

DESCRIPTION

TITLE OF THE INVENTION: SILICONE-RELEASANT POLYESTER FILM
AND PRODUCTION METHOD THEREFOR

TECHNICAL FIELD

[0001]

The present invention relates to a silicone-release polyester film. More specifically, the present invention relates to a silicone-release polyester film having releasability and adhesiveness suitable for molding ranging from light peeling to heavy peeling in, for example, ceramic green sheet forming or the like to be used in production of a stacked ceramic capacitor, and being capable of preventing the occurrence of breakage or deformation of the sheet or the like, a method for the production thereof, and so on.

BACKGROUND ART

[0002]

In the production of a stacked ceramic capacitor, a release film is used as a carrier film for forming a ceramic green sheet. As a substrate of the release film, a polyester film is used particularly in terms of dimensional stability and heat resistance. In recent years, while stacked ceramic capacitors have been miniaturized and

increased in capacity, high reliability for in-vehicle use has been required, and the demand for improvement in the quality of ceramic green sheets has been increasing.

[0003]

As the ceramic green sheet is made thinner and highly infallible, the thickness of the dried sheet has been fallen in a region of several μm or less. Therefore, the carrier film is particularly required to have light peelability. As a result of the reduction in thickness, the rigidity of the ceramic green sheet is reduced, so that the peeling force of the conventional release film causes breakage or deformation when the green sheet is peeled off and the chip defect rate increases. Therefore, light peelability is required.

[0004]

Accordingly, it is required to reduce the peeling force of a release film, and for example, a method of adjusting the peeling force by controlling the crosslinked structure of silicone has been proposed (for example, Patent Document 1). However, such a method of controlling the crosslinked structure of a release layer may require new design of a polymer or a crosslinking agent having a special structure, or may require stronger energy at the time of ultraviolet irradiation, electron beam irradiation, or the like, and therefore there is a problem that the cost

increases.

[0005]

In addition, a release layer including a silicone resin having a crosslinked structure and a silicone resin having no crosslinked structure has been proposed (for example, Patent Document 2). In this method, however, since the solvent of the coating agent for forming the release layer is an organic solvent, there is a problem that an extensive organic solvent treatment facility is needed at the time of coating and drying, and the running cost of the volatilized organic solvent treatment is also increased, resulting in an increase in cost.

[0006]

Furthermore, there are working environment problems, and safety problems such as organic solvent explosion and fire. In addition, a method in which no organic solvent is used has also been proposed (for example, Patent Document 3), but this method has a problem that handling of the coating agent becomes complicated due to an increase in its viscosity, so that the coating agent is difficult to apply uniformly.

PRIOR ART DOCUMENTS

PATENT DOCUMENTS

[0007]

Patent Document 1: JP-A-2006-7689

Patent Document 2: JP-A-2008-254207

Patent Document 3: JP-A-2003-192987

SUMMARY OF THE INVENTION

PROBLEMS TO BE SOLVED BY THE INVENTION

[0008]

In view of the above circumstances, an object of the present invention is to provide a silicone-release polyester film that can be suitably used as, for example, a carrier film or the like in the production of a stacked ceramic capacitor and that is superior in appropriate light peelability as much as it can be peeled without being broken, such as being ruptured even when it is an extremely thin film, and a method for producing the same.

MEANS FOR SOLVING THE PROBLEMS

[0009]

As a result of intensive studies to solve the above problems, the present inventors have found that the above problems can be solved by maximizing the crosslinking density in the release layer forming process as much as possible using a specific polydimethylsilicone, and have accomplished the present invention.

[0010]

That is, the present invention provides the following silicone-release polyester films (silicone-releasable polyester films).

[0011]

[1]

A silicone-release polyester film having a coating layer formed using a coating composition for release including:

an aqueous dispersion (1) of a silicone (A) having a number average molecular weight of 25000 or more and containing three or more alkenyl groups in one molecule;

an aqueous dispersion (2) of a silicone (B) having a number average molecular weight of 25000 or less and having an alkenyl group at only both ends in one molecule;

an aqueous dispersion (3) of a silicone (C) having a number average molecular weight of 10000 or less and having a hydrogen atom directly bonded to an Si atom represented by an Si-H group; and

a platinum-based catalyst,

wherein where a total solid content of the silicone (A), the silicone (B), and the silicone (C) is 100 parts by mass, the coating composition for release contains the silicone (A) in an amount of 80 parts by mass or more, the silicone (B) in an amount of 2 parts by mass or more and 20 parts by mass or less, and the silicone (C) in an amount of

2 parts by mass or more and 20 parts by mass or less.

