient of dynamic friction} = & \{ (\text{coefficient of dynamic} \\ \text{friction for the cured layer coated at } 1.6 \text{ g/m}^2) - & (\text{coefficient of dynamic friction} \\ \text{for the cured layer coated at } 0.6 \text{ g/m}^2) \} / & \text{coefficient of dynamic friction for the} \\ \text{cured layer coated at } 0.6 \text{ g/m}^2 \times 100 \end{aligned}$$

[7] A sheet-form article that has a cured layer provided by thermally curing the curable organopolysiloxane composition according to any of [1] to [6].

[8] The sheet-form article according to [7], characterized in that the cured layer is a cured layer provided by coating the curable organopolysiloxane composition according to any of [1] to [6] on a sheet-form article at a rate of 1.0 to 10.0 g/m² and curing the composition by the application of heat.

[9] The sheet-form article according to [7] or [8], wherein the substrate is a polyethylene-laminated paper or a plastic film.

[10] A surface-protection sheet comprising a sheet-form article according to any of [7] to [9].

[11] A method of producing the sheet-form article according to [7] or [8], said method being characterized by

coating a sheet-form substrate with 1.0 to 10.0 g/m² of the curable organopolysiloxane composition according to any of [1] to [6]; and
forming a cured layer by curing by the application of heat.

[12] A method of producing a surface-protection sheet, characterized by

coating a substantially transparent sheet-form substrate with 1.0 to 10.0 g/m² of the curable organopolysiloxane composition according to any of [1] to [6]; and

forming a cured layer by curing by the application of heat.

[13] A laminate constructed by applying a pressure-sensitive adhesive sheet (SA)

comprising a layer of a pressure-sensitive adhesive provided on at least one side of a sheet-form article to a sheet-form substrate (S1) comprising a sheet-form article having on at least one side thereof a cured layer provided by thermally curing the curable organopolysiloxane composition according to any of [1] to [6], wherein application is performed so that the pressure-sensitive adhesive layer is in contact with the

aforementioned cured layer.

[14] A laminate constructed by applying a release sheet (SR) comprising a release

layer provided on at least one side of a sheet-form substrate to a sheet-form substrate (S1) comprising a sheet-form substrate having on at least one side thereof a cured layer provided by thermally curing the curable organopolysiloxane composition according to

any of [1] to [6], wherein application is performed so that the release layer is in contact with the aforementioned cured layer.”

Advantageous Effects of Invention

[0012] The curable organopolysiloxane composition according to the present invention can form a cured layer that, when executed as a thick coating on a substrate,

characteristically exhibits an inhibition of the increase in the dynamic friction coefficient over that for execution as a thin coating as well as a small velocity dependence by the dynamic friction coefficient. This cured layer exhibits an excellent releasability with respect to pressure-sensitive adhesives and tacky substances and exhibits a smooth slipperiness. The present invention further provides a sheet-form article that has a cured layer provided by the cure of this composition, wherein this cured layer exhibits the technical effects cited above. The present invention in particular provides a laminate

comprising this sheet-form article and a surface-protection sheet and further provides a method of producing this sheet-form article and a method of producing this surface-protection sheet.

Best Mode for Carrying Out the Invention

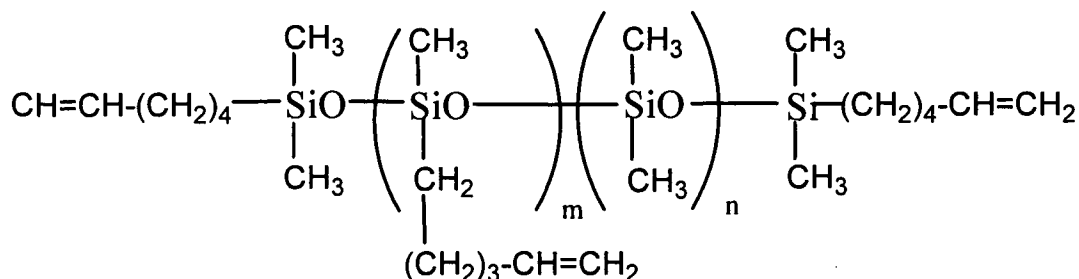
5 [0013] The curable organopolysiloxane composition of the present invention characteristically comprises (A) at least one organopolysiloxane that has a viscosity at 25°C of 20 to 500 mPa · s and a content of C₄₋₁₂ higher alkenyl groups in the range of 1.0 to 5.0 mass%, (B) an organopolysiloxane that ranges from a gum to a fluid with a viscosity at 25°C of at least 1,000,000 mPa · s and that has a content of C₂₋₁₂ alkenyl
10 groups of 0.005 to 0.100 mass%, (C) an organohydrogenpolysiloxane that has at least two silicon-bonded hydrogen atoms (Si-H) in each molecule, and (D) a platinum-type catalyst. Each constituent component in this curable organopolysiloxane composition and the sheet-form article and laminate that use this composition are described in detail in the following.

15 [0014] Component (A) is at least one organopolysiloxane that has a viscosity at 25°C of 20 to 500 mPa · s and a content of C₄₋₁₂ higher alkenyl groups in the range of 1.0 to 5.0 mass%. Component (A) has a low viscosity and a high content of the higher alkenyl group, e.g., hexenyl, and the use of this component (A) as the base component makes possible the formation on the surface of a substrate of a cured layer that has a high
20 crosslink density, and also effectively promotes the bleed out of component (B), which has an alkenyl group content of 0.005 to 0.100 mass% and thus a low reactivity, from the interior of the cured layer to the surface. As a consequence, even when the curable organopolysiloxane composition of the present invention is executed as a thick coating on a substrate, there is a suppression or inhibition of the velocity dependence of the
25 dynamic friction coefficient that is a function of the cured layer thickness and of the

increase in the dynamic friction coefficient that is a function of the cured layer thickness, and an excellent releasability with respect to pressure-sensitive adhesives and tacky substances and a smooth slipperiness are exhibited. At below the indicated lower limit on the higher alkenyl content, the dynamic friction coefficient increases as the resulting cured layer becomes thicker and the dynamic friction coefficient of the cured layer also exhibits a velocity dependence as the cured layer becomes thicker, and as a consequence the objects of the present invention cannot be achieved. When, on the other hand, the indicated upper limit on the higher alkenyl content is exceeded, bleed out by component (B) to the cured layer surface is inhibited and the technical effects of an excellent releasability and a smooth slipperiness may be lost.

[0015] Viewed from the perspective of the technical effects of the present invention, component (A) preferably has a content of C₄₋₁₂ higher alkenyl in the range of 1.5 to 4.0 mass%; the C₄₋₁₂ higher alkenyl in component (A) is particularly preferably the hexenyl group; and component (A) is preferably an organopolysiloxane that has hexenyl at both molecular chain terminals and in side chain position, as shown by the structural formula given below. In addition, viewed from the perspective of the technical effects of suppressing or inhibiting the velocity dependence of the dynamic friction coefficient that is a function of the cured layer thickness and the variation in the dynamic friction coefficient that is a function of the cured layer thickness, component (A) is suitably a mixture of at least two organopolysiloxanes, in which (A1) an organopolysiloxane having a content of C₄₋₁₂ higher alkenyl in the range of 0.5 to 2.0 mass% and (A2) an organopolysiloxane having a content of C₄₋₁₂ higher alkenyl in the range of 2.5 to 5.0 mass% are mixed at a mass ratio of 1/4 to 4/1 and more suitably are mixed at a mass ratio of 1/2 to 2/1. The higher alkenyl group content of this mixture is preferably in the range of 1.5 to 4.0 mass% and particularly preferably is in the range of 2.0 to 3.5 mass%.

