DOUBLE-SIDED MOLDING METHOD AND MOLDED PRODUCT

TECHNICAL FIELD

[0001] The present disclosure relates to a double-sided molding method to form respective patterns on both surfaces of an object to be molded, and a molded product.

BACKGROUND ART

[0002] Conventionally, nano-imprinting technologies are known as schemes for forming a fine pattern in a micro-order or in a nano-order. This is to press, against an object to be molded like a resin, a mold that has a fine molding pattern, and to transfer the pattern to the object to be molded by utilizing heat and light. In recent years, in order to enhance the performances of optical members, such as an optical lens and a waveguide for an AR glass, transferring of respective fine patterns to both surfaces of a substrate is desired. Hence,

developments have been made for apparatuses for double-sided imprinting (see, for example, Patent Document 1) and for double-sided imprinting methods for applying a water-soluble protection film, etc., so as to protect a fine pattern, and for removing such a protection film after imprinting is performed on both surfaces (see, for example, Patent Document 2).

CITATION LIST

PATENT LITERATURES

[0003] Patent Document 1: WO2014/034576A

Patent Document 2: WO2019/159969A

SUMMARY OF INVENTION

TECHNICAL PROBLEM

[0004] However, since the apparatuses for double-sided imprinting are special apparatuses, an initial installation cost is expensive. Conversely, the scheme

for forming a water-soluble protection film has technical problems such that it takes a time for applying or removing the protection film.

[0005] Hence, pasting of a protective film to which an adhesive is applied on a fine pattern is conceivable. However, general protective films are designed for semiconductor processes, and are suitable for the protection of a semiconductor element formed of a material other than a resin, but have excessive intimate-contact characteristics to a fine pattern formed of a resin. Hence, there is a technical problem such that an adhesive is left. In particular, since pressurization is performed in molding according to nano-imprinting process, when the adhesive of the protective film enters the fine pattern, the adhesive is likely to stick in comparison with general semiconductor processes. Hence, general protective films are not applicable as those are. Furthermore, it is necessary for the protective film not

to be separated from the object to be protected during the processes, and not to cause a failure in the fine pattern subjected to protection.

[0006] Accordingly, an objective of the present disclosure is to provide a double-sided molding method that utilizes a protective film which is not separated from a resin pattern subjected to protection during a process, does not cause a failure, and does not leave an adhesive when the protective film is removed, and a molded product of the same.

[0007] In this specification, a fine pattern according to the present disclosure means a pattern with a size molded by imprinting process, in particular, a pattern with a size molded in nano-imprinting process. More specifically, it is a pattern that has a region where the depth of the concavity of the molded concavo-convex structure or the height of the convexity thereof is 1-nm order (1 nm to 9 nm) to 100-μm order (100 μm to 999 μm).

In the case of nano-imprinting processes, it may have a region where the depth of the concavity of the molded concavo-convex structure or the height of the convexity thereof is 1-nm order (1 nm to 9 nm) to 100-nm order (100 nm to 999 nm). Moreover, the bottom width of the concavity of the molded concavo-convex structure and the top width of the convexity thereof may be also in the above-described size. Note that among combinations of the depth of the concavity (or the height of the convexity) and the bottom with of the concavity (or the top width of the convexity), one may be 1-nm order to 100-μm order, and the other may be 1-nm order to 100-nm order, or vice versa. The bottom width of the concavity or the top height of the convexity may be a size that is greater than the above-described size, e.g., 1-mm order, depending on an application

The cross-sectional shape of the concavo-convex structure may be, depends on a mold, a polygonal shape

like a rectangular, a shape with a curvature like a half circle, and a shape that is a combination of a curvature with a straight line. Those may be shapes having undergone various chamfering processes or tapering processes.

SOLUTION TO PROBLEM

[0008] In order to accomplish the above objective, a double-sided molding method according to the present disclosure is for forming a first resin pattern on a first surface of a substrate and for forming a second resin pattern on a second surface of the substrate, the double-sided molding method including:

a protective film pasting process of pasting, on the first resin pattern, a silicone-rubber-layer side of a protective film including a silicone-rubber layer; and

a second resin pattern molding process of forming the second resin pattern on the second surface after the protective film pasting process.

[0009] In this case, it is preferable that a tensile strength of the silicone-rubber layer should be greater than an adhesive force of the silicone-rubber layer. Moreover, the tensile strength of the silicone-rubber layer may be greater than or equal to 1.0 MPa. Furthermore, the adhesive force of the silicone-rubber layer may be greater than or equal to 10 kPa and be smaller than or equal to 1500 kPa.

[0010] It is preferable that an elasticity of the silicone-rubber layer should be smaller than an elasticity of a first resin forming the first resin pattern. The elasticity of the silicone-rubber layer may be smaller than 200 MPa. Moreover, the elasticity of the first resin may be greater than or equal to 200 MPa.

[0011] It is preferable that a thickness of the silicone-rubber layer should be greater than or equal to 1 μm and be smaller than or equal to 1 mm.

[0012] Moreover, it is preferable that the double-sided molding method should further include a protective film removing process of removing the protective film pasted on the first surface after the second resin pattern molding process.

[0013] The silicone-rubber layer may be a cured addition-and-curable type silicone adhesive composition which contains:

(A) organo-polysiloxane which has, in a molecule, at least two alkenyl radicals coupled to a silicon atom, and which has a viscosity that is 0.01 to 1000 Pa·s at 25 °C: 100 parts by mass;

(B) organo-polysiloxane resin having an alkenyl radical: 5 to 500 parts by mass;

(C) organo-hydrogen-polysiloxane which has, in a molecule, greater than or equal to two hydrogen atoms coupled with a silicon atom: an amount that causes the hydrogen atoms coupled with the respective silicon atoms in the constituent (C) to be 0.1 to 5.0 times mol relative to a total amount of alkenyl radicals coupled with all the silicon atoms in the composition; and

(D) platinum-group metal-based catalyst,

and which does not contain non-cross-linkable organo-polysiloxane resin.

[0014] Moreover, a molded product according to the present disclosure includes:

a substrate including a first surface and a second surface;

a first resin pattern formed on the first surface; and

a protective film including a silicone-rubber layer pasted on the first resin pattern.

[0015] In this case, it is preferable that a tensile strength of the silicone-rubber layer should be greater than an adhesive force of the silicone-rubber layer. The tensile strength of the silicone-rubber layer may be greater than or equal to 1.0 MPa. Moreover, the adhesive force of the silicone-rubber layer may be greater than or equal to 10 kPa and be smaller than or equal to 1500 kPa.

[0016] It is preferable that an elasticity of the silicone-rubber layer should be smaller than an elasticity of a first resin forming the first resin pattern. The elasticity of the silicone-rubber layer may be smaller than 200 MPa. Moreover, the elasticity of the first resin may be greater than or equal to 200 MPa.

[0017] It is preferable that a thickness of the silicone-rubber layer should be greater than or equal to 1 μm and be smaller than or equal to 1 mm.

[0018] Moreover, the molded product may further include a second resin pattern formed on the second surface.

[0019] Furthermore, the silicone-rubber layer may be a cured addition-and-curable type silicone adhesive composition which contains:

(A) organo-polysiloxane which has, in a molecule, at least two alkenyl radicals coupled to a silicon atom, and which has a viscosity that is 0.01 to 1000 Pa·s at 25 °C: 100 parts by mass;

(B) organo-polysiloxane resin having an alkenyl radical: 5 to 500 parts by mass;

(C) organo-hydrogen-polysiloxane which has, in a molecule, greater than or equal to two hydrogen atoms coupled with a silicon atom: an amount that causes the hydrogen atoms coupled with the respective silicon atoms in the constituent (C) to be 0.1 to 5.0 times mol relative to a total amount of alkenyl radicals coupled with all the silicon atoms in the composition; and

(D) platinum-group metal-based catalyst,

and which does not contain non-cross-linkable organo-polysiloxane resin.

ADVANTAGEOUS EFFECTS OF INVENTION

[0020] According to the double-sided molding method of the present disclosure, a defect of a pattern is suppressed using a protective film. Hence, respective patterns can be transferred to, by imprinting, both surfaces of an object to be molded using conventional imprinting apparatuses.

BRIEF DESCRIPTION OF DRAWINGS

[0021] FIG. 1 is a cross-sectional view illustrating a double-sided molding method according to the present disclosure.

DESCRIPTION OF EMBODIMENTS

[0022] A double-sided molding method according to the present disclosure is for forming a first resin pattern 110 (also referred to as a first pattern) on a first surface 11 of a substrate 1, and also for forming a second resin pattern 120 (also referred to as a second pattern) on a second surface 12 of the substrate 1. The double-sided molding method mainly includes a protective film pasting process, and a second resin pattern molding process for forming the second resin pattern 120 on the second surface 12 after the protective film pasting process. The first surface 11 and the second surface 12 mean substantially opposing major surfaces of the substrate to each other, and are each a surface with a larger area than those of the other surfaces.

[0023] The substrate 1 is to form the first resin pattern 110 on the first surface 11 and is to form the second resin pattern 120 on the second surface 12 of such a substrate 1. The substrate 1 may be in any shape as

far as the first resin pattern 110 and the second resin pattern 120 may be formed, by imprinting, on both surfaces, respectively. Example shapes of the substrate 1 are a plate shape, a film shape with a flexibility, and a lens shape. Hence, the first surface 11 and the second surface 12 may be each a flat surface, a curved surface, or may be a combination thereof. It becomes clear from such a definition that the substrate can be described as a base material that has two major surfaces. When the substrate (the base material) is not rigid but flexible, improvement for the handling-easiness of the substrate (the base material) can be expected by pasting the protective film.