[0012]

[2]

The silicone-release polyester film according to [1], wherein the silicone (A) has alkenyl groups at both ends and in a side chain in one molecule.

[0013]

[3]

The silicone-release polyester film according to [1] or [2], wherein the alkenyl groups of the silicone (A) are vinyl groups.

[0014]

[4]

The silicone-release polyester film according to any one of [1] to [3], wherein the alkenyl groups of the silicone (B) are vinyl groups.

[0015]

[5]

The silicone-release polyester film according to any one of [1] to [4], wherein the alkenyl groups of the silicone (A) and the silicone (B) are vinyl groups.

[0016]

[6]

The silicone-release polyester film according to any one of [1] to [5], wherein the content of the platinum-

based catalyst is 120 ppm or more based on the total amount of the silicone (A) and the silicone (B).

[0017]

[7]

The silicone-release polyester film according to any one of [1] to [6], which is to be used for ceramic green sheet forming in production of a stacked ceramic capacitor.

[0018]

The present invention also provides the following method for producing a silicone-release polyester film.

[0019]

[8]

A method for producing a silicone-release polyester film, the method comprising:

a step of forming a coating layer formed using a coating composition for release including:

an aqueous dispersion (1) of a silicone (A) having a number average molecular weight of 25000 or more and containing three or more alkenyl groups in one molecule;

an aqueous dispersion (2) of a silicone (B) having a number average molecular weight of 25000 or less and having an alkenyl group at only both ends in one molecule;

an aqueous dispersion (3) of a silicone (C) having a number average molecular weight of 10000 or less and having a hydrogen atom directly bonded to an Si atom represented

by an Si-H group; and

a platinum-based catalyst,

wherein where a total solid content of the silicone (A), the silicone (B), and the silicone (C) is 100 parts by mass, the coating composition for release contains the silicone (A) in an amount of 80 parts by mass or more, the silicone (B) in an amount of 2 parts by mass or more and 20 parts by mass or less, and the silicone (C) in an amount of 2 parts by mass or more and 20 parts by mass or less.

[0020]

[9]

The method according to [8], wherein the silicone (A) has alkenyl groups at both ends and in a side chain in one molecule.

[0021]

[10]

The method according to [8] or [9], wherein the alkenyl groups of the silicone (A) and the silicone (B) are vinyl groups.

EFFECT OF THE INVENTION

[0022]

Since the silicone-release polyester film of the present invention has the above configuration, it is possible to provide, as a release film for sheet forming, a

releasable polyester film that has moderately low peeling strength as much as it can be peeled without being broken, such as being ruptured, even when it is a very thin film and that is superior in uniformity of a release layer. The releasable polyester film of the present invention having such characteristics can be suitably used, for example, as a carrier film for forming a ceramic green sheet to be used for a stacked ceramic capacitor.

[0023]

In addition, the method for producing a silicone-release polyester film of the present invention makes it possible to efficiently and easily obtain a silicone-release polyester film having the characteristics described above.

MODE FOR CARRYING OUT THE INVENTION

[0024]

Hereinafter, a detailed description is made of embodiments of the present invention, but the present invention is not limited to these embodiments.

[0025]

<Silicone-release polyester film>

The silicone-release polyester film of the present invention is a silicone-release polyester film having a coating layer formed using a coating composition for

release including:

an aqueous dispersion (1) of a silicone (A) having a number average molecular weight of 25000 or more and containing three or more alkenyl groups in one molecule;

an aqueous dispersion (2) of a silicone (B) having a number average molecular weight of 25000 or less and having an alkenyl group at only both ends in one molecule;

an aqueous dispersion (3) of a silicone (C) having a number average molecular weight of 10000 or less and having a hydrogen atom directly bonded to an Si atom represented by an Si-H group; and

a platinum-based catalyst,

wherein where a total solid content of the silicone (A), the silicone (B), and the silicone (C) is 100 parts by mass, the coating composition for release contains the silicone (A) in an amount of 80 parts by mass or more, the silicone (B) in an amount of 2 parts by mass or more and 20 parts by mass or less, and the silicone (C) in an amount of 2 parts by mass or more and 20 parts by mass or less.