[Formula 1]



In the preceding formula, **m** and **n** are each positive numbers; **m** is a number that provides a hexenyl group $-(\text{CH}_2)_4\text{CH}=\text{CH}_2$ content in the molecule in the range of 1.0 to 5.0 mass%; and **m** + **n** is a number in a range that provides a viscosity at 25°C of 20 to 500 mPa · s.

[0016] In addition, when the technical effect of suppressing or inhibiting the increase (velocity dependence) in the dynamic friction coefficient of the substrate-cured layer surface in the case of high-speed measurement is particularly important, component (A) particularly preferably is at least one organopolysiloxane that has a higher alkenyl group content in the range of 2.0 to 5.0 mass% and more preferably in the range of 2.0 to 3.5 mass% or a mixture of at least two organopolysiloxanes that has a higher alkenyl group content in the range of 2.0 to 5.0 mass% and more preferably in the range of 2.0 to 3.5 mass%.

[0017] Component (B) is an additive for imparting slipperiness to the surface of the cured layer and more particularly — by effectively bleeding out to the surface of the cured layer provided by the high crosslink-density cure achieved through the use of component (A) — imparts an optimal dynamic friction coefficient to the surface of the cured layer and provides an excellent releasability versus pressure-sensitive adhesives and tacky substances and a smooth slipperiness.

[0018] Component (B) is an organopolysiloxane that ranges from a gum-state to a fluid with a viscosity at 25°C of at least 1,000,000 mPa · s and that has a content of C₂₋₁₂

alkenyl groups in the range of 0.005 to 0.100 mass%. The non-alkenyl silicon-bonded organic groups can be exemplified by alkyl groups such as methyl, ethyl, propyl, and so forth; aryl groups such as phenyl and so forth; haloalkyl groups such as 3,3,3-trifluoropropyl, nonafluorohexyl, and so forth; and the silanol group.

5 **[0019]** In order to achieve the objects of the present invention, component (B) is preferably a low-reactivity organopolysiloxane that has a C₂₋₁₂ alkenyl group content in the range of 0.005 to 0.100 mass% and preferably 0.010 to 0.050 mass% and at least 90% and more preferably all of the non-alkenyl silicon-bonded organic groups are preferably an unreactive alkyl or aryl group. An alkenyl group content in component (B) below the
10 previously cited lower limit can produce problems such as an increase in silicone migration to the substrate and a low residual adhesiveness. At an alkenyl content above the previously cited upper limit, component (B) is incorporated into the cured layer by the addition reaction and the effect of imparting slipperiness to the cured layer surface may be unsatisfactory.

15 **[0020]** With regard to the characteristics of component (B), it may range from a gum-state to a fluid with a viscosity at 25°C of at least 1,000,000 mPa · s, while the viscosity when component (B) is a fluid is preferably at least 10,000,000 mPa · s. When component (B) takes the form of a gum, its plasticity is preferably in the range of 0.5 to 10.0 mm and particularly preferably is in the range of 0.9 to 3.0 mm. This plasticity is
20 the plasticity measured with a plastometer based on the method described in Japanese Industrial Standard 6249 and is the value determined when a load of 1 kgf is applied for 3 minutes at 25°C to a 4.2 g spherical sample.

[0021] Component (B) can be specifically exemplified by polydimethylsiloxanes, dimethylsiloxane · phenylmethylsiloxane copolymers, and dimethylsiloxane ·
25 diphenylsiloxane copolymers, in each case endblocked at the molecular chain terminals by the same or different groups selected from the group consisting of silicon-bonded

alkyl, alkenyl, aryl, haloalkyl, and silanol. Component (B) is particularly preferably a straight-chain or branched dimethylpolysiloxane that is endblocked at the molecular chain terminals by the same or different groups selected from the trimethylsiloxy group, silanol group, and vinyl group. Mixtures of polydimethylsiloxanes having different
5 degrees of polymerization may also be used.

[0022] Component (B) is most suitably a polydimethylsiloxane endblocked at both molecular chain terminals by the dimethylvinylsiloxy group, wherein the use of a polydimethylsiloxane gum is particularly preferred.

[0023] The curable organopolysiloxane composition of the present invention contains
10 from 0.5 to 15 mass parts component (B) per 100 mass parts component (A) and particularly preferably contains 1.0 to 5.0 mass parts component (B) per 100 mass parts component (A). The cured layer surface has an unsatisfactory slipperiness when the component (B) content is less than the indicated lower limit. When the indicated upper limit is exceeded, the viscosity of the organopolysiloxane composition becomes
15 excessively high, which can cause problems for actual processes, such as coating, production, and so forth, particularly in the case of use in a solvent-free form.

[0024] Component (C) is an organohydrogenpolysiloxane that has at least two silicon-bonded hydrogen atoms (Si-H) in each molecule and is a crosslinking agent. Component (C) preferably has at least three silicon-bonded hydrogen atoms in each molecule, and
20 there are no particular limitations on their bonding position. The silicon-bonded hydrogen atom content is preferably from 0.1 to 2.0 mass% with reference to the organopolysiloxane composition as a whole and is more preferably from 0.5 to 1.8 mass% with reference to the organopolysiloxane composition as a whole. In addition to the hydrogen atom, the organic groups bonded to silicon in component (C) can be
25 exemplified by alkyl groups such as methyl, ethyl, propyl, butyl, and octyl, wherein

methyl is preferred. The molecular structure of component (C) can be exemplified by straight chain, branched chain, and branched cyclic.

[0025] The viscosity of component (C) at 25°C is 1 to 1,000 mPa · s and is preferably 5 to 500 mPa · s. The reasons for this are as follows: when the viscosity at 25°C is less

than 1 mPa · s, component (C) readily volatilizes from the organopolysiloxane

composition; long curing times are required for the organopolysiloxane composition

when the viscosity at 25°C exceeds 1,000 mPa · s. Component (C) can be specifically

exemplified by dimethylsiloxane · methylhydrogensiloxane copolymers endblocked at

both terminals by the trimethylsiloxy group, dimethylsiloxane · methylhydrogensiloxane

copolymers endblocked by the dimethylhydrogensiloxy group at both terminals,

methylhydrogenpolysiloxanes endblocked by the trimethylsiloxy group at both terminals,

cyclic methylhydrogenpolysiloxanes, and cyclic methylhydrogensiloxane ·

dimethylsiloxane copolymers. Two or more organohydrogenpolysiloxanes can be used in combination as component (C).

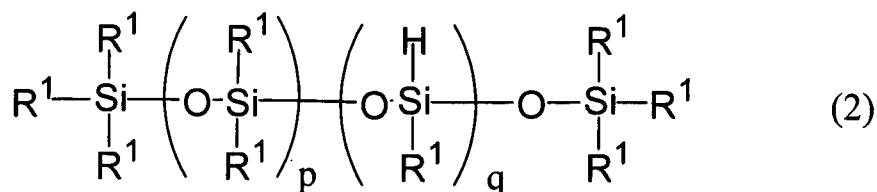
[0026] Component (C) is more preferably one organohydrogenpolysiloxane

represented by the following general formula (2) or two or more

organohydrogenpolysiloxanes represented by general formula (2). The cured layer is

formed by an addition reaction (hydrosilylation reaction) with the silicon-bonded alkenyl groups in components (A) and (B).