[0024] Moreover, the material of the substrate 1 is not limited to any particular material as far as the first resin pattern 110 can be formed on the first surface 11 and the second resin pattern 120 can be formed on the second surface 12 of the substrate 1. Applicable

examples are an inorganic material, such as glass or silicon, a metal material like aluminum, and a resin material, such as a silicone-based resin, an epoxy-based resin, or an acrylic-based resin.

[0025] Moreover, the first resin pattern 110 and the second resin pattern 120 are each formed of a fine concavo-convex structure, and are each to give a desired function to each surface of the substrate 1. The concavo-convex structure is not limited to any particular structure as far as a desired function can be given to the surface of the substrate 1, and for example, may be a structure that diffracts light like an AR waveguide, a structure that suppresses reflection like moth-eye, or a structure that polarizes light like a wire grid. Note that the first resin pattern 110 and the second resin pattern 120 may have different functions and structures from each other.

[0026] A first resin 31 applied for the first resin pattern 110 and a second resin 32 applied for the second resin pattern 120 are not limited to any particular resins as far as the first resin pattern 110 and the second resin pattern 120 can be formed, and for example, may be a photo-curable resin capable of optical imprinting, and a thermoplastic resin or thermosetting resin capable of thermal imprinting. Note that an intermediate layer may be formed between the substrate 1 and the first resin 31 or second resin 32 so as to improve an intimate-contact, etc., between the substrate 1 and the first resin 31 or second resin 32. Moreover, the substrate 1 may be a resin on which the first resin pattern 110 and the second resin pattern 120 can be formed. In this case, as for the substrate 1, for example, a photo-curable resin capable of optical imprinting, and a thermoplastic resin or thermosetting resin capable of thermal imprinting may be applied. The

state of the resin in the first resin pattern 110 or that in the second resin pattern 120 are not limited to any particular states, and may be an uncured state of a curable resin, a B-stage state, and a C-stage state.

[0027] The first resin pattern 110 is formed on the first surface 11 of the substrate 1 by a first resin pattern molding process prior to a protective film pasting process. The formation of the first resin pattern 110 may be carried out in any schemes, but for example, the substrate 1 as illustrated in FIG. 1, part (a) is prepared, and a primer 4 is applied as illustrated in part (b). The primer 4 herein is to improve the wettability between the substrate 1 and the resin to be applied thereon. Subsequently, as illustrated in FIG. 1, part (c), a resin is applied to the first surface 11 of the substrate 1, and as illustrated in FIG. 1, part (d) and part (e), conventionally known imprinting, such as optical imprinting or thermal imprinting, is performed on

the first surface 11 of the substrate 1 for such a formation. Moreover, a mask to which a pattern is transferred by imprinting may be formed on the substrate 1, and etching may be performed using the mask so as to form the first resin pattern 110 on the substrate 1. Furthermore, the pattern of a resist may be formed on, by imprinting, etc., the substrate 1, and this may be utilized as a resist so as to form the first pattern by etching on the substrate surface. The pattern of the resist may be eliminated after the first pattern is formed, or may be left as a part of the first pattern. This means that it is not always necessary for the first resin pattern to be formed by imprinting.

[0028] As illustrated in FIG. 1, part (f), the protective film pasting process is a process of pasting, on the first resin pattern 110, the silicone-rubber layer side of the protective film 2 that includes a silicone-rubber layer. As for the protective film 2, it is

appropriate that at least a part of the silicone-rubber layer is pasted on the convexities of the first resin pattern 110. As for the pasting of the protective film 2, conventionally known film pasting apparatuses like a laminating apparatus are applicable.

[0029] The protective film 2 herein is to be pasted on the first resin pattern 110 of the substrate 1 and to protect the first resin pattern 110 against damage, etc. The protective film 2 includes a film layer and the silicone-rubber layer. It is preferable that the film layer and the silicone-rubber layer should be in a stacked structure, and may include an intermediate layer like an intimate-contact accomplishing layer that improves the intimate-contact between the film layer and the silicone-rubber layer. Moreover, the protective film may be obtained by film formation of, for example, applying a silicone rubber on the film layer. When a silicone rubber film can be formed alone, the protective

film can be obtained by pasting the silicone-rubber layer on the film layer. In this case, when the silicone-rubber layer can be handled alone, the film layer is not always requisite. For example, such a silicone-rubber layer can be obtained by, not only a scheme of forming a silicone rubber film alone, but also a scheme of removing the film layer from the protective film.

[0030] Moreover, the silicone rubber film may be directly formed on the first pattern including the first resin pattern. In such a case, it may be advantageous, in some cases for subsequent removal of the silicone-rubber layer, that the film is formed in such a way that voids remain at the bottom, etc., of the concavity of the concavo-convex structure rather than formation of the film in such a way that the silicone rubber is completely filled in the concavity.

[0031] The film layer is not limited to any particular layer as far as it is not damaged after pasted on the

first resin pattern 110 and until removed from the first resin pattern 110 after the second resin pattern 120 is formed. Example applicable materials of the film layer are a polymer film, such as polyethylene-terephthalate, polyolefin, polyvinyl-chloride or polyimide, a metal film, such as a copper foil or an aluminum foil, non-woven fabric cloth, and foam. The film layer may have a thickness selected depending on the size of a pattern to be molded and the distribution thereof, on the shape of the substrate major surface, and on the handling-easiness of the protective film, and for example, such a thickness is 1 μm to 1 mm, and may be 30 to 500 μm.

[0032] The silicone-rubber layer is to be intimately in contact with the surface of the substrate 1 where the first resin pattern 110 is formed, and is to protect the first resin pattern 110 against scratch, etc. In this case, when the tensile strength of the silicone-rubber layer is smaller than the adhesive force of the silicone-

rubber layer, an adhesive may be possibly left on the resin pattern when the protective film is removed. Hence, it is preferable that the tensile strength of the silicone-rubber layer should be greater than the adhesive force of the silicone-rubber layer. It is also preferable that the silicone-rubber layer should have a tensile strength in such a way that the silicone-rubber layer does not break at least during an imprinting process. Accordingly, it is preferable that the silicone-rubber layer should have a tensile strength which is greater than or equal to 0.5 MPa, and more preferably, greater than or equal to 1.0 MPa. Although there is no particular limit, the upper limit of the tensile strength may be 20 MPa or so from the standpoint of easiness of obtainment.

[0033] <Measuring Method for Tensile Strength of Rubber Layer>

A metal pressing plate was prepared on which a PTFE sheet (available from NICHIAS Corporation, product name: TOMBO No. 9001) was placed, and a metal spacer in a rectangular frame shape (thickness: 2 mm) was placed on the PTFE sheet. Next, a silicone adhesive composition was poured in the spacer, a Teflon sheet and another metal pressing plate were placed thereon so as to hold the silicone adhesive composition. Those were pressed and cured under a condition that was 150 °C × 10 minutes, and further heated in an oven for 30 minutes at 150 °C. Subsequently, those were left as those were for 14 hours at a room temperature so as to obtain a sheet with a thickness that was 2.0 mm. For example, the heating condition is adjustable as appropriate so as to match, as possible, the vulcanization level in a state utilized as the protective film. It is necessary that respective surfaces of the Teflon sheet, the metal spacer and the metal pressing plate are clean, and have a smooth surface

texture that does not produce concavities and convexities which give an adverse effect to the tensile strength of the sheet surface, and a polishing process is performed on the Teflon sheet, the metal spacer and the metal pressing plate as needed. Note that as for an apparatus and other conditions, etc., see JIS K 6299: 2012 "rubber, creation method of experimental sample" as appropriate.

The obtained sheet was punched out by a punching tool defined in JIS K 6251: 2017 "vulcanized rubber and thermoplastic rubber, how to obtain tensile characteristics", and thus a dumbbell second test piece was obtained. Using such a test piece, in accordance with JIS K 6251: 2017, a tensile strength was obtained by carrying out a tensile test at a tensile speed that was 500 mm/minute, and at a measurement temperature that was 23 ℃ (room temperature) by an autograph AGS-X available from SHIMADZU Corporation. Note that, as for the other measurement conditions, etc., see JIS K 6249: 2003

"uncured and cured silicone rubber testing method" and JIS K 6250: 2019 "rubber, physical testing method general rule", in addition to the above-described JIS K 6251: 2017 as needed.

[0034] According to the present disclosure, although the tensile strength is a value obtained by the above-described measurement, there may be a case in which a sheet which is already cured and which has a thickness other than 2 mm is merely available. This corresponds to a case in which adjustment cannot be made since the composition of an object before cured is unknown. In such a case, when the film layer of the protective film is removable and such a removal does not give, to the rubber layer, a damage that gives an adverse effect to the tensile strength, an estimation can be made by carrying out measurement on the rubber layer from which the film layer is removed. In this case, the tensile strength at a thickness that is 2 mm can be estimated by

setting the measuring conditions other than the thickness to be consistent with those of the above-described measuring method, and by adopting an actual thickness when the result is to be calculated. According to the knowledges of the inventors of the present disclosure, the value of the tensile strength measured with a sheet that had a thickness which was 1 mm and the value of the tensile strength measured with a sheet that had a thickness which was 200 μm had the similar results to each other.