[0026]

[Polyester film]

For the polyester film of the present invention, known polyesters can be appropriately used, and for example, those shown below can be suitably used.

[0027]

(Polyester)

The polyester that constitutes a polyester film to be used as the substrate film (hereinafter, sometimes referred to as "substrate") in the present invention is not particularly limited, and a film formed product of a polyester commonly used as a substrate for a release film can be used. A crystalline linear saturated polyester composed of an aromatic dibasic acid component and a diol component is preferable. For example, polyethylene terephthalate, polyethylene isophthalate, polyethylene-2,6-naphthalate, polybutylene terephthalate, poly(1,4-cyclohexylenedimethylene terephthalate), polytrimethylene terephthalate, or copolymers containing constituent components of these resins as main components are more preferable. In particular, polyester films formed from polyethylene terephthalate are particularly suitable. In polyethylene terephthalate, the content of repeating units of ethylene terephthalate is preferably 90 mol% or more, more preferably 95 mol% or more, and other dicarboxylic acid components and diol components may be copolymerized in small amounts. For example, from the viewpoint of cost, a copolymer produced from only terephthalic acid and ethylene glycol is preferable.

[0028]

Known additives such as an antioxidant, a light

stabilizer, an ultraviolet absorber, and a crystallization agent may be added as long as the effect of the release film of the present invention is not impaired. The polyester film is preferably a biaxially oriented polyester film because of its elastic modulus in both directions, and the like.

[0029]

The intrinsic viscosity of the polyester film is preferably 0.50 dl/g or more and 0.70 dl/g or less, and more preferably 0.52 dl/g or more and 0.65 dl/g or less. When the intrinsic viscosity is 0.50 dl/g or more, breakage does not often occur in a stretching step, which is preferable. Conversely, when the intrinsic viscosity is 0.70 dl/g or less, the cuttability of the polyethylene terephthalate film at the time of being cut into a predetermined product width is good and dimensional failure does not occur, which is preferable. In addition, it is preferable that the raw material pellets are sufficiently vacuum-dried.

[0030]

In the present specification, the term "polyester film" simply means a polyester film including a surface layer A and a surface layer B (in which the surface layer A and the surface layer B are laminated).

[0031]

The method for producing the polyester film in the present invention is not particularly limited, and methods conventionally commonly used can be used. For example, the polyester film can be obtained by melting the polyester with an extruder, extruding the melted resin into a film form, cooling the extrudate with a rotary cooling drum to obtain an unstretched film, and biaxially stretching the unstretched film. A biaxially stretched film can be obtained by a method in which a film uniaxially stretched in a machine direction or a transverse direction is sequentially stretched biaxially in the transverse direction or the machine direction, or a method in which the unstretched film is simultaneously stretched biaxially in the machine direction and the transverse direction.

[0032]

In the present invention, a stretching temperature when stretching the polyester film is preferably set to be equal to or higher than a secondary transition point (T_g) of the polyester. The polyester film is stretched in each of the machine direction and the transverse direction preferably by once or more and 8 times or less, and particularly preferably by twice or more and 6 times or less.

[0033]

The thickness of the polyester film is preferably 12

μm or more and 100 μm or less, more preferably 16 μm or more and 50 μm or less, and still more preferably 19 μm or more and 33 μm or less. When the thickness of the film is 12 μm or more, there is no risk of deformation due to heat during film production, processing steps, and molding, which is preferable. When the thickness of the film of 100 μm or less, the amount of the film to be disposed after being used is not extremely large, which is preferable for reducing the environmental load.

[0034]

The polyester film substrate may include a single layer or two or more layers. For example, the substrate film may be a polyester film including a surface layer A substantially free of particles having a particle size of 1.0 μm or more and a surface layer B containing particles. Preferably, the surface layer A is substantially free of inorganic particles having a particle size of 1.0 μm or more.

[0035]

In this aspect, particles having a particle size of less than 1.0 μm and 1 nm or more may be present in the surface layer A. The surface layer A is substantially free of particles, for example, inorganic particles, having a particle size of 1.0 μm or more, and therefore the occurrence of defects due to the transfer of the particle

shape in the substrate to the resin sheet can be reduced.