[Formula 2]



[0027] R^1 in the formula is a substituted or unsubstituted monovalent saturated

hydrocarbyl group and is exemplified by the same groups as previously cited. p is a

positive integer; q is an integer greater than or equal to 2; and p and q satisfy the relationship $10 \leq (p + q) \leq 200$. When $(p + q)$ is less than the indicated lower limit, volatilization may occur and a satisfactory cure may not be obtained, depending on the curing conditions. When the indicated upper limit is exceeded, gel production may occur as the bath standing time increases. In addition, p and q preferably satisfy the relationship $0.3 \leq q/(p + q) \leq 1$. Curing of the curable organopolysiloxane composition according to the present invention may be unsatisfactory when $q/(p + q)$ is less than the indicated lower limit.

[0028] Component (C) is incorporated in an amount that provides a value of 0.5 to 5 and preferably 1 to 5 for the molar ratio of the SiH in component (C) with reference to the alkenyl groups in components (A) and (B). The curability is diminished when this molar ratio is less than the indicated lower limit; when the indicated upper limit is exceeded, a large peeling resistance occurs and a practical releasability may not be obtained.

[0029] Component (D) is a platinum-type catalyst and is a catalyst that accelerates the addition reaction (hydrosilylation reaction) between the silicon-bonded alkenyl and the silicon-bonded hydrogen present in the system. Specific examples of preferred platinum-type catalysts are chloroplatinic acid, alcohol-modified chloroplatinic acid, olefin complexes of chloroplatinic acid, complexes between chloroplatinic acid and ketones, complexes between vinylsiloxanes and chloroplatinic acid, platinum tetrachloride, finely divided platinum, solid platinum supported on a support such as alumina or silica, platinum black, olefin complexes of platinum, alkenylsiloxane complexes of platinum, carbonyl complexes of platinum, and platinum-type catalysts comprising a thermoplastic organic resin powder, e.g., methyl methacrylate resin, polycarbonate resin, polystyrene resin, silicone resin, and so forth, that incorporates a platinum-type catalyst as listed above. The use is particularly preferred of complexes between chloroplatinic acid and

divinyltetramethyldisiloxane, complexes between chloroplatinic acid and tetramethyltetravinyldicyclotetrasiloxane, and platinum/alkenylsiloxane complexes such as platinum/divinyltetramethyldisiloxane complexes, platinum/tetramethyltetravinyldicyclotetrasiloxane complexes, and so forth.

5 [0030] Component (D) is added in a catalytic quantity and is added generally at 1 to 1,000 ppm and preferably in the range of 5 to 500 ppm, in each case as the quantity of platinum metal in component (D) with reference to the total mass of the curable organopolysiloxane composition of the present invention.

[0031] In addition to the preceding components, the curable organopolysiloxane
10 composition of the present invention preferably also incorporates (E) a hydrosilylation reaction inhibitor in order to inhibit gelation and curing at ambient temperature and thereby improve the storage stability at ambient temperature while providing curability under the application of heat. This hydrosilylation reaction inhibitor can be exemplified by acetylenic compounds, ene-yne compounds, organonitrogen compounds,
15 organophosphorus compounds, and oxime compounds. Specific examples are alkyne alcohols such as 2-methyl-3-butyne-2-ol, 3,5-dimethyl-1-hexyne-3-ol, 3-methyl-1-pentyn-3-ol, 2-phenyl-3-butyne-2-ol, 1-ethynyl-1-cyclohexanol (ETCH), and so forth; 3-methyl-3-trimethylsiloxy-1-butyne; 3-methyl-3-trimethylsiloxy-1-pentyne; 3,5-dimethyl-3-trimethylsiloxy-1-hexyne; ene-yne compounds such as 3-methyl-3-pentyn-1-yne, 3,5-
20 dimethyl-3-hexyn-1-yne, and so forth; 1-ethynyl-1-trimethylsiloxy-cyclohexane; bis(2,2-dimethyl-2-butyloxy)dimethylsilane; and alkenylsiloxanes such as 1,3,5,7-tetramethyl-1,3,5,7-tetravinyldicyclotetrasiloxane, 1,3,5,7-tetramethyl-1,3,5,7-tetrahexenyldicyclotetrasiloxane, and so forth. The quantity of incorporation of the hydrosilylation reaction inhibitor (E) is generally in the range of 0.001 to 5 mass parts
25 per 100 mass parts component (A), but should be selected as appropriate in view of the type of component (E), the performance and quantity of incorporation of the

hydrosilylation reaction catalyst, the content of higher alkenyl groups in component (A), the quantity of silicon-bonded hydrogen atoms in component (C), the desired pot life, and the working environment.

[0032] The composition of the present invention comprises components (A), (B), (C), and (D) and optionally component (E) and is particularly well suited for use as a solvent-free curable organopolysiloxane composition. An alkenyl group-containing organopolysiloxane resin may also be incorporated into the composition of the present invention in order to lower the peeling force exhibited by the cured layer versus pressure-sensitive adhesives and tacky substances. A thickener, such as finely divided silica and so forth, may also be incorporated in order to raise the viscosity of the coating bath. Particularly when the composition of the present invention is used in a solvent-free form, the viscosity at 25°C of the composition as a whole is, based on a consideration of the coatability on sheet-form substrates, preferably in the range from 50 to 10,000 mPa · s and more preferably from 100 to 5,000 mPa · s.

[0033] On the hand, with the goal, inter alia, of achieving a thin coating, the composition of the present invention can be used dispersed in a known organic solvent. The organic solvent can be exemplified by aromatic hydrocarbon solvents such as toluene, xylene, and so forth; aliphatic hydrocarbon solvents such as hexane, octane, isoparaffin, and so forth; ketone solvents such as acetone, methyl ethyl ketone, methyl isobutyl ketone, and so forth; ester solvents such as ethyl acetate, isobutyl acetate, and so forth; ether solvents such as diisopropyl ether, 1,4-dioxane, and so forth; cyclic polysiloxanes having a degree of polymerization of 3 to 6, such as hexamethylcyclotrisiloxane, octamethylcyclotetrasiloxane, decamethylcyclopentasiloxane, and so forth; halogenated hydrocarbons such as trichloroethylene, perchloroethylene, trifluoromethylbenzene, 1,3-bis(trifluoromethyl)benzene, methylpentafluorobenzene, and so forth. In the case of the

application of a thin coating on a sheet-form substrate that has a low heat resistance, such as a polyolefin, the use is preferred of an ether solvent based on the curability and the swelling issue. It should be noted that the technical effects of the present invention with regard to an inhibition of the increase in the dynamic friction coefficient for the execution of a thick coating on a substrate over that for execution as a thin coating and a small velocity dependence by the dynamic friction coefficient in the case of a thick coating on a substrate, may not be satisfactory in the case of a thin coating.