[0035] Moreover, it is preferable that the silicone-rubber layer should have an adhesive force which allows such a layer to be intimately in contact with the first resin pattern 110, and which does not allow such a layer to be separated therefrom during an imprinting process. Hence, it is preferable that the adhesive force of the silicone-rubber layer should be greater than or equal to 10 kPa, and more preferably, greater than or equal to 20

kPa. Moreover, it is preferable that the protective film should be easily removed without any adhesive being left. Accordingly, it is preferable that, for example, the adhesive force of the silicone-rubber layer should be smaller than or equal to 1500 kPa, and more preferably, smaller than or equal to 1200 kPa.

[0036] <Measuring Method for Adhesive force of Rubber Layer (Silicone-rubber layer)>

A silicone adhesive composition was poured in an aluminum Petri dish so as to accomplish a thickness that was 1 mm. After it was left so as to cause a surface thereof to be substantially horizontal, it was heated in an oven at 150 ℃ for 30 minutes, left for 14 hours under an environment that was 23 ℃ and 50-% RH (Relative Humidity) so as to obtain a rubber layer. The heating condition is adjustable as appropriate so as to match, as possible, the vulcanization level in a state utilized as the protective film. Note that since the surface texture

of the rubber layer gives an adverse effect to the adhesive force, a smooth state was maintained without causing air bubbles to be remained and without any large concavity and convexity and further a large inclination to be present. Moreover, not only within the measurement, attempts were made so as to prevent a dirt from sticking to the surface (the adhesive surface) of the rubber layer, avoid any contact to the adhesive surface, and prevent a foreign material to stick.

[0037] Next, a double-sided adhesive tape (available from Nitto Denko Corporation, product name: general-purpose double-sided tape No. 501F) was pasted on the back surface of the aluminum Petri dish under an environment that was 23 °C and 50-% RH (Relative Humidity), and was sufficiently fastened to the lower pressure mount that was the sample stage of a compact bench tester EZ-SX available from SHIMADZU Corporation. An SUS probe in a rectangular pillar shape with a size 1

mm by 1 mm and attached to the tester was depressed vertically against the surface (the adhesive surface) of the rubber layer from the upper side toward the lower side. As for such depression, after the probe was caused to contact the adhesive surface at a rate of 0.05 mm/s, contact load that was 1 MPa was applied for 15 seconds.

Subsequently, contrary to the depression, the probe was moved from the lower side toward the upper side so as to be vertical to the surface (the adhesive surface) of the rubber layer at a rate of 200 mm/min, necessary force for the probe to be removed from the surface of the rubber layer was measured, and the maximum measured value was taken as the adhesive force. Measurements were carried out by five times for each sample, and the average value of the adhesive forces in respective measurements is taken as the adhesive force according to the present disclosure.

[0038] Note that an adverse effect given from the surface texture of the probe to the adhesive force in the measurement is not ignorable. Accordingly, it is preferable that the material should be SUS304, and the surface roughness should be limited to 250 to 500 nm at a root-mean-square roughness (Rq).

[0039] According to the present disclosure, there is a tendency such that, as for the adhesive force, a precise value is not likely to be obtained unless a sample has a thickness greater than or equal to 1 mm. Hence, in the above-described measurements, although the measurement was performed on the sample with a thickness that was 1 mm, there may be a case in which a sheet which is already cured and which has a thickness less than 1 mm is merely available. This corresponds to a case in which adjustment cannot be made since the composition of an object before cured is unknown. In such a case, when the film layer of the protective film is removable and such a

removal does not give, to the rubber layer, a damage that gives an adverse effect to the adhesive force, an estimation can be made by carrying out measurement on a sheet which is obtained by laminating a plurality of rubber layers from which respective film layers are removed and which has thus a thickness that is at least 1 mm. In this case, the surface of the rubber layer subjected to measurement may become rough. The surface roughness of the surface subjected to measurement may give an adverse effect to the measured value of the adhesive force. Hence, when the surface subjected to measurement is rough, it is preferable that the surface subjected to measurement should be made smooth by, for example, pressurization via a Teflon sheet prior to the measurement.

[0040] Moreover, it is preferable that the elasticity of the silicone-rubber layer should be able to achieve a flexibility capable of protecting the first resin pattern

110 of the substrate 1 against pressure and shock during the process. Hence, it is preferable that the elasticity of the silicone-rubber layer should be smaller than the elasticity of the first resin 31 that forms the first resin pattern 110. For example, it is preferable that the elasticity of the silicone-rubber layer should be smaller than 200 MPa, and more preferably, smaller than 100 MPa. In this case, it is preferable that the elasticity of the first resin 31 should be greater than or equal to 200 MPa, and more preferably, greater than or equal to 500 MPa. Note that although there is no particular limit, from the standpoint of easiness of obtainment and of handling, the lower limit of the elasticity of the silicone-rubber layer may be 0.1 MPa or 3 MPa or so. Moreover, although there is no particular limit, from the standpoint of the easiness of obtainment and of handling, the upper limit of the elasticity of the first resin 31 may be 50 GPa or so.

[0041] <Measuring Method for Elasticity of Rubber Layer (Silicone-rubber layer)>

A metal pressing plate was prepared on which a PTFE sheet (available from NICHIAS Corporation, product name: TOMBO No. 9001) was placed, and a metal spacer in a rectangular frame shape (thickness: 2 mm) was placed on the PTFE sheet. Next, a silicone adhesive composition was poured in the spacer, a Teflon sheet and another metal pressing plate were placed thereon so as to hold the silicone adhesive composition. Those were pressed and cured under a condition that was 150 °C × 10 minutes, and further heated in an oven for 30 minutes at 150 °C. Subsequently, those were left as those were for 14 hours at a room temperature so as to obtain a sheet with a thickness that was 2.0 mm. For example, the heating condition is adjustable as appropriate so as to match, as possible, the vulcanization level in a state utilized as the protective film. It is necessary that respective

surfaces of the Teflon sheet, the metal spacer and the metal pressing plate are clean, and have a smooth surface texture that does not produce concavities and convexities which give an adverse effect to the tensile strength of the sheet surface, and a polishing process is performed on the Teflon sheet, the metal spacer and the metal pressing plate as needed. Note that as for an apparatus and other conditions, etc., see JIS K 6299: 2012 "rubber, creation method of experimental sample" as appropriate.

The obtained sheet was cut in a size that was 5 mm by 30 mm to produce a sample. Next, the elasticity of the obtained sample was measured by dynamic viscoelasticity measurement (DMA) according to a scheme conforming to JIS K 7244-4: 1999 "plastic, dynamic and mechanical characteristic testing method, Section 4: tensile vibration and non-resonant method". More specifically, both ends of the sample were attached to the chuck of a dynamic viscoelasticity measuring

apparatus (available from UBM corporation, Rheogel-E4000) in such a way that a tensile direction became the lengthwise direction of the sample, and tensile load was applied under the following measuring conditions so as to carry out a measurement by a tension method. The measured value in this measurement at 25 °C was taken as an elasticity.

[Measurement Conditions for Elasticity]

Measured sample: rectangle in a size 5 mm by 30 mm

Distance from chuck: 20 mm

Measurement mode: Tension method (sinusoidal wave distortion, tensile mode, distortion amount: automatic distortion)

Temperature increasing rate: 3 °C/min

Temperature: higher than or equal to −60 °C but lower than or equal to 200 °C

Frequency: 10 Hz

Tensile load (static load): 20 g

[0042] According to the present disclosure, although the elasticity is a value obtained by the above-described measurement, there may be a case in which only a sheet which is already cured and which has a thickness other than 2 mm is available. This corresponds to a case in which adjustment cannot be made since the composition of an object before cured is unknown. In such a case, when the film layer of the protective film is removable and such a removal does not give, to the rubber layer, a damage that gives an adverse effect to the elasticity, an estimation can be made by carrying out measurement on the rubber layer from which the film layer is removed. In this case, the elasticity at a thickness that is 2 mm can be estimated by setting the measuring conditions other than the thickness to be consistent with those of the above-described measuring method, and by adopting an actual thickness when the result is to be calculated.

According to the knowledges of the inventors of the present disclosure, the value of the elasticity measured with a sample that had a thickness which was smaller than 2 mm and the value of the elasticity measured with a sample that had a thickness which was 2 mm had the similar results to each other when measurements of the elasticity were carried out for multiple samples from a thickness that was 100 μm to a thickness that was 2 mm regarding the silicone rubber with the same composition.

[0043] Moreover, it is preferable that the silicone-rubber layer should have a thickness capable of protecting the first resin pattern 110. Hence, it is preferable that the thickness of the silicone-rubber layer should be greater than or equal to 1 μm, and more preferably, greater than or equal to 5 μm. Furthermore, when the silicone-rubber layer is too thick, this may disrupt the formation of the second resin pattern 120. Hence, it is preferable that the thickness of the

silicone-rubber layer should be smaller than or equal to 1 mm, and more preferably, smaller than or equal to 500 μm. Still further, the thickness of the silicone-rubber layer or the protective film may be greater than or equal to the depth of the concavity of the concavo-convex structure or the height of the convexity thereof, or may be smaller than the depth of the concavity of the concavo-convex structure or the height of the convexity thereof depending on the protective form for the concavo-convex structure of the fine pattern. Example forms for protection are a form in which at least a part of the silicone-rubber layer enters at least some of the concavities for protection, a form in which the silicone-rubber layer and the film layer enter at least some of the concavities for protection, and a form in which the silicone-rubber layer covers the openings of the concavities in a shape like a tent for protection. Those can be selected as appropriate by appropriately adjusting

the thickness, hardness like elasticity, and adhesive force, etc., of the silicone-rubber layer and those of the film layer, and can be selected in accordance with the size and distribution of the pattern to be molded, and with the molding condition.