[0036]

In one aspect, the surface layer A does not contain particles having a particle size of less than 1.0 μm , and therefore the occurrence of defects due to the transfer of the particle shape in the substrate to the resin sheet can be suppressed more effectively.

[0037]

In one aspect, the polyester film substrate is preferably a laminated film including a surface layer A substantially free of inorganic particles in at least one surface. This makes it possible to suppress more effectively the occurrence of defects due to the transfer of the particle shape in the substrate to the resin sheet.

[0038]

For example, in a preferred aspect, the surface layer A substantially free of particles having a particle size of less than 1.0 μm is also substantially free of particles having a particle size of 1.0 μm or more.

[0039]

Here, in the present invention, the phrase "substantially free of particles" means, for example, in the case of particles of less than 1.0 μm , a content that is 50 ppm or less, preferably 10 ppm or less, and most preferably equal to or less than the detection limit when

an inorganic element is quantified by fluorescent X-ray analysis. This is because, even if the particles are not positively added into the film, contamination components derived from foreign matters, and dirt attached to raw material resins, or lines or devices in film producing steps may be peeled off and mixed into the film. The phrase "substantially free of particles having a particle size of 1.0 μm or more" means that particles having a particle size of 1.0 μm or more are not positively contained.

[0040]

A laminated polyester film having a multilayer configuration including two or more layers preferably includes a surface layer B that can contain inorganic particles and the like on the opposite surface of the surface layer A substantially free of inorganic particles.

[0041]

As the laminated configuration, when the layer on the side to which the release layer is applied is a layer A, the layer on the opposite surface thereof is a layer B, and the core layer other than these is a layer C, the layer configuration in the thickness direction may be a laminated structure such as release layer/A/B or release layer/A/C/B. As a matter of course, the layer C may have a plurality of layer configurations. The surface layer B may contain no

inorganic particles. In that case, a coat layer containing at least inorganic particles and a binder is preferably provided on the surface layer B in order to impart slipperiness for winding the film into a roll.

[0042]

In the polyester film substrate of the present invention, the surface layer B forming the surface opposite from the surface to which the release layer is applied preferably contains inorganic particles, and especially, silica particles and/or calcium carbonate particles are preferably used from the viewpoint of the slipperiness of the film and the ease of air release. As to the content of inorganic particles contained, the inorganic particles are preferably contained in the surface layer B in an amount of 5000 ppm or more and 15000 ppm or less in total.

[0043]

At this time, the average area surface roughness (S_a) of the film of the surface layer B is preferably in a range of 1 nm or more and 40 nm or less. More preferably, the average area surface roughness is in a range of 5 nm or more and 35 nm or less. When the total content of the silica particles and/or the calcium carbonate particles is 5000 ppm or more, and the S_a is 1 nm or more, air can be uniformly released when the film is wound into a roll, and the film has a good winding appearance and good flatness,

so that the film is suitable for the production of an ultrathin ceramic green sheet. In addition, when the total content of the silica particles and/or the calcium carbonate particles is 15000 ppm or less and the Sa is 40 nm or less, the aggregation of a lubricant is less likely to occur, and coarse protrusions are not formed, so that the quality is stable during the production of the ultrathin ceramic green sheet, which is preferable.

[0044]

As the particles contained in the layer B, inert inorganic particles other than silica and/or calcium carbonate particles and/or heat-resistant organic particles can be used, but silica particles and/or calcium carbonate particles are more preferably used from the viewpoint of transparency and cost. Other examples of the inorganic particles that can be used include alumina-silica composite oxide particles and hydroxyapatite particles. Examples of the heat-resistant organic particles include crosslinked polyacrylic particles, crosslinked polystyrene particles, and benzoguanamine-based particles. When silica particles are used, porous colloidal silica is preferable, whereas when calcium carbonate particles are used, light calcium carbonate surface-treated with a polyacrylic acid-based polymeric compound is preferable from the viewpoint of preventing the lubricant from falling off.