[0034] Optional components other than the preceding may be added to the curable organopolysiloxane composition according to the present invention. Known additives can be added, for example, an adhesion promoter comprising an alkoxysilane compound, such as 3-glycidoxypropyltrimethoxysilane, 3-methacryloxypropyltrimethoxysilane, and so forth; an oxidation inhibitor, such as a phenol type, quinone type, amine type, phosphorus type, phosphite type, sulfur type, thioether type, and so forth; a photostabilizer, such as a triazole type, benzophenone type, and so forth; a flame retardant, such as a phosphate ester type, halogen type, phosphorus type, antimony type, and so forth; one or more static inhibitors comprising a cationic surfactant, anionic surfactant, nonionic surfactant, and so forth; a heat stabilizer; a dye; a pigment; and so forth.

[0035] In particular, a static inhibitor is preferably added when the sheet-form article having a cured layer provided by the composition according to the present invention is used as a surface-protection sheet for protecting the surface of an optical component, e.g., a liquid-crystal panel, plasma display, polarization plate, phase retardation plate, and so forth, or the surface of an electrical · electronic component, e.g., a printed wiring board, integrated circuit, transistor, capacitor, and so forth.

[0036] The composition of the present invention can be produced simply by mixing components (A) to (D), as desired component (E), and any other optional components to

uniformity. There are no particular limitations on the sequence in which the components are added; however, when the composition will not be used immediately after mixing, a mixture of components (A), (B), and (C) is preferably stored separately from component (D) and the two are then mixed immediately prior to use. In the case of a composition comprising components (A) to (D) and also component (E), the amount of component (E) incorporation is preferably adjusted to provide a composition that does not undergo crosslinking at ambient temperature, but which undergoes crosslinking and curing upon the application of heat.

[0037] A sheet-form article that has on its surface a cured layer that exhibits an excellent slipperiness, an excellent transparency, and an excellent adherence to the sheet-form substrate can be produced by uniformly coating the hereinabove-described curable organopolysiloxane composition of the present invention on a sheet-form substrate and heating under conditions sufficient to bring about the hydrosilylation reaction-mediated crosslinking of components (A) and (C). The cured layer provided by the cure of the composition of the present invention also has other advantages, i.e., it has an excellent flexibility and an excellent air permeability and exhibits little air bubble inclusion even when applied on a target material that does not have a flat shape. As a consequence, it is very suitable for use in applications where the release properties of the cured layer and its adherence to the object to be protected are both crucial, as in the case of protective films for optical displays and glass surfaces.

[0038] In particular, the curable organopolysiloxane composition of the present invention can provide a sheet-form article for which the % increase (Δ) in the coefficient of dynamic friction of cured layers provided by applying the composition at different coating rates, and specifically at 0.6 g/m^2 (= thin cured layer) and 1.6 g/m^2 (= thick coating layer), on a sheet-form substrate, e.g., polyethylene-laminated paper or polyethylene terephthalate film, and curing by the application of heat in each instance at

130°C/30 seconds, is not more than 10%, and can form cured layers for which the increases in the dynamic friction coefficient with respect to changes in the coating rate are characteristically inhibited or suppressed. Moreover, the present invention can provide sheet-form articles in which the previously defined increase in the dynamic friction coefficient is not more than 5% and can even provide sheet-form articles for which the increase in the dynamic friction coefficient is -15% to 3%.

[0039] The “coefficient of dynamic friction for the cured layer” in the “% increase (Δ) in the coefficient of dynamic friction” is the value of the dynamic friction coefficient between the front and back sides of the sheet-form substrate having the cured layer on its surface, determined one day after formation of this cured layer by measurement of the dynamic friction coefficient based on Japanese Industrial Standard P8147 using a measurement instrument such as a Tensilon tensile tester and a load of 1000 g, a displacement velocity of 10 mm/minute, a temperature of 23°C, and an ambient with a humidity of 65%.

[0040] The % increase (Δ) in the coefficient of dynamic friction is the value determined using the following formula and is the percentage increase in the dynamic friction coefficient of the cured layer when the dynamic friction coefficient is measured by the previously described method on a sample composed of the sheet-form substrate having a cured layer obtained at a coating rate of 0.6 g/m^2 and on a sample composed of the same sheet-form substrate having a cured layer obtained at a coating rate of 1.6 g/m^2 .

$$\Delta (\%) = \{(\text{coefficient of dynamic friction for the cured layer coated at } 1.6 \text{ g/m}^2 - \text{coefficient of dynamic friction for the cured layer coated at } 0.6 \text{ g/m}^2) / \text{coefficient of dynamic friction for the cured layer coated at } 0.6 \text{ g/m}^2\} \times 100$$

[0041] Substrates that are substantially flat and that have the width and thickness appropriate to the particular application, e.g., as a tape, film, and so forth, can be used

without particular limitation as the sheet-form substrate, and specific examples are paper, synthetic resin films, fabrics and textiles, synthetic fibers, metal foils such as aluminum foil, copper foil, and so forth, glass fibers, and composite sheet-form substrates made by laminating a plurality of the preceding sheet-form substrates.

5 **[0042]** The synthetic resin films can be exemplified by synthetic resin films of, for example, polyester, polytetrafluoroethylene, polyimide, polyphenylene sulfide, polyamide, polycarbonate, polystyrene, polypropylene, polyethylene, polyvinyl chloride, polyethylene terephthalate, and so forth. Since the cured layer of the present invention is substantially transparent, the selection of a high-transparency sheet-form substrate
10 composed of these synthetic resin films to serve as a substantially transparent sheet-form substrate is useful for obtaining a protective film that exhibits an excellent transparency.

[0043] The paper can be exemplified by Japanese paper, synthetic paper, polyolefin-laminated paper and particularly polyethylene-laminated paper, cardboard, and clay-coated paper.

15 **[0044]** The thickness of the sheet-form substrates cited above as examples is not particularly limited, but is generally about 5 to 300 μm . In order to improve the adherence between the sheet-form substrate and the cured layer, a supporting film may be used that has been subjected to a primer treatment, corona treatment, etching treatment, or plasma treatment. Primer compositions useful in this regard can be
20 exemplified by a condensation-type silicone primer composition comprising a polydiorganosiloxane having the SiOH group at the terminals, an SiH group-containing polysiloxane and/or an alkoxy group-containing polysiloxane, and a condensation-reaction catalyst, and by an addition-type silicone primer composition comprising a polydiorganopolysiloxane containing alkenyl, e.g., vinyl, an SiH group-containing
25 polysiloxane, and an addition-reaction catalyst.

[0045] The opposite side of the sheet-form substrate from the cured layer may be subjected to a surface treatment, e.g., an anti-marring treatment, an antistaining treatment, an anti-fingerprint treatment, an antiglare treatment, an anti-reflective treatment, an anti-static treatment, and so forth. These surface treatments may be performed after the curable organopolysiloxane composition of the present invention has been coated on the sheet-form substrate, or the composition may be applied after the surface treatment has been performed.

[0046] The anti-marring treatment (hardcoat treatment) can be exemplified by treatment with, for example, an acrylate type, silicone type, oxetane type, inorganic type, or organic/inorganic hybrid type hardcoating agent.

[0047] The antistaining treatment can be exemplified by treatment with, for example, a fluorine type, silicone type, ceramic type, or photocatalyst type antistaining agent.