[0044] Although an object in a film shape that has a thickness smaller than 250 μm is sometimes referred to as a film, a film according to the present disclosure involves an object in a film shape or in a plate shape that has a thickness greater than or equal to 250 μm. Moreover, the protective film according to the present disclosure can be provided in, for example, a roll form in which the lengthen protective film is wound around a roll, or a sheet form in which the protective film is cut into a piece of sheet in accordance with a necessary size.

[0045] The silicone-rubber layer is not limited to any particular material as far as such a material can be

intimately in contact with the surface of the substrate 1 where the first resin pattern 110 is formed, and can protect the first resin pattern 110 against scratches, etc. For example, such a layer can be obtained from, for example, addition or condensed silicone adhesive compositions. Among those compositions, an addition silicone adhesive composition is preferable from the standpoint of little curing shrinkage and good film formation on the film layer. Note that when the film layer has a rigidity that can withstand a curing shrinkage when the silicone-rubber layer is formed, a condensed silicone adhesive composition is applicable. A preferable and example condensed silicone adhesive composition is a composition containing, for example, organo-polysiloxane, organo-polysiloxane resin, organo-hydrogen-polysiloxane and a metal-based catalyst. More specifically, a cured addition-and-curable type silicone adhesive composition is applicable which contains:

(A) organo-polysiloxane which has, in a molecule, at least two alkenyl radicals coupled to a silicon atom, and which has a viscosity that is 0.01 to 1000 Pa·s at 25 °C: 100 parts by mass;

(B) organo-polysiloxane resin having an alkenyl radical: 5 to 500 parts by mass;

(C) organo-hydrogen-polysiloxane which has, in a molecule, greater than or equal to two hydrogen atoms coupled with a silicon atom: an amount that causes the hydrogen atoms coupled with the respective silicon atoms in constituent (C) to be 0.1 to 5.0 times mol relative to the total amount of alkenyl radicals coupled with all silicon atoms in the composition; and

(D) platinum-group metal-based catalyst,

and which does not contain non-cross-linkable organo-polysiloxane resin.

[0046] (A) Organo-polysiloxane

Constituent (A) is a cross-linked constituent of this composition, and organo-polysiloxane which has a viscosity that is 0.01 to 1000 Pa·s at 25 °C, preferably, 0.05 to 500 Pa·s, and which has, in a molecule, alkenyl radicals coupled to at least two silicon atoms. When the viscosity at 25 °C is smaller than 0.01 Pa·s, the adhesive force of the cured substance decreases, and when the viscosity exceeds 1000 Pa·s, the workability decreases. Note that the above viscosity is a measured value by rotation viscometer (the same is true of the following).

Such organo-polysiloxane is not limited to any particular one as far as the above-described viscosity and alkenyl radical containing amount are satisfied. Conventionally known organo-polysiloxane is applicable, and the structure thereof may be linear or branch. Moreover, greater than or equal to two kinds of organo-

polysiloxane with different viscosities may be mixed with each other and applied together.

[0047] The alkenyl radical coupled to a silicon atom is not limited to any particular one, but alkenyl radical with a carbon number that is 2 to 10 is preferable, and alkenyl radical with a carbon number that is 2 to 8 is more preferable.

Specific examples are vinyl, allyl, 1-butenyl and 1-hexenyl radicals, etc. Among those, vinyl radical is preferable from the standpoint of the easiness of synthesis and of the costs.

Note that alkenyl radical may be present at either the end of the molecular chain of organo-polysiloxane or somewhere therein, but it is preferable that such radicals should be present at respective ends from the standpoint of flexibility.

[0048] The organic radicals other than the alkenyl radical coupled to a silicon atom are not limited to any

particular radicals, but univalent hydrocarbon radical with a carbon number that is 1 to 20 is preferable, and univalent hydrocarbon radical with a carbon number that is 1 to 10 is more preferable.

Specific examples are: alkyl radicals, such as methyl, ethyl, n-propyl, n-butyl, n-hexyl and n-dodecyl radicals; aryl radical like phenyl radicals; and aralkyl radicals, such as 2-phenylethyl and 2-phenyl propyl radicals.

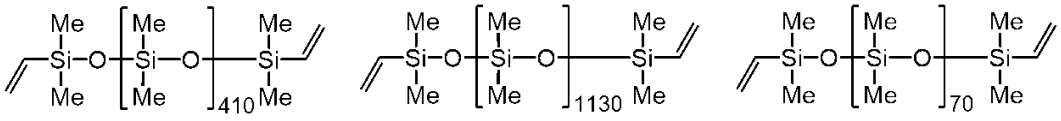
Moreover, some of or all of the hydrogen atoms of these hydrocarbon radicals may be substituted with halogen atoms, such as chlorine, fluorine and bromine, and specific examples are halogen-substituted univalent hydrocarbon radicals, such as fluoromethyl radical, bromoethyl radical, chloromethyl radical and 3,3,3-trifluoro propyl radical.

Among those, it is preferable that greater than or equal to 90 mol% should be methyl radical from the standpoint of the easiness of synthesis and of the costs.

Hence, it is particularly preferable that constituent (A) should be dimethylpolysiloxane that has respective ends closed by dimethyl vinyl silyl radicals, respectively. Note that constituent (A) may be applied alone, or greater than or equal to two kinds thereof may be applied together.

[0049] A specific example of such constituent (A) is organo-polysiloxane represented by the following formula, but is not limited to such example.

[0050] [Chemical Formula 1]



(where Me means methyl radical. The same is true of the following)

[0051] (B) Organo-polysiloxane Resin

Constituent (B) is a cross-linked resin that has alkenyl radical, and has a role of improving the hardness and rigidity of the cured substance, and also of applying the adhesiveness to the cured substance.

General silicone adhesives have the adhesiveness added thereto by combining a non-cross-linked resin. When such an adhesive is applied to protect a concavo-convex structure like the first resin pattern 110, the non-cross-linked resin not taken in a cross-linked structure is displaced on such a concavo-convex structure.

Conversely, constituent (B) applied for the composition according to the present disclosure has alkenyl radical, and is taken in the cross-linked structure at the time of curing. Accordingly, the material displacement to an element can be minimized when the cured substance is applied as a tentative fixing material.

[0052] It is preferable that the weight-average molecular weight of constituent (B) should be 500 to 30000, and more preferably, 1000 to 20000. When such molecular weight is within such a range, the workability of the composition and the adhesive force of the cured substance are improved. Note that the weight-average molecular weight is a standard polystyrene equivalent in Gel Permeation Chromatography (GPC).

[0053] It is preferable that, in constituent (B), the contained amount of alkenyl radical coupled with the silicon atom should be 0.001 to 1.000 mol per 100 g of constituent (B), and 0.010 to 0.500 mol is more preferable. When the amount is within such a range, the adhesive force of the cured substance and the mechanical properties thereof improve.

[0054] It is preferable that constituent (B) should contain at least a kind of branch formation unit including trifunctional siloxane unit (i.e., organo-

silsesquioxane unit) represented by $RSiO_{3/2}$ (where R represents a substituted or unsubstituted univalent hydrocarbon radical), and tetrafunctional siloxane unit represented by $SiO_{4/2}$.

Moreover, the organo-polysiloxane resin of constituent (B) can optionally contain monofunctional siloxane unit (i.e., triorganosiloxy unit) and/or bifunctional siloxane unit (i.e., a diorganosiloxane unit), and the total contained amount of $RSiO_{3/2}$ unit and $SiO_{4/2}$ unit is preferably greater than or equal to 10 mol% relative to whole siloxane unit in the organo-polysiloxane resin of constituent (B), and more preferably, 20 to 90 mol%.

[0055] In the above $RSiO_{3/2}$ unit, the preferable substituted or unsubstituted univalent hydrocarbon radical represented by R has a number of carbon atoms that is 1 to 10, and specific examples are: alkyl radicals, such as methyl, ethyl, n-propyl, isopropyl, n-

butyl, isobutyl, tert-butyl, n-pentyl, neopentyl, n-hexyl, n-heptyl, n-octyl, n-nonyl and n-decyl radicals; cycloalkyl radicals, such as cyclopentyl, cyclohexyl and cycloheptyl radicals; alkenyl radicals (the term alkenyl radical therein means to involve cycloalkenyl radical), such as vinyl, allyl(2-propenyl), 1-propenyl, isopropenyl, butenyl, pentenyl, hexenyl and cyclohexenyl radicals; aryl radicals, such as phenyl, tolyl, xylyl, naphthyl and biphenylyl radicals; aralkyl radicals, such as benzyl, phenylethyl and phenylpropyl radicals; and alkaryl radical like methylbenzyl radical.

Moreover, greater than or equal to one hydrogen atom of these hydrocarbon radicals may be substituted with a fluorine atom, a chlorine atom, a halogen atom like a bromine atom, or a cyano radical, and example substituted hydrocarbon radicals are halogenated alkyl radicals, such as chloromethyl radical, 2-bromoethyl

radical, 3-chloropropyl radical and 3,3,3-trifluoro propyl radical.