[0045]

The average particle diameter of the inorganic particles to be added to the surface layer B is preferably 0.1 μm or more and 2.0 μm or less, and particularly preferably 0.3 μm or more and 1.0 μm or less. When the average particle diameter of the inorganic particles is 0.1 μm or more, the slipperiness of the release film is good, which is preferable. When the average particle diameter is 2.0 μm or less, there is no possibility of adversely affecting the smoothness of the surface of the release layer, and therefore there is no possibility of generating pinholes in the ceramic green sheet, which is preferable.

[0046]

In order to improve the adhesiveness of the release layer or the like to be applied later, or in order to prevent electric charge, a coat layer may be provided on the film before the surface of the surface layer A and/or the surface of the surface layer B are/is subjected to stretching or after being subjected to uniaxial stretching in the film forming process, or the film may be subjected to a corona treatment or the like.

[0047]

In the present invention, the ceramic sheet peelability of the silicone-release polyester film can be measured, for example, as follows. A slurry prepared is

uniformly applied onto a coating layer of a release polyester film such that the thickness after drying is 2 μm or the like, and then dried to form a ceramic sheet. Subsequently, the release polyester film with the ceramic sheet formed thereon is cut into a size of 25 mm $\times$ 150 mm, and an adhesive tape is bonded to the ceramic sheet side to prepare a test piece.

[0048]

The test piece obtained is subjected to humidity control for 24 hours under conditions of, for example, 23°C and a humidity of 50%, and then the ceramic sheet (the adhesive tape side) is peeled at a peeling angle of 90° and a peeling rate of 10 m/min or the like using a tensile tester, and the peeling strength is measured. With respect to the peeling strength of the ceramic sheet, for example, under the conditions of Examples, a case where the peeling strength is less than 0.60 N/mm is regarded to be favorable, and a case where the peeling strength is 0.55 N/mm or less can be evaluated to be more favorable.

[0049]

[Coating composition for release]

The coating composition for release of the present invention includes:

an aqueous dispersion (1) of a silicone (A) having a number average molecular weight of 25000 or more and

containing three or more alkenyl groups in one molecule;

an aqueous dispersion (2) of a silicone (B) having a number average molecular weight of 25000 or less and having alkenyl groups at only both ends in one molecule;

an aqueous dispersion (3) of a silicone (C) having a number average molecular weight of 10000 or less and having a hydrogen atom directly bonded to a Si atom represented by a Si-H group; and

a platinum-based catalyst.

[0050]

The alkenyl group-containing silicone component in the present invention is composed of at least two components differing in molecular weight.

[0051]

(Alkenyl group-containing silicone (A))

In the present invention, a silicone (A) having a number average molecular weight of 25000 or more and containing three or more alkenyl groups in one molecule (hereinafter, this may be referred to as "silicone (A)" or "alkenyl group-containing silicone (A)") is used.

[0052]

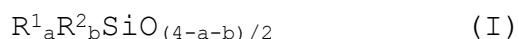
The alkenyl group-containing silicone (A) preferably has alkenyl groups at both ends and in a side chains in one molecule.

[0053]

The alkenyl group-containing silicone (A) contains at least three or more alkenyl groups in one molecule, and the number of the alkenyl groups may be, for example, 4 or more, 5 or more, 6 or more, or the like. The upper limit of the number of the alkenyl groups in the alkenyl group-containing silicone (A) may be any number as long as the effect of the present invention is exhibited, and may be, for example, 30 or less, 20 or less, 15 or less, 10 or less, or the like. If the number of alkenyl groups in the alkenyl group-containing silicone (A) were 2 or less in one molecule, crosslinking reactivity would be reduced, and peeling of a ceramic sheet would be heavy.

[0054]

Examples of the alkenyl group-containing silicone (A) include an organopolysiloxane having a structure represented by the following general formula (I).



(In the formula (I), R^1 represents an alkenyl group having 2 to 8 carbon atoms, R^2 represents a monovalent saturated hydrocarbon group having 1 to 16 carbon atoms selected from alkyl groups or aryl groups, a represents an integer of 0 to 3, b represents an integer of 0 to 2, provided that $a + b \leq 3$ is satisfied.)

[0055]

The alkenyl group-containing silicone (A) may have

either a linear structure or a branched structure, may be one partly having cross-linking, and may be a mixture thereof.

[0056]

Examples of the alkenyl group having 2 to 8 carbon atoms represented by R^1 include a vinyl group, an allyl group, a butenyl group, a pentenyl group, and a hexenyl group. Among them, a vinyl group is particularly preferable.