[0048] The anti-reflective treatment can be exemplified by wet treatments based on coating with, for example, a fluorine type or silicone type anti-reflective agent, and by dry treatments using vapor deposition or sputtering. The anti-static treatment can be exemplified by treatment using, for example, a surfactant type, silicone type, organoboron type, electroconductive polymer type, metal oxide type, or vapor-deposited metal type anti-static agent.

[0049] Temperatures from 50 to 200°C are generally suitable for curing the curable organopolysiloxane composition of the present invention on the sheet-form substrate, but temperatures above 200°C may be used as long as the sheet-form substrate has a good heat resistance. There are no particular limitations on the heating method, and heating may be carried out, for example, by heating in a convection oven, passage through a long heating oven, and radiant heating using an infrared lamp or a halogen lamp. Curing may also be carried out by combining the application of heat with exposure to ultraviolet radiation. When component (D) is a platinum/alkenylsiloxane complex catalyst, a cured

layer that exhibits an excellent slipperiness, an excellent transparency, and an excellent adherence to the sheet-form substrate can be easily obtained in a brief period of time, i.e., 1 to 40 seconds, at 100 to 150°C, even when this catalyst is incorporated at 80 to 200 ppm as the amount of platinum metal with reference to the total quantity of the composition.

[0050] On the other hand, in the case of sheet-form substrates that have a low heat resistance, such as polyolefin and so forth, the curable organopolysiloxane composition of the present invention, after its application to a sheet-form substrate of, for example, polyolefin, is preferably heated at a low temperature of 50 to 100°C and more preferably 50 to 80°C. In this case, a consistent cure can be effected at cure times of 30 seconds to several minutes, for example, 1 to 10 minutes.

[0051] With regard to the method of coating the curable organopolysiloxane composition of the present invention on the surface of a sheet-form substrate, immersion; spraying; gravure coating; offset coating; offset gravure coating; roll coating using, for example, an offset transfer roll coater; reverse roll coating; air knife coating; curtain coating using, for example, a curtain flow coater; comma coating; Mayer bar coating; and other known methods used to form a cured layer, can be used without limitation.

[0052] The coating rate is set in conformity to the particular application, but an amount that provides 0.1 to 200.0 g/m² on the sheet-form substrate is generally used.

The coating rate can be selected from 0.1 to 1.0 g/m² when the goal is to execute a thin coating of the curable organopolysiloxane of the present invention as a release layer, while the coating rate can be selected from 1.0 to 10.0 g/m² when the goal is to execute a thick coating in the case of applications that require both releasability and adhesiveness, such as protective film service. In particular, due, inter alia, to the excellent slipperiness in the case of execution as a thick coating, the curable organopolysiloxane of the present

invention is preferably coated at 1.0 to 10.0 g/m² and particularly preferably 1.0 to 5.0 g/m².

[0053] The cured layer provided by the curable organopolysiloxane composition of the present invention has the ability to function as a cured release layer. On the other hand, the execution of a thick coating of this composition has the advantage of making it possible to also use this cured layer as a micro-tacky adhesive layer that also has the same excellent release characteristics as in the case of the thin coating. Applications of the composition of the present invention that exploit these characteristics are described in the following.

[0054] The composition of the present invention is useful for forming a cured layer that exhibits an excellent surface slipperiness and an excellent releasability versus pressure-sensitive adhesives and tacky substances. The composition of the present invention can be very suitably used in particular as a cured release film-forming agent for, e.g., process paper, asphalt packaging paper, and various plastic films.

[0055] In particular, due to its excellent releasability with respect to another, pressure-sensitive adhesive or tacky layer, the cured layer provided by the composition of the present invention can be used as a release layer for process paper that is a laminate that includes a pressure-sensitive adhesive or tacky layer, as a release layer for paper for wrapping or packaging a pressure-sensitive adhesive or tacky substance, as a release layer for laminates such as pressure-sensitive tapes, pressure-sensitive labels, and so forth. Specifically, by using the curable organopolysiloxane composition of the present invention, a laminate can be obtained that is constructed by applying a pressure-sensitive adhesive sheet (SA) comprising a layer of a pressure-sensitive adhesive (or an adhesive layer) provided on at least one side of a sheet-form substrate to a sheet-form substrate (S1) comprising a sheet-form substrate having on at least one side thereof a cured layer (a parting layer or release layer) provided by thermally curing the curable

organopolysiloxane composition of the present invention, wherein application is performed so that the pressure-sensitive adhesive layer is in contact with the aforementioned cured layer.

[0056] The pressure-sensitive adhesive or tacky substance used in the laminates

5 referenced above denotes the entire spectrum of pressure-sensitive adhesives and adhesives and so forth, and can be exemplified by acrylic resin-based pressure-sensitive adhesives, rubber-based pressure-sensitive adhesives, silicone-based pressure-sensitive adhesives, acrylic resin-based adhesives, synthetic rubber-based adhesives, silicone-based adhesives, epoxy resin-based adhesives, and polyurethane-based adhesives. Other
10 examples are asphalt, tacky foods such as mochi (=rice cakes), as well as pastes, glues, starches, and birdlime.

[0057] On the other hand, by executing a thick coating of the composition of the present invention, the cured layer provided this composition can be used, on the other hand, as a micro-tacky adhesive layer that also has the same excellent release

15 characteristics as in the case of a thin coating, and is very useful in particular since it can be used as an adhesive layer for protective sheets, re-releasable adhesive sheets, and so forth. Such an adhesive layer, once affixed to the target, maintains an adherence that is long-term stable and is free of slippage or peeling at the location of bonding, and has the advantage of an excellent peelable ability after long-term adherence. In addition, re-
20 applying is easily carried out, and, in the case of long-term use of the protective sheet, the cured layer has the advantage of being resistant to deformation, whitening, the production of residual adhesive, and so forth.

[0058] A protective sheet or re-releasable adhesive sheet having a cured layer provided by the composition of the present invention can be used for applications in which it is
25 affixed to and protects the surface of a member, e.g., a metal sheet or plate, painted metal sheet or plate, aluminum sash, resin sheet or plate, decorative steel sheet or plate,

polyvinyl chloride-laminated steel sheet or plate, glass sheet or plate, and so forth, during the transport, processing, or curing of the member. In addition, it can be very suitably used as a protective sheet in the processes for producing various types of liquid-crystal display panels (also known as monitors and displays), in the distribution channel
5 for polarization plates, in the production and distribution channels for resin members for various types of instrumentation and machinery, e.g., automobiles, for food packaging, and so forth.

[0059] Similarly, since a protective sheet provided with an adhesive layer comprising the cured layer of the present invention is easily re-applied, this protective sheet is
10 suitable as a protective sheet for various types of displays as follows. The protective sheet of the present invention may be used with the goal of preventing surface damage, preventing surface contamination, preventing fingerprints, preventing static, avoiding reflection, obtaining an anti-peeking effect, and so forth, in various contexts during the production, distribution, and use of these displays.

[0060] The laminate constituting this surface-protection sheet can specifically be
15 obtained using the curable organopolysiloxane composition of the present invention by applying a release sheet (SR) comprising a release layer provided on at least one side of a sheet-form substrate to a sheet-form substrate (S1) comprising a sheet-form substrate having on at least one side thereof a cured layer (release layer and adhesive layer)
20 provided by thermally curing the curable organopolysiloxane composition of the present invention, wherein application is performed so that the release layer is in contact with the aforementioned cured layer.