[0056] Example constituents (B) are copolymer including $R^1_3SiO_{1/2}$ unit, $R^1R^2SiO_{2/2}$ unit and $SiO_{4/2}$ unit, copolymer including $R^1_3SiO_{1/2}$ unit, $R^1_2SiO_{2/2}$ unit, $R^1R^2SiO_{2/2}$ unit, and $SiO_{4/2}$ unit, copolymer including $R^1_3SiO_{1/2}$ unit, $R^1_2R^2SiO_{1/2}$ unit, $R^1_2SiO_{2/2}$ unit, and $SiO_{4/2}$ unit, copolymer including $R^1_3SiO_{1/2}$ unit, $R^1_2R^2SiO_{1/2}$ unit, and $SiO_{4/2}$ unit, copolymer including $R^1_2R^2SiO_{1/2}$ unit, $R^1_2SiO_{2/2}$ unit, and $SiO_{4/2}$ unit, and copolymer including $R^1R^2SiO_{2/2}$ unit, $R^1SiO_{3/2}$ unit and/or $R^2SiO_{3/2}$ unit.

[0057] In the above formula, R^1 is a substituted or unsubstituted univalent hydrocarbon radical that does not have unsaturated aliphatic coupling, and is, for example, the radicals other than alkenyl radical among the above univalent hydrocarbon radicals exemplified by R. In particular, alkyl radicals, such as methyl, ethyl, n-propyl, n-butyl, n-pentyl, n-hexyl, and n-heptyl

radicals; aryl radicals, such as phenyl, tolyl, xylyl and naphthyl radicals; aralkyl radicals, such as benzyl and phenethyl radicals; and halogenated alkyl radicals, such as chloromethyl, 3-chloropropyl and 3,3,3-trifluoro propyl radicals, are preferable.

R^2 is alkenyl radical and examples thereof are vinyl, allyl, butenyl, pentenyl, hexenyl and heptenyl radicals.

[0058] More specific examples are copolymer including $(CH_3)_3SiO_{1/2}$ unit, $(CH_2=CH)SiO_{3/2}$ unit and $SiO_{4/2}$ unit, copolymer including $(CH_2=CH)(CH_3)_2SiO_{1/2}$ unit and $SiO_{4/2}$ unit, copolymer including $(CH_2=CH)(CH_3)_2SiO_{1/2}$ unit, $(CH_2=CH)$ $SiO_{3/2}$ unit, and $SiO_{4/2}$ unit, copolymer including $(CH_3)_3SiO_{1/2}$ unit, $(CH_2=CH)(CH_3)_2SiO_{1/2}$ unit and $SiO_{4/2}$ unit, and ones having some of methyl radicals thereof substituted with phenyl radicals.

[0059] Specific examples of constituent (B) can be expressed by the following average unit formula. In the

formula, Vi represents vinyl radical (the same is true of the following).

$(Me_3SiO_{1/2})_{0.35}(ViMe_2SiO_{1/2})_{0.1}(SiO_{4/2})_{0.55}$

$(Me_3SiO_{1/2})_{0.4}(ViMe_2SiO_{1/2})_{0.1}(SiO_{4/2})_{0.5}$

$(ViMeSiO)_{0.4}(Me_2SiO)_{0.15}(MeSiO_{3/2})_{0.45}$

$(ViMe_2SiO_{1/2})_{0.2}(Me_2SiO)_{0.25}(MeSiO_{3/2})_{0.55}$

$(Me_3SiO_{1/2})_{0.2}(ViMe_2SiO_{1/2})_{0.05}(MeSiO_{3/2})_{0.75}$

[0060] Although the blended amount of constituent (B) is 5 to 500 parts by mass relative to constituent (A) that is 100 parts by mass, it is preferable that such an amount should be 10 to 400 parts by mass. When constituent (B) is less than 5 parts by mass, sufficient adhesiveness as a tentative fixing material is unobtainable, and when it exceeds 450 parts by mass, the adhesiveness cannot be developed.

Note that, as for constituent (B), a single kind thereof may be applied or greater than or equal to two kinds thereof may be applied together.

[0061] (C) Organo-hydrogen-polysiloxane

Constituent (C) contains hydrogen atoms (i.e., SiH radical) coupled to, in a molecule, at least two (in general, 2 to 300), preferably, greater than or equal to three (e.g., 3 to 150 or so) silicon atoms, and may be any one of straight-chain, branch, annular, or three-dimensional mesh structure resin composition.

This organo-hydrogen-polysiloxane generally has a number of silicon atoms that is 2 to 300 in a molecule (i.e., polymerization degree), preferably, 3 to 200 or so.

A representative example of such organo-hydrogen-polysiloxane is organo-hydrogen-polysiloxane represented by the following average mean composition formula (1).

$$H_aR^3_bSiO_{(4-a-b)/2} \qquad (1)$$

(where R^3 is an unsubstituted or substituted univalent hydrocarbon radical which is independent from each other

and which does not contain aliphatic unsaturated bond, and a and b are each a number that satisfies $0 < a < 2$, $0.8 \leq b \leq 2$ and $0.8 < a+b \leq 3$, preferably, are each a number that satisfies $0.05 \leq a \leq 1$, $1.5 \leq b \leq 2$ and $1.8 \leq a+b \leq 2.7$.)

[0062] A preferable example of the above univalent hydrocarbon radical that does not contain aliphatic unsaturated bond of R^3 has a number of carbon atoms that is 1 to 10, and specific examples are: alkyl radicals, such as methyl, ethyl, n-propyl, isopropyl, n-butyl, isobutyl, tert-butyl, n-pentyl, neopentyl, n-hexyl, n-heptyl, n-octyl, n-nonyl and n-decyl radicals; cycloalkyl radicals, such as cyclopentyl, cyclohexyl and cycloheptyl radicals; aryl radicals, such as phenyl, tolyl, xylyl, naphthyl and biphenylyl radicals; aralkyl radicals, such as benzyl, phenylethyl and phenyl propyl radicals; alkalil radical like methylbenzyl radical; and halogenated alkyl radicals, such as chloromethyl, 2-

bromoethyl, 3-chloropropyl and 3,3,3-trifluoro propyl radicals in which greater than or equal to one hydrogen atom in those hydrocarbon radicals is substituted with fluorine atom, chlorine atom, halogen atom like bromine atom or cyano radical.

Among these, one that has a number of carbon atoms that is 1 to 7 is preferable, and alkyl radical, phenyl radical and 3,3,3-trifluoro propyl radical which have a number of carbon atoms which is 1 to 3 are more preferable.

[0063] Specific examples of such organo-hydrogen-polysiloxane are: siloxane oligomer, such as 1,1,3,3-tetramethyldisiloxane, 1,3,5,7-tetramethyl cyclo-tetrasiloxane, 1,3,5,7,8-pentamethyl-cyclo-pentasiloxane, tris(dimethyl-hydrogen-siloxy)methylsilane and tris(dimethyl-hydrogen-siloxy)phenylsilane; methyl-hydrogen-cyclo-polysiloxane, methyl-hydrogen-siloxane dimethyl-siloxane cyclic copolymer, molecular-chain-both-

terminal-trimethyl-siloxy-radical-close methyl-hydrogen-polysiloxane, molecular-chain-both-terminal-trimethyl-siloxy-radical-close dimethyl-siloxane methyl-hydrogen-siloxane copolymer, molecular-chain-both-terminal dimethyl-hydrogen-siloxy-radical-close dimethyl-polysiloxane, molecular-chain-both-terminal-dimethyl-hydrogen-siloxy-radical-close methyl-hydrogen-polysiloxane, molecular-chain-both-terminal-dimethyl-hydrogen-siloxy-radical-close dimethyl-siloxane methyl-hydrogen-siloxane copolymer; silicone resin which includes $R^3_2(H)SiO_{1/2}$ unit and $SiO_{4/2}$ unit, and which may optionally include $R^3_3SiO_{1/2}$ unit, $R^3_2SiO_{2/2}$ unit, $R^3(H)SiO_{2/2}$ unit, $(H)SiO_{3/2}$ unit or $R^3SiO_{3/2}$ unit (in the formula, however, R^3 represents the same meaning as above); and the above-exemplified compounds in which some of methyl radicals are substituted with ethyl radicals, other alkyl radicals like n-propyl radicals and/or phenyl radicals.

[0064] Organo-hydrogen-polysiloxane applied to the composition according to the present disclosure can be obtained by conventionally known schemes, and for example, at least a kind of chlorosilane selected from R^3SiHCl_2 and $R^3{}_2SiHCl$ (where R^3 represents the same meaning as above) is co-hydrolyzed, or chlorosilane and at least a kind of chlorosilane selected from $R^3{}_3SiCl$ and $R^3{}_2SiCl_2$ (where R^3 represents the same meaning as above) may be combined and co-hydrolyzed to obtain the aiming substance. Moreover, organo-hydrogen-polysiloxane applied to the composition according to the present disclosure may be a product material obtained by causing polysiloxane obtained by such co-hydrolyzation as described above to be further subjected to equilibration reaction.

[0065] As for the amount of constituent (C), a number of hydrogen atoms (i.e., SiH radicals) coupled to silicon atoms in organo-hydrogen-polysiloxane of constituent (C)

is 0.1 to 0.5 per a total of one silicon-atom-coupled alkenyl radical of organo-polysiloxane of constituent (A) and that of constituent (B), but an amount that causes such a number to be 0.2 to 2.0 is preferable.

Note that a single kind of constituent (C) may be applied alone or greater than or equal to two kinds thereof may be applied together.