[0057]

Examples of the alkyl group represented by R^2 include a methyl group, an ethyl group, a propyl group, and a butyl group, and examples of the aryl group include a phenyl group and a tolyl group. Among them, it is preferable that 80 mol% or more of the substituent of R^2 is a methyl group from the viewpoint of light peelability.

[0058]

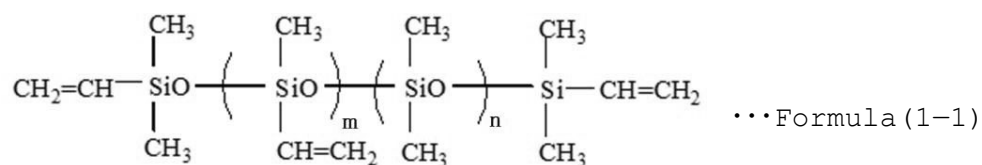
From the viewpoint of the curing rate and pot life of the composition, it is preferable that the amount of silicon atoms having an alkenyl group is, for example, in the range of 0.05 to 20 mol% based on the total amount of silicon atoms in the alkenyl group-containing silicone (A). When the proportion of the silicon atoms having an alkenyl group is less than the lower limit, the curing rate of the composition decreases, and it may be difficult to

efficiently form a cured silicone film during the film formation. When the proportion of the silicon atoms having an alkenyl group exceeds the upper limit, the pot life of the composition may be shortened.

[0059]

Examples of the alkenyl group-containing silicone (A) include a silicone represented by the following Formula (1-1).

[Formula 1]



(In Formula (1-1), m is 2.5, and n is 400.)

[0060]

The alkenyl group-containing silicone (A) can be produced by a known method. The alkenyl group-containing silicone in the present invention is preferably contained in the aforementioned composition in the form of an aqueous dispersion (aqueous dispersion (1)).

[0061]

When the alkenyl group-containing silicone (A) is processed into an aqueous dispersion (aqueous dispersion (1)), the content of the alkenyl group-containing silicone (A) in 100 parts by mass of the aqueous dispersion (1) may be, for example, 1 part by mass or more and 80 parts by

mass or less, and may be 3 parts by mass or more and 75 parts by mass or less, 5 parts by mass or more and 70 parts by mass or less, 10 parts by mass or more and 65 parts by mass or less, 15 parts by mass or more and 60 parts by mass or less, or the like. When the content is 10 parts by mass or less, the long-term stability of the emulsion may deteriorate, and when the content is 80 parts by mass or more, the viscosity increases and the dispersibility may deteriorate.

[0062]

The number average molecular weight of the alkenyl group-containing silicone (A) is 25000 or more, and may be, for example, 26000 or more, 27000 or more, 28000 or more, 30000 or more, or the like. The upper limit of the number average molecular weight of the alkenyl group-containing silicone (A) may be any value as long as the effect of the present invention is exhibited, and may be set to, for example, 45000 or less, 40000 or less, or the like. When the number average molecular weight is 50000 or more, the emulsion of the aqueous dispersion may be unstable.

[0063]

The content of the alkenyl group-containing silicone (A) is preferably 80 parts by mass or more and 96 parts by mass or less where the total solid content of the silicone (A) and the silicone (B) both containing alkenyl groups and

the Si-H group-containing silicone (C) is 100 parts by mass, and may be, for example, 85 parts by mass or more and 95 parts by mass or less, 88 parts by mass or more and 94 parts by mass or less, 90 parts by mass or more and 92 parts by mass or less, or the like. When the content is 96 parts by mass or more, the amount of a polymer silicone increases and the crosslinking density decreases. When the content is 80 parts by mass or less, crosslinking points between a high-molecular silicone and a low-molecular silicone decrease, and the crosslinking density decreases.

[0064]

(Alkenyl group-containing silicone(B))

A silicone (B) having a number average molecular weight of 25000 or less and having alkenyl groups at only both ends in one molecule (hereinafter, this may be referred to as "silicone (B)" or "alkenyl group-containing silicone (B)") is used.