Examples

[0061] Examples and comparative examples are provided below in order to specifically
25 describe the present invention, but the present invention is not limited to the following examples. In the examples that follow, parts is mass parts in all instances; Hex denotes

the hexenyl group; and Me denotes the methyl group. The viscosity and plasticity are the values measured at 25°C. The slipperiness of the cured layer provided by a curable organopolysiloxane composition was evaluated by measurement of the dynamic friction coefficient using the method described below.

5 **[0062]**

[Formation of the cured layer]

The curable organopolysiloxane composition was coated in an amount that provided 0.6, 1.0, or 1.6 g/m² as siloxane on the surface of the substrate using a printing tester (R1-2 from Mei Seisakusho Co., Ltd.) in conformity to the coating rate. After coating, the
10 substrate was heated for 30 seconds at 130°C in a convection oven to form a cured layer on the substrate surface.

[0063]

[Measurement of the dynamic friction coefficient for polyethylene-laminated paper (for Practical Examples 1 to 3, Comparative Examples 1 to 3)]

15 Using polyethylene-laminated paper having on its surface a cured layer obtained by the method described above, a measurement sample was prepared one day after curing in which the untreated back side (paper substrate side) of the polyethylene-laminated paper was laid against the cured layer (surface, cured silicone layer) and the front/back dynamic friction coefficient of the polyethylene-laminated paper bearing the cured layer
20 obtained as described above was measured using a Tensilon tensile tester (trademark: Tensilon RTC-1210, from Orientec Co., Ltd.). The measurements were performed at each individual displacement velocity using the following conditions: load: 1000 g; displacement velocity of 10, 30, or 100 mm/minute; ambient of 23°C and 65% humidity.

[0064]

25 [Measurement of the dynamic friction coefficient for polyethylene terephthalate film (for Practical Example 4 to 6)]

Using polyethylene terephthalate (PET) film (thickness = 50 μm) having on its surface a cured layer obtained by the method described above, a measurement sample was prepared one day after curing in which the untreated back side (PET substrate side) of the polyethylene terephthalate film was laid against the cured layer (surface, cured silicone layer) and the front/back dynamic friction coefficient of the PET film bearing the cured layer obtained as described above was measured using a Tensilon tensile tester (trademark: Tensilon RTC-1210, from Orientec Co., Ltd.). The measurements were performed at each individual displacement velocity using the following conditions: load: 1000 g; displacement velocity of 10, 30, or 100 mm/minute; ambient of 23°C and 65% humidity.

[0065]

[The % increase (Δ) in the coefficient of dynamic friction]

The dynamic friction coefficient was measured (value measured at a displacement velocity of 10 mm) by the previously described method on a sample having a coating rate of 0.6 g/m^2 and a sample having a coating rate of 1.6 g/m^2 and the % increase (Δ) in the coefficient of dynamic friction of the cured layer was determined according to the following formula. The percent increase in the dynamic friction coefficient was similarly determined as a reference value at displacement velocities of 30 and 100 mm/minute (Tables 1 and 3).

$$\Delta (\%) = \{(\text{coefficient of dynamic friction for the cured layer coated at } 1.6 \text{ g/m}^2 - \text{coefficient of dynamic friction for the cured layer coated at } 0.6 \text{ g/m}^2) / \text{coefficient of dynamic friction for the cured layer coated at } 0.6 \text{ g/m}^2\} \times 100$$

[0066]

[Velocity dependence of the dynamic friction coefficient of the cured layer: (δS) %]

The dynamic friction coefficient was measured by the previously described method at a displacement velocity of 10 mm/minute and 100 mm/minute on the cured layer at the same coating rate, and the % change (δ_S) in the dynamic friction coefficient for the cured layer was determined using the following formula.

$$\delta_S (\%) = \{(\text{coefficient of dynamic friction for the cured layer measured at a displacement velocity of 100 mm/minute} - \text{coefficient of dynamic friction for the cured layer measured at a displacement velocity of 10 mm/minute}) / \text{coefficient of dynamic friction for the cured layer measured at a displacement velocity of 10 mm/minute}\} \times 100$$

10 [0067] [Practical Example 1]

93.6 parts of (A1) a polydimethylsiloxane having the hexenyl group at both molecular chain terminals and in side chain position, a viscosity of 220 mPa · s, and a hexenyl group content of 1.15 mass%; 3.0 parts of (B1) a dimethylsiloxane gum having a plasticity of 1.4 mm and endblocked by the vinyl group at the molecular chain terminals; 15 3.2 parts of (C1) a methylhydrogenpolysiloxane having a viscosity of 25 mPa · s and a silicon-bonded hydrogen content of 1.6 mass% and endblocked by the trimethylsiloxy group at both molecular chain terminals; and 0.2 part (E) 1-ethynyl-1-cyclohexanol (ETCH) were mixed to uniformity. Into the resulting mixture was blended (D) a chloroplatinic acid · 1,3-divinyl-1,1,3,3-tetramethyldisiloxane complex having a 20 platinum metal content of 0.6 mass%, at a quantity of addition that provided a platinum metal quantity of 100 ppm, thereby producing a solvent-free curable organopolysiloxane composition having a viscosity of 800 mPa · s and designated as composition 1. The silicon-bonded hydrogen atom (Si–)H/Hex molar ratio in this composition was 1.27. The obtained organopolysiloxane composition was coated by the previously described 25 method on polyethylene-laminated paper at coating rates of 0.6, 1.0 and 1.6 g/m² and

was cured and the dynamic friction coefficient was measured on each of the resulting cured layers. The results are reported in Table 1.

[0068] [Practical Example 2]

46.8 parts of (A1) a polydimethylsiloxane having the hexenyl group at both
5 molecular chain terminals and in side chain position, a viscosity of 220 mPa · s, and a hexenyl group content of 1.15 mass%; 44.5 parts of (A2) a polydimethylsiloxane having the hexenyl group at both molecular chain terminals and in side chain position, a viscosity of 100 mPa · s, and a hexenyl group content of 3.00 mass%; 3.0 parts of (B1) a dimethylsiloxane gum having a plasticity of 1.4 mm and endblocked by the vinyl group
10 at the molecular chain terminals; 7.8 parts of (C1) a methylhydrogenpolysiloxane having a viscosity of 25 mPa · s and a silicon-bonded hydrogen content of 1.6 mass% and endblocked by the trimethylsiloxy group at both molecular chain terminals; and 0.2 part (E) 1-ethynyl-1-cyclohexanol (ETCH) were mixed to uniformity. Into the resulting mixture was blended (D) a chloroplatinic acid · 1,3-divinyl-1,1,3,3-tetramethyldisiloxane
15 complex having a platinum metal content of 0.6 mass%, at a quantity of addition that provided a platinum metal quantity of 100 ppm, thereby producing a solvent-free curable organopolysiloxane composition having a viscosity of 600 mPa · s and designated as composition 2. The silicon-bonded hydrogen atom (Si–)H/Hex molar ratio in this composition was 1.25. The obtained organopolysiloxane composition was coated on
20 polyethylene-laminated paper at coating rates of 0.6, 1.0 and 1.6 g/m² by the previously described method and was cured and the dynamic friction coefficient was measured on each of the resulting cured layers. The results are reported in Table 1.