[0066] (D) Platinum-group Metal-based Catalyst

The platinum-group metal-based catalyst of constituent (D) is not limited to any particular catalyst as far as it can promote addition reaction between alkenyl radicals of constituent (A) and of constituent (B), and, Si-H radical of constituent (C), and conventionally known substances are applicable, but among those, a catalyst selected from platinum and platinum compound is preferable.

Specific examples of the catalyst are: platinum-group metal alone, such as platinum (including platinum

black), rhodium and palladium; platinum chloride, platinum chloride, chloroplatinic acid, chloroplatinic acid salt, and alcohol denaturation platinum chloride, such as $H_2PtCl_4 \cdot nH_2O$, $H_2PtCl_6 \cdot H_2O$, $NaHPtCl_6 \cdot nH_2O$, $KHPtCl_6 \cdot nH_2O$, $Na_2PtCl_6 \cdot nH_2O$, $K_2PtCl_4 \cdot nH_2O$, $PtCl_4 \cdot nH_2O$, $PtCl_2$ and $Na_2HPtCl_4 \cdot nH_2O$ (however, n in the formula is an integer from 0 to 6, and is preferably 0 or 6); complex of platinum chloride with olefine; substance in which platinum-group metal, such as platinum black or palladium, is supported on carrier, such as alumina, silica and carbon; rhodium-olefin complex, chlorotris(triphenyl-phosphine)rhodium (Wilkinson's catalyst); and complex of platinum chloride, chloroplatinic acid or chloroplatinic acid salt with vinyl-radical-containing siloxane. Those may be applied alone or greater than or equal to two kinds thereof may be combined and applied together.

[0067] The blended amount of constituent (D) is an effective amount as a catalyst, an amount capable of advancing a reaction between constituent (A) and constituent (B), and, constituent (C) is sufficient, and such an amount may be adjusted as appropriate in accordance with a desired curing speed.

In particular, an amount that becomes 0.1 to 10000 ppm in a mass standard converted into platinum-group metal atom relative to the mass of constituent (A) is preferable, and an amount that becomes 1 to 5000 ppm is more preferable. When the blended amount of constituent (D) is within the above range, a further efficient catalyst action is expected.

[0068] (E) Organic Solvent

The silicone composition may be a solvent-free composition obtained by combining respective predetermined amounts of constituents (A) to (D), but may be applied as a solvent composition diluted by organic

solvent as needed. Dilution by organic solvent achieves practical advantages, such as improvement of workability in application, improvement of application by spin coater, film thickness control, and improvements of the state of an applied film like the thickness of the applied film and the surface finishing state thereof.

[0069] An available organic solvent is not limited to any particular solvent as far as a compound can dissolve silicone, and examples are: aromatic hydrocarbon-based compounds, such as toluene and xylene; aliphatic hydrocarbon-based compounds, such as hexane, heptane and isoparaffin; ketone compounds, such as acetone, methyl-ethyl-ketone and methyl-isobutyl-ketone; ester compounds, such as ethyl-acetate and butyl-acetate; and ether compounds, such as diisopropyl-ether and 1,4-dioxane. A single kind of those may be applied alone or greater than or equal to two kinds thereof may be combined and applied together.

When an organic solvent is applied, a preferable blended amount thereof is 1 to 10000 parts by mass relative to 100 parts by mass of constituent (A), and 10 to 5000 parts by mass is more preferable. When such an amount is less than 1 parts by mass, the advantages by dilution may not be obtained, and when such an amount exceeds 10000 parts by mass, the film thickness after the application may become too thin.

[0070] (F) Antistatic Agent

An antistatic agent as constituent (F) may be added to the composition according to the present disclosure for the purposes of reducing a surface resistivity and of giving antistatic characteristics to a material.

Example antistatic agents are salt of alkali metal or of alkaline-earth metal, or an ionic liquid. In this specification, the ionic liquid is a molten salt that is a liquid at a room temperature (25 °C), is also

called as ordinary-temperature molten salt, and in particular, has a melting point that is lower than or equal to 50 °C, but an agent that has a melting point which is -100 to 30 °C is preferable, and having a melting point which is -50 to 20 °C is more preferable. Such an ionic liquid has characteristics such that there is no vapor pressure (nonvolatility), a heat resistance is high, being non-combustibility, and being chemically stable.

[0071] Example salts of alkali metal or of alkaline-earth metal are: alkali metal salts, such as lithium, sodium and potassium; and alkaline-earth metal salts, such as calcium and barium. Specific examples of those are: alkali metal salts, such as $LiClO_4$, $LiCF_3SO_3$, $LiN(CF_3SO_2)_2$, $LiAsF_6$, LiCl, NaSCN, KSCN, NaCl, NaI and KI; and alkaline-earth metal salts, such as $Ca(ClO_4)_2$, and $Ba(ClO_4)_2$.

Among those, from the standpoint of low resistance value and solubility, lithium salts, such as $LiClO_4$, $LiCF_3SO_3$, $LiN(CF_3SO_2)_2$, $LiAsF_6$ and LiCl, are preferable, and $LiCF_3SO_3$, $LiN(CF_3SO_2)_2$ are more preferable.

[0072] The ionic liquid contains quaternary ammonium cation and anion. The quaternary ammonium cation is in the form of any one of the followings: imidazolium; pyridinium; or cation represented by a formula $R^6{}_4N^+$ (where R^6 is an organic radical independent from each other and with a number of hydrogen atoms or carbon atoms that is 1 to 20).

[0073] Specific examples of the organic radical represented by R^6 are univalent hydrocarbon radical and alkoxy-alkyl radical with a number of carbon atoms that is 1 to 20, and more specifically: alkyl radicals, such as methyl, pentyl, hexyl and heptyl radicals; aryl radicals, such as phenyl, tolyl, xylyl and naphthyl radicals; aralkyl radicals, such as benzyl and phenethyl

radicals, cyclo-alkyl radicals, such as cyclo-pentyl, cyclo-hexyl, and cyclo-octyl radicals; and alkoxy-alkyl radical like ethoxy-ethyl radical ($-CH_2CH_2OCH_2CH_3$). Note that, among the organic radials represented by R^2, two of those may be coupled to each other so as to form a cyclic structure, and in this case, two R^6 form bivalent organic radical together. The principal chain of the bivalent organic radical may include carbon only, or may contain therein heteroatoms, such as oxygen atom and nitrogen atom. A more specific example is bivalent hydrocarbon radical (e.g., alkylene radical with a number of carbon atoms that is 3 to 10) that is expressed by a formula: $-(CH_2)_c-O-(CH_2)_d-$ (where c is an integer from 1 to 5, d is an integer from 1 to 5, and c + d is an integer from 4 to 10).

[0074] Specific examples of cation represented by $R^6{}_4N^+$ are methyl-tri-n-octyl-ammonium cation, ethoxy-ethyl-

methyl-pyrrolidinium cation and ethoxy-ethyl-methyl-morpholinium cation.

The above anion is not limited to any particular anion, but for example, $AlCl_4^-$, $Al_3Cl_{10}^-$, $Al_2Cl_7^-$, ClO_4^-, PF_6^-, BF_4^-, $CF_3SO_3^-$, $(CF_3SO_2)_2N^-$ and $(CF_3SO_2)_3C^-$ are preferable, and PF_6^-, BF_4^-, $CF_3SO_3^-$ and $(CF_3SO_2)_2N^-$ are more preferable.

[0075] When constituent (F) is applied, it is preferable that the blended amount thereof should be, relative to 100 parts by mass of constituent (A), 0.001 to 10 parts by mass from the standpoint of antistatic characteristics and heat resistance, and more preferably, 0.005 to 10 parts by mass.

Note that a single kind of antistatic agent may be applied alone, or greater than or equal to two kinds may be combined and applied together.

[0076] As for the antistatic characteristics of a cured substance obtained from the addition-and-curable type

silicone adhesive composition according to the present disclosure and containing constituent (F), it is preferable that, using a static honestmeter (available from SHISHIDO electrostatic, ltd.,), a time at which an electrostatic potential becomes half (a half decay period) after 6kV of electrostatic is charged to the surface of the cured substance by corona discharge should be within two minutes, and more preferably, within one minute.

[0077] (G) Reaction Control Agent

For the purpose of suppressing a curing reaction at a room temperature and of extending shelf life and pot life, a reaction control agent that is constituent (G) may be blended with the composition according to the present disclosure.

The reaction control agent is not limited to any particular agent as far as such an agent can suppress the catalytic activity of constituent (D), and a

conventionally known reaction control agent is applicable. Specific examples are: acetylenic alcohol compounds, such as 1-ethynyl-1-cyclohexanol and 3-butyn-1-ol; Various nitrogen compounds; organophosphorus compound; oxime compound; and organic chloro compound. A single kind of those may be applied alone, or greater than or equal to two kinds may be applied together. Among those, acetylenic alcohol compound that has no corrosiveness to metal is preferable.

[0078] When constituent (G) is applied, it is preferable that the blended amount thereof should be, relative to 100 parts by mass of constituent (A), 0.001 to 5 parts by mass, and more preferably, 0.01 to 1 parts by mass. When the blended amount of the reaction control agent is less than 0.001 parts by mass, sufficient shelf life and pot life may be unobtainable in some cases, and when such an amount exceeds 5 parts by mass, the curability of the composition may decrease.

Note that, in order to improve the dispersibility to the silicone resin, the reaction control agent may be diluted by an organic solvent, such as toluene, xylene and isopropyl alcohol, and then such diluted agent may be applied.