[0069] [Practical Example 3]

89.0 parts of (A2) a polydimethylsiloxane having the hexenyl group at both
25 molecular chain terminals and in side chain position, a viscosity of 100 mPa · s, and a hexenyl group content of 3.00 mass%; 3.0 parts of (B1) a dimethylsiloxane gum having a

plasticity of 1.4 mm and endblocked by the vinyl group at the molecular chain terminals; 7.8 parts of (C1) a methylhydrogenpolysiloxane having a viscosity of 25 mPa · s and a silicon-bonded hydrogen content of 1.6 mass% and endblocked by the trimethylsiloxy group at both molecular chain terminals; and 0.2 part (E) 1-ethynyl-1-cyclohexanol (ETCH) were mixed to uniformity. Into the resulting mixture was blended (D) a chloroplatinic acid · 1,3-divinyl-1,1,3,3-tetramethyldisiloxane complex having a platinum metal content of 0.6 mass%, at a quantity of addition that provided a platinum metal quantity of 100 ppm, thereby producing a solvent-free curable organopolysiloxane composition having a viscosity of 300 mPa · s and designated as composition 3. The silicon-bonded hydrogen atom (Si–)H/Hex molar ratio in this composition was 1.25. The obtained organopolysiloxane composition was coated on polyethylene-laminated paper at coating rates of 0.6, 1.0 and 1.6 g/m² by the previously described method and was cured and the dynamic friction coefficient was measured on each of the resulting cured layers. The results are reported in Table 1.

15 **[0070]** [Comparative Example 1]

The procedure of Practical Example 2 was followed, but using 91.3 parts of (CA1) a polydimethylsiloxane having the vinyl group at both molecular chain terminals and in side chain position, a viscosity of 60 mPa · s and a vinyl group content of 1.60 mass% in place of said component (A1) and component (A2), to obtain a solvent-free curable organopolysiloxane composition (comparative composition 1). The obtained organopolysiloxane composition was coated on polyethylene-laminated paper at coating rates of 0.6, 1.0 and 1.6 g/m² by the previously described method and was cured and the dynamic friction coefficient was measured on each of the resulting cured layers. The results are reported in Table 1.

25 **[0071]** [Comparative Example 2]

The procedure of Practical Example 2 was followed, but using 91.3 parts of (CA1) a polydimethylsiloxane having the hexenyl group at both molecular chain terminals and in side chain position, a viscosity of 350 mPa · s and a vinyl group content of 0.70 mass% in place of said component (A1) and component (A2), to obtain a solvent-free curable organopolysiloxane composition (comparative composition 2). The obtained organopolysiloxane composition was coated on polyethylene-laminated paper at coating rates of 0.6, 1.0 and 1.6 g/m² by the previously described method and was cured and the dynamic friction coefficient was measured on each of the resulting cured layers. The results are reported in Table 1.

10 **[0072]** [Comparative Example 3]

The procedure of Practical Example 2 was followed, but using 91.3 parts of (CA1) a polydimethylsiloxane having the hexenyl group at both molecular chain terminals and in side chain position, a viscosity of 100 mPa · s and a vinyl group content of 8.00 mass%, in place of said component (A1) and component (A2), to obtain a solvent-free curable organopolysiloxane composition (comparative composition 2). The obtained organopolysiloxane composition was coated on polyethylene-laminated paper at coating rates of 0.6, 1.0 and 1.6 g/m² by the previously described method and was cured and the dynamic friction coefficient was measured on each of the resulting cured layers. The results are reported in Table 1.

20 **[0073]** Furthermore, the release force is measured for the cured coatings of practical example 2, comparative example 1 to 3 using the method described below. The results are shown in Table 2.

[Release force evaluation]

An acrylic-type solvent-based pressure-sensitive adhesive (trade name: Oribain BPS-5127, from Toyo Ink Mfg. Co., Ltd.) was uniformly coated using an applicator at 30 g/m² as solids on the surface of the cured coating layer produced by the method

described above and heating was carried out for 2 minutes at 70°C. High-quality paper (areal weight = 64 g/m²) was then pasted on the surface of this acrylic-type pressure-sensitive adhesive and the resulting adhered paper was cut to a width of 5 cm to fabricate the test specimen. A load of 20 g/cm² was placed on this test specimen followed by
5 standing for 24 hours in the air at a temperature of 25°C and a humidity of 60%. Using a tensile tester (Tensilon universal testing instrument, from A & D Co., Ltd.), the adhered paper was then peeled off at an angle of 180° and a peel rate of 0.3 m/minute and the force (mN/50mm) required for peeling was measured.

[0074] [Practical Example 4]

10 The dynamic friction coefficient was measured on the cured layers proceeding as in Example 1, but in this case using the polyethylene terephthalate (PET) film rather than the polyethylene-laminated paper. The results are reported in Table 2.

[0075] [Practical Example 5]

15 The dynamic friction coefficient was measured on the cured layers proceeding as in Example 2, but in this case using the polyethylene terephthalate (PET) film rather than the polyethylene-laminated paper. The results are reported in Table 2.

[0076] [Practical Example 6]

20 The dynamic friction coefficient was measured on the cured layers proceeding as in Example 3, but in this case using the polyethylene terephthalate (PET) film rather than the polyethylene-laminated paper. The results are reported in Table 2.

[0077] [Table 1.]

friction coefficient	coating rate (g/m ²)	pulling velocity during measurement of the dynamic friction coefficient (mm/minute)			velocity dependence: (δ _S)%
		10	30	100	
Example 1 (composition 1)	0.6	0.102	0.112	0.130	27.5
	1.0	0.096	0.106	0.128	33.3
	1.6	0.102	0.120	0.146	43.1
	(Δ) %*	0.0	7.1	12.3	
Example 2 (composition 2)	0.6	0.098	0.106	0.121	23.5
	1.0	0.098	0.110	0.126	28.6
	1.6	0.098	0.110	0.136	38.8
	(Δ) %*	0.0	3.8	12.4	
Example 3 (composition 3)	0.6	0.102	0.108	0.118	15.7
	1.0	0.100	0.108	0.122	22.0
	1.6	0.090	0.096	0.106	17.8
	(Δ) %*	-11.8	-11.1	-10.2	
Comparative Example 1 (Comparative Composition 1)	0.6	0.144	0.152	0.184	27.8
	1.0	0.152	0.168	0.192	26.3
	1.6	0.180	0.228	0.256	42.2
	(Δ) %*	25.0	50.0	39.1	
Comparative Example 2 (Comparative Composition 2)	0.6	0.144	0.140	0.156	8.3
	1.0	0.144	0.152	0.176	22.2
	1.6	0.144	0.176	0.232	61.1
	(Δ) %*	0.0	25.7	48.7	
Comparative Example 3 (Comparative Composition 3)	0.6	0.126	0.122	0.136	7.9
	1.0	0.122	0.106	0.104	-14.8
	1.6	0.108	0.096	0.108	0.0
	(Δ) %*	-14.3	-21.3	-20.6	

* Increase in the dynamic friction coefficient

[0078] [Table 2.]

Release force(mN/50mm)	peel rate (0.3 m/minute)
Example 2 (composition 2)	230
Comparative Example 1 (Comparative Composition 1)	480
Comparative Example 2 (Comparative Composition 2)	290
Comparative Example 3 (Comparative Composition 3)	330

[0079] [Table 3.]

friction coefficient	coating rate (g/m ²)	pulling velocity during measurement of the dynamic friction coefficient (mm/minute)		
		10	30	100
Example 4 (composition 1)	0.6	0.112	0.140	0.192
	1.0	0.148	0.176	0.244
	1.6	0.176	0.208	0.288
	(Δ) %*	57.1	48.6	50.0
Example 5 (composition 2)	0.6	0.148	0.184	0.256
	1.0	0.148	0.172	0.244
	1.6	0.144	0.168	0.240
	(Δ) %*	-2.7	-8.7	-6.3
Example 6 (composition 3)	0.6	0.168	0.216	0.296
	1.0	0.144	0.184	0.260
	1.6	0.168	0.188	0.260
	(Δ) %*	0.0	-13.0	-12.2

* Increase in the dynamic friction coefficient

[0080] As shown in Table 1 for the use of polyethylene-laminated paper as the substrate, the composition of the present application, and particularly compositions 2 and 3, provided an inhibition of the increase in the dynamic friction coefficient of the cured layer even when the applied thickness was varied from 0.6 to 1.0 to 1.6 g/m², and provided an inhibition of the velocity dependence of the dynamic friction coefficient at a coating rate of 1.6 g/m² (thick coating). In addition, with composition 3, the velocity dependence of the dynamic friction coefficient was suppressed to less than 20% even at a coating rate of 1.6 g/m² (thick coating). On the other hand, in the cured coating layer of comparative examples 1 to 3, especially at a displacement velocity of more than 30 mm/minute, the dynamic friction coefficient was varied by over 20% from 0.6 to 1.0 to 1.6 g/m², dependent on the thickness. For the cured coating of comparative example 2 and 3, the velocity dependence of the dynamic friction coefficient at a coating rate of 1.6 g/m² (thick coating) is very large value. Furthermore, as shown in Table 2, the release forces of comparative examples are relatively higher than those of practical examples.

[0081] As shown in Table 2 for the use of polyethylene terephthalate film as the substrate, the composition of the present application, and particularly compositions 2 and 3, provided an inhibition of the increase in the dynamic friction coefficient of the cured layer even when the applied thickness was varied from 0.6 to 1.0 to 1.6 g/m².

CLAIMS

1. A curable organopolysiloxane composition comprising

(A) 100 mass parts of at least one organopolysiloxane that has a viscosity at
5 25°C of 20 to 500 mPa · s and a content of C₄₋₁₂ higher alkenyl groups in the
range of 1.0 to 5.0 mass%,

(B) 0.5 to 15 mass parts of an organopolysiloxane that ranges from a gum-state
to a fluid with a viscosity at 25°C of at least 1,000,000 mPa · s and that has a
content of C₂₋₁₂ alkenyl groups of 0.005 to 0.100 mass%,

10 (C) an organohydrogenpolysiloxane that has at least two silicon-bonded
hydrogen atoms (Si-H) in each molecule, in an amount that provides a value of
0.5 to 5 for the molar ratio of the SiH group in component (C) to the alkenyl
groups in components (A) and (B), and

(D) a platinum-type catalyst in a catalytic amount.

15 2. The curable organopolysiloxane composition according to claim 1,
wherein component (A) is a mixture of at least two organopolysiloxanes, in which

(A1) an organopolysiloxane having a content of C₄₋₁₂ higher alkenyl groups in
the range of 0.5 to 2.0 mass% and

20 (A2) an organopolysiloxane having a content of C₄₋₁₂ higher alkenyl groups in
the range of 2.5 to 5.0 mass%
are mixed at a mass ratio of 1/4 to 4/1.

3. The curable organopolysiloxane composition according to claim 1 or 2,
wherein the higher alkenyl group in component (A) is the hexenyl group.

4. The curable organopolysiloxane composition according to claim 1, wherein component (B) is a dimethylpolysiloxane endblocked by the dimethylvinylsiloxy group at both molecular chain terminals.

5. The curable organopolysiloxane composition according to any of claims 1 to 4, characterized in that the composition is solvent free and the viscosity of the composition as a whole is 100 to 5,000 mPa · s at 25°C.

6. The curable organopolysiloxane composition according to any of claims 1 to 5, characterized in that, when the coefficient of dynamic friction is measured according to Japanese Industrial Standard P8147 at a displacement velocity of 10 mm/minute on cured layers provided by coating the curable organopolysiloxane composition on a sheet-form substrate at 0.6 g/m² and at 1.6 g/m² and curing in each instance by heating at 130°C for 30 seconds, the % increase (Δ) in the coefficient of dynamic friction calculated with the following formula is not more than 10%.

$$\begin{aligned} & \% \text{ increase } (\Delta) \text{ in the coefficient of dynamic friction} \\ & = \left[\left\{ (\text{coefficient of dynamic friction for the cured layer coated at } 1.6 \text{ g/m}^2) \right. \right. \\ & \quad \left. \left. - (\text{coefficient of dynamic friction for the cured layer coated at } 0.6 \right. \right. \\ & \quad \left. \left. \text{g/m}^2) \right\} / \text{coefficient of dynamic friction for the cured layer coated at } 0.6 \right. \\ & \quad \left. \text{g/m}^2 \right] \times 100 \end{aligned}$$

7. A sheet-form article that has a cured layer provided by thermally curing the curable organopolysiloxane composition according to any of claims 1 to 6.

8. The sheet-form article according to claim 7, characterized in that the cured layer is a cured layer provided by coating the curable organopolysiloxane composition according to any of claims 1 to 6 on a sheet-form substrate at a rate of 1.0 to 10.0 g/m² and curing the composition by the application of heat.

9. The sheet-form article according to claim 7 or 8, wherein the substrate is a polyethylene-laminated paper or a plastic film.
10. A surface-protection sheet comprising a sheet-form article according to any of claims 7 to 9.
- 5 11. A method of producing the sheet-form article according to claim 7 or 8, said method being characterized by
- coating a sheet-form substrate with 1.0 to 10.0 g/m^2 of the curable organopolysiloxane composition according to any of claims 1 to 6; and forming a cured layer by curing by the application of heat.
- 10 12. A method of producing a surface-protection sheet, characterized by
- coating a substantially transparent sheet-form substrate with 1.0 to 10.0 g/m^2 of the curable organopolysiloxane composition according to any of claims 1 to 6; and
- forming a cured layer by curing by the application of heat.
- 15 13. A laminate constructed by applying a pressure-sensitive adhesive sheet (SA) comprising a layer of a pressure-sensitive adhesive provided on at least one side of a sheet-form substrate to a sheet-form substrate (S1) comprising a sheet-form substrate having on at least one side thereof a cured layer provided by thermally curing the curable organopolysiloxane composition according to any of
- 20 claims 1 to 6, wherein application is performed so that the pressure-sensitive adhesive layer is in contact with the aforementioned cured layer.
14. A laminate constructed by applying a release sheet (SR) comprising a release layer provided on at least one side of a sheet-form substrate to a sheet-form substrate (S1) comprising a sheet-form substrate having on at least one side thereof
- 25 a cured layer provided by thermally curing the curable organopolysiloxane

composition according to any of claims 1 to 6, wherein application is performed so that the release layer is in contact with the aforementioned cured layer.