[0079] Note that, within a range in which the advantageous effects of the present disclosure are not disrupted, additives, such as a coloring material (a colorant or a dye), a silane coupling agent, an adhesion aid, a polymerization inhibitor, an antioxidant, an UV absorber that is a light resistance stabilizer, and a light stabilizer, etc., may be blended with the composition according to the present disclosure.

Moreover, the composition according to the present disclosure may be mixed with other resin compositions as appropriate and such mixed composition may be applied.

[0080] The addition-and-curable type silicone adhesive composition according to the present disclosure can be obtained by mixing above constituents (A) to (D) and other constituents as needed in an arbitrary sequence, and by stirring those. A process of mixing and stirring each constituent is not limited to any particular process.

The form of the composition may be either a one-component type or a two-component type. The one-component type composition can be stored for a long time period by cold-storing or freezing. The two-component composition can be stored for a long time period at an ambient temperature.

[0081] For example, the one-component type composition containing constituents (A) to (G) can be obtained by, putting constituent (A), constituent (B), constituent (D), constituent (E) and constituent (F) in a gate mixer (available from INOUE MFG. Inc., product made: planetary

mixer), mixing those at a room temperature for 30 minutes, adding constituent (G) and mixing those at a room temperature for 30 minutes, and then adding constituent (C) and mixing those for 30 minutes.

[0082] Conversely, the two-component type composition containing the constituents that are constituents (A) to (G) can be formed by arbitrary combinations as far as a combination of constituent (A), constituent (C) and constituent (D), and, a combination of constituent (B), constituent (C) and constituent (D) do not coexist. For example, constituent (A), constituent (B), constituent (D), constituent (E), and constituent (F) are put in a gate mixer, and heated and mixed at a room temperature for 30 minutes so as to obtain a composition that is material A. Moreover, constituent (A), constituent (C) and constituent (G) are put in the gate mixer, and mixed at room temperature for 30 minutes so as to obtain a composition that is material B. A two-component type

composition containing material A and material B is thus obtained.

[0083] It is preferable that the viscosity of the addition-and-curable type silicone adhesive composition according to the present disclosure should be, from the standpoint of molding characteristics and of workability, smaller than or equal to 1000 Pa·s as a measured viscosity by rotation viscometer at 23 °C, more preferably, smaller than or equal to 500 Pa·s, and further preferably, 100 Pa·s. When such a value exceeds 5000 Pa·s, the workability may remarkably decrease.

[0084] The curing conditions for the addition-and-curable type silicone composition according to the present disclosure are not limited to any particular conditions, and can be made as consistent with those for conventionally known curable silicone compositions. Curing at a room temperature and curing by heating are both appropriate, and such a composition may be cured by

a reaction for preferably 0.1 to 3 hours, more preferably, 0.5 to 2 hours, at a temperature of 20 to 180 ℃, more preferably, 50 to 150 ℃.

[0085] The second resin pattern molding process is, as illustrated in FIG. 1, parts (g) to (k), a process of forming the second resin pattern 120 on the second surface 12 after the protective film pasting process. The second resin pattern 120 may be formed by any schemes, but for example, conventionally known imprinting, such as optical imprinting or thermal imprinting, is applicable. Moreover, a resin like a resist to which imprinting is applicable may be applied on the substrate 1, a pattern may be transferred to the resin by imprinting, and then etching may be carried out with the resin on which the pattern is formed being utilized as a mask so as to obtain the second resin pattern 120.

[0086] Moreover, the double-sided molding method according to the present disclosure may include a protective film removing process of removing the protective film 2 pasted on the first surface 11 after the second resin pattern molding process as illustrated in FIG. 1, part (l). The protective film 2 may be removed by mechanical scheme or by hand working. For example, the end portion of the protective film 2 may be held by tweezers, etc., and may be removed. Note that when the double-side molded product is to be packaged and transported, such a product may be packed and transported with the protective film being left as it is. In that case, the protective film may be removed when the double-side molded product is to be utilized.

[0087] As illustrated in FIG. 1, part (f), a molded product according to the present disclosure includes the substrate 1 including the first surface 11 and the second surface 12, the first resin pattern 110 formed on the

first surface 11, and the protective film 2 including the silicone-rubber layer pasted on the first resin pattern 110. As for such a molded component, the second resin pattern 120 can be formed on the second surface 12 of the substrate 1 with the first resin pattern 110 being protected.

[0088] Moreover, as illustrated in FIG. 1, part (k), the molded product according to the present disclosure may include the second resin pattern 120 formed on the second surface 12 of the substrate 1.

[0089] The substrate 1, the protective film 2, the first resin pattern 110 and the second resin pattern 120 are consistent with those described with reference to the double-sided molding method according to the present disclosure. Hence, the detailed descriptions thereof will be omitted.

[0090] Although the embodiments utilizing the silicone rubber have been described above, according to the

present disclosure, the layer may be other than the silicone-rubber layer to which the silicone rubber is applied. As far as a damage to the pattern is suppressed, which is the advantages effect of the present disclosure, the layer may be a rubber layer to which a rubber other than the silicone rubber is applied. Examples rubbers other than the silicone rubber are a nitrile rubber, a fluorine rubber, an urethane rubber, an acrylic rubber, an isoprene rubber, a styrene rubber, a butadiene rubber, a butyl rubber, an ethylene-propylene rubber, an ethylene-propylene-diene rubber, an ethylene-acetic rubber, and a chloroprene rubber. Various characteristics, such as tensile strength, adhesive force, elasticity, and thickness, of the rubber layers to which such rubbers are applied, and how to utilize those may be consistent with the above-described various characteristics of the silicone-rubber layer and how to utilize such a layer. Utilization of a rubber

facilitates a control to an intimate-contact with a fine pattern, and can suppress an adhesive being left due to excessive intimate-contact. Hence, a damage to the pattern can be suppressed.

[0091] Moreover, the term rubber according to the present disclosure means, in many cases, a thermosetting elastomer. A preferable thermosetting elastomer has a rubber elasticity, and is not likely to be soft even heat is applied. The thermosetting elastomer can increase the degree of freedom for a thermal environment in the molding process. Conversely, a thermoplastic elastomer may be applied as far as the thermal environment in the molding process is controllable. Furthermore, a gel which still has a rubber elasticity among gels in which dispersoids are connected in a mesh form in a liquid dispersant and thus a flowability is lost, i.e., a so-called elastomer gel is known. Such an elastomer gel may be utilized instead of rubbers. Such a modification is

adoptable in accordance with the size and distribution of a pattern to be molded, and with a level of suppression for a pattern damage. Hence, the silicone-rubber layer according to the present disclosure can be also referred to as a rubber layer or a thermosetting elastomer layer, and may be also referred to as an elastomer layer including a thermoplastic elastomer layer and an elastomer gel layer. As described above, various conditions, such as tensile strength, adhesive force, elasticity and thickness of the layer utilizing those elastomers, such as thermosetting elastomer, thermoplastic elastomer and an elastomer gel, and how to utilize those can be consistent with the above-described various characteristics of the silicone-rubber layer and how to utilize such a layer.

[0092] Although embodiments of the present disclosure have been described above, the present disclosure can be

expressed as following (1-1) to (9-4) when viewed from difference aspects.

(1-1)

A double-sided molding method for forming the first resin pattern on the first surface of the base material and for forming the second resin pattern on the second surface of the base material, the double-sided molding method including:

the protective film pasting process of pasting, on the first resin pattern, the silicone-rubber-layer side of the protective film including the silicone-rubber layer; and

the second resin pattern molding process of forming the second resin pattern on the second surface after the protective film pasting process.

(1-2)

A molded product including:

the base material including the first surface and the second surface;

the first resin pattern formed on the first surface; and

the protective film including the silicone-rubber layer pasted on the first resin pattern.

(2-1)

A double-sided molding method for forming the first pattern on the first surface of the substrate and for forming the second pattern on the second surface of the substrate, the double-sided molding method including:

the protective film pasting process of pasting, on the first pattern, the silicone-rubber-layer side of the protective film including the silicone-rubber layer; and

the second resin pattern molding process of forming the second pattern on the second surface after the protective film pasting process.

(2-2)

A molded product including:

the substrate including the first surface and the second surface;

the first pattern formed on the first surface; and

the protective film including the silicone-rubber layer pasted on the first pattern.

(3-1)

A double-sided molding method for forming the first resin pattern on the first surface of the substrate and for forming the second resin pattern on the second surface of the substrate, the double-sided molding method including:

the protective film pasting process of pasting, on the first resin pattern, the rubber-layer side of the protective film including the rubber layer; and

the second resin pattern molding process of forming the second resin pattern on the second surface after the protective film pasting process.

(3-2)

A molded product including:

the substrate including the first surface and the second surface;

the first resin pattern formed on the first surface; and

the protective film including the rubber layer pasted on the first resin pattern.

(4-1)

A double-sided molding method for forming the first pattern on the first surface of the base material and for forming the second pattern on the second surface of the base material, the double-sided molding method including:

the protective film pasting process of pasting, on the first pattern, the rubber-layer side of the protective film including the rubber layer; and

the second pattern molding process of forming the second pattern on the second surface after the protective film pasting process.

(4-2)

A molded product including:

the base material including the first surface and the second surface;

the first pattern formed on the first surface; and

the protective film including the rubber layer pasted on the first pattern.

(4-3)

A double-sided molding method for forming the second pattern on the second surface of the base material

which has the first pattern formed on the first surface, the double-sided molding method including:

a preparing process of preparing the base material with the rubber-layer side of the protective film including the rubber layer pasted on the first pattern; and

the second pattern molding process of forming the second pattern on the second surface after the preparing process.

(5-1)

A method for producing the double-side molded product having the first pattern formed on the first surface of the base material and having the second pattern formed on the second surface of the base material, the method including:

the protective film pasting process of pasting, on the first pattern, the rubber-layer side of the protective film including the rubber layer; and

the second pattern molding process of forming the second pattern on the second surface after the protective film pasting process.

(5-2)

A method for producing the double-side molded product having the first pattern formed on the first surface of the base material and having the second pattern formed on the second surface of the base material, the method including:

the preparing process of preparing the base material with the rubber-layer side of the protective film including the rubber layer pasted on the first pattern; and

the second pattern molding process of forming the second pattern on the second surface after the preparing process.

(6-1)

A double-sided molding method for forming the first pattern on the first surface of the base material and for forming the second pattern on the second surface of the base material, the double-sided molding method including:

the rubber layer forming process of providing the rubber layer on the first pattern; and

the second pattern forming process of forming the second pattern on the second surface after the rubber layer forming process.

(6-2)

A molded product including:

the base material including the first surface and the second surface;

the first pattern formed on the first surface; and

the rubber layer provided on the first pattern.

(6-3)

A double-sided molding method for forming the second pattern on the second surface of the base material which has the first pattern formed on the first surface, the double-sided molding method including:

the preparing process of preparing the base material with the rubber layer being provided on the first pattern; and

the second pattern molding process of forming the second pattern on the second surface after the preparing process.

(7-1)

A method for producing the double-side molded product having the first pattern formed on the first surface of the base material and having the second pattern formed on the second surface of the base material, the method including:

the rubber layer providing process of providing the rubber layer on the first pattern; and

the second pattern molding process of forming the second pattern on the second surface after the rubber layer providing process.

(7-2)

A method for producing the double-side molded product having the first pattern formed on the first surface of the base material and having the second pattern formed on the second surface of the base material, the method including:

the preparing process of preparing the base material having the rubber layer provided on the first pattern; and

the second pattern molding process of forming the second pattern on the second surface after the preparing process.

(8-1)

A protective film utilized for forming the second resin pattern on the second surface of the

substrate having the first resin pattern formed on the first surface, in which:

the protective film includes the silicone-rubber layer; and

the protective film is utilized to protect, by pasting the silicone-rubber layer on the first resin pattern, the first resin pattern when the second resin pattern is formed.

(8-2)

A protective film utilized for forming the second resin pattern on the second surface of the base material having the first pattern formed on the first surface, in which:

the protective film includes the rubber layer; and

the protective film is utilized to protect, by pasting the rubber layer on the first pattern, the first pattern when the second pattern is formed.

(8-3)

A rubber layer utilized for forming the second pattern on the second surface of the base material having the first pattern formed on the first surface, the rubber layer being utilized to protect, by being pasted on the first pattern, the first pattern when the second pattern is formed.

(8-4)

A rubber utilized for forming the second pattern on the second surface of the base material having the first pattern formed on the first surface, the rubber being utilized to protect, by being pasted on the first pattern, the first pattern when the second pattern is formed.

(9-1)

An application of the protective film utilized for forming the second resin pattern on the second

surface of the base material having the first resin pattern formed on the first surface, in which:

the protective film includes the silicone-rubber layer; and

the protective film is applied to protect, by pasting the silicone-rubber layer on the first resin pattern, the first resin pattern when the second resin pattern is formed.

(9-2)

An application of the protective film utilized for forming the second pattern on the second surface of the base material having the first pattern formed on the first surface, in which:

the protective film includes the rubber layer; and

the protective film is applied to protect, by pasting the rubber layer on the first pattern, the first pattern when the second pattern is formed.

(9-3)

An application of the rubber layer utilized for forming the second pattern on the second surface of the base material having the first pattern formed on the first surface, the rubber layer being applied to protect, by being pasted on the first pattern, the first pattern when the second pattern is formed.

(9-4)

An application of the rubber utilized for forming the second pattern on the second surface of the base material having the first pattern formed on the first surface, the rubber being applied to protect, by being pasted on the first pattern, the first pattern when the second pattern is formed.

Respective structural components of the above-described various embodiments may be further subdivided, and each of the subdivided structural components alone or a combination of thereof may be adopted to those (1-1) to

(9-4). Moreover, an arbitrary structural component may be omitted as far as a process condition is satisfied.

REFERENCE SIGNS LIST

[0093]

1	Substrate
2	Protective film
4	Primer
11	First surface
12	Second surface
31	First resin
32	Second resin
110	First resin pattern
120	Second resin pattern

CLAIMS

1. A double-sided molding method for forming a first resin pattern on a first surface of a substrate and for forming a second resin pattern on a second surface of the substrate, the double-sided molding method comprising:

a protective film pasting process of pasting, on the first resin pattern, a silicone-rubber-layer side of a protective film comprising a silicone-rubber layer; and

a second resin pattern molding process of forming the second resin pattern on the second surface after the protective film pasting process.

2. The double-sided molding method according to claim 1, wherein a tensile strength of the silicone-rubber layer is greater than an adhesive force of the silicone-rubber layer.

3. The double-sided molding method according to claim 2, wherein the tensile strength of the silicone-rubber layer is greater than or equal to 0.5 MPa.

4. The double-sided molding method according to claim 2, wherein the adhesive force of the silicone-rubber layer is greater than or equal to 10 kPa and is smaller than or equal to 1500 kPa.

5. The double-sided molding method according to any one of claims 1 to 4, wherein an elasticity of the silicone-rubber layer is smaller than an elasticity of a first resin forming the first resin pattern.

6. The double-sided molding method according to claim 5, wherein the elasticity of the silicone-rubber layer is smaller than 200 MPa.

7. The double-sided molding method according to claim 5, wherein the elasticity of the first resin is greater than or equal to 200 MPa.

8. The double-sided molding method according to any one of claims 1 to 4, wherein a thickness of the silicone-rubber layer is greater than or equal to 1 μm and is smaller than or equal to 1 mm.

9. The double-sided molding method according to any one of claims 1 to 4, further comprising a protective film removing process of removing the protective film pasted on the first surface after the second resin pattern molding process.

10. The double-sided molding method according to any one of claims 1 to 4, wherein the silicone-rubber layer

is a cured addition-and-curable type silicone adhesive composition which contains:

(A) organo-polysiloxane which has, in a molecule, at least two alkenyl radicals coupled to a silicon atom, and which has a viscosity that is 0.01 to 1000 Pa·s at 25 °C: 100 parts by mass;

(B) organo-polysiloxane resin having an alkenyl radical: 5 to 500 parts by mass;

(C) organo-hydrogen-polysiloxane which has, in a molecule, greater than or equal to two hydrogen atoms coupled with a silicon atom: an amount that causes the hydrogen atoms coupled with the respective silicon atoms in the constituent (C) to be 0.1 to 5.0 times mol relative to a total amount of alkenyl radicals coupled with all the silicon atoms in the composition; and

(D) platinum-group metal-based catalyst,

and which does not contain non-cross-linkable organo-polysiloxane resin.

11. A molded product comprising:

a substrate comprising a first surface and a second surface;

a first resin pattern formed on the first surface; and

a protective film comprising a silicone-rubber layer pasted on the first resin pattern.

12. The molded product according to claim 11, wherein a tensile strength of the silicone-rubber layer is greater than an adhesive force of the silicone-rubber layer.

13. The molded product according to claim 12, wherein the tensile strength of the silicone-rubber layer is greater than or equal to 1.0 MPa.

14. The molded product according to claim 12, wherein the adhesive force of the silicone-rubber layer is greater than or equal to 10 kPa and is smaller than or equal to 1500 kPa.

15. The molded product according to any one of claim 11 or 14, wherein an elasticity of the silicone-rubber layer is smaller than an elasticity of a first resin forming the first resin pattern.

16. The molded product according to claim 15, wherein the elasticity of the silicone-rubber layer is smaller than 200 MPa.

17. The molded product according to claim 15, wherein the elasticity of the first resin is greater than or equal to 200 MPa.

18. The molded product according to any one of claim 11 or 14, wherein a thickness of the silicone-rubber layer is greater than or equal to 1 μm and is smaller than or equal to 1 mm.

19. The molded product according to any one of claims 11 to 14, further comprising a second resin pattern formed on the second surface.

20. The molded product according to any one of claims 11 to 14, wherein the silicone-rubber layer is a cured addition-and-curable type silicone adhesive composition which contains:

(A) organo-polysiloxane which has, in a molecule, at least two alkenyl radicals coupled to a silicon atom, and which has a viscosity that is 0.01 to 1000 Pa·s at 25 °C: 100 parts by mass;

(B) organo-polysiloxane resin having an alkenyl radical: 5 to 500 parts by mass;

(C) organo-hydrogen-polysiloxane which has, in a molecule, greater than or equal to two hydrogen atoms coupled with a silicon atom: an amount that causes the hydrogen atoms coupled with the respective silicon atoms in the constituent (C) to be 0.1 to 5.0 times mol relative to a total amount of alkenyl radicals coupled with all the silicon atoms in the composition; and

(D) platinum-group metal-based catalyst,

and which does not contain non-cross-linkable organo-polysiloxane resin.