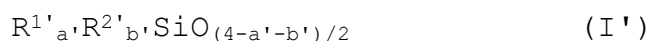
[0065]

The alkenyl group-containing silicone (B) has alkenyl groups only at both ends in one molecule. It is presumed that the low-molecular-weight alkenyl group-containing silicone (B) enables a crosslinking reaction that complements the crosslinked network of the high-molecular-weight alkenyl group-containing silicone (A), maximizes the crosslinking density as much as possible, and enables light

peeling from a ceramic sheet, but the scope of rights is not limited only to the mechanism described above.

[0066]

Examples of the alkenyl group-containing silicone (B) include an organopolysiloxane having a structure represented by the following general formula (I').



(In the formula (I'), $R^{1'}$ represents an alkenyl group having 2 to 8 carbon atoms, $R^{2'}$ represents a monovalent saturated hydrocarbon group having 1 to 16 carbon atoms selected from alkyl groups or aryl groups, a' represents an integer of 0 to 1, b' represents an integer of 0 to 2, provided that $a' + b' \leq 3$ is satisfied.)

[0067]

The alkenyl group-containing silicone (B) may have either a linear structure or a branched structure, may be one partly having cross-linking, and may be a mixture thereof.

[0068]

Examples of the alkenyl group having 2 to 8 carbon atoms represented by $R^{1'}$ include a vinyl group, an allyl group, a butenyl group, a pentenyl group, and a hexenyl group. Among them, a vinyl group is particularly preferable. The alkenyl group-containing silicone (B) has alkenyl groups only at both ends in one molecule.

[0069]

Examples of the alkyl group represented by R^{2'} include a methyl group, an ethyl group, a propyl group, and a butyl group, and examples of the aryl group include a phenyl group and a tolyl group. Among them, it is preferable that 80 mol% or more of the substituent of R^{2'} is a methyl group from the viewpoint of light peelability.

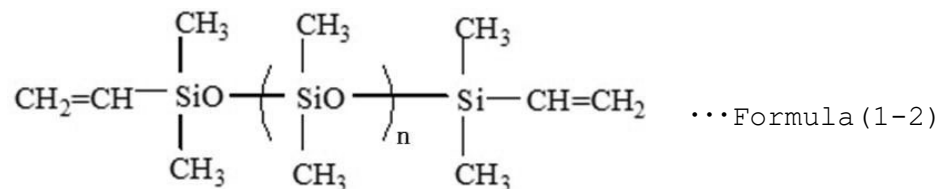
[0070]

From the viewpoint of the curing rate and pot life of the composition, it is preferable that the amount of silicon atoms having an alkenyl group is, for example, in the range of 0.05 to 20 mol% based on the total amount of silicon atoms in the alkenyl group-containing silicone (B).

[0071]

Examples of the alkenyl group-containing silicone (B) include a silicone represented by the following Formula (1-2).

[Formula 2]



(In Formula (1-2), n is 200.)

[0072]

The alkenyl group-containing silicone (B) can be produced by a known method. The alkenyl group-containing

silicone (A) in the present invention is preferably contained in the aforementioned composition in the form of an aqueous dispersion (aqueous dispersion (2)).

[0073]

The number average molecular weight of the alkenyl group-containing silicone (B) is 25000 or less, and may be, for example, 24000 or less, 23000 or less, 22000 or less, 21000 or less, 20,000 or less, 19000 or less, 18000 or less, 17000 or less, or the like. The lower limit of the number average molecular weight of the alkenyl group-containing silicone (B) may be any value as long as the effect of the present invention is exhibited, and may be set to, for example, 10000 or more, 11000 or more, 12000 or more, or the like. When the number average molecular weight is 25000 or more, this is almost the same as that of the silicone the crosslinking density is almost equal to that of the silicone (A), and therefore, the crosslinking density is not improved. On the other hand, when the number average molecular weight is excessively small, it becomes difficult to form a crosslinked network in the silicone (A).

[0074]

The alkenyl group-containing silicone (B) can be produced by a known method. The alkenyl group-containing silicone (B) is preferably contained in the aforementioned

composition in the form of an aqueous dispersion (aqueous dispersion (2)).

[0075]

When the alkenyl group-containing silicone (B) is processed into an aqueous dispersion (aqueous dispersion (2)), the content of the alkenyl group-containing silicone (B) in 100 parts by mass of the aqueous dispersion (2) may be, for example, 1 part by mass or more and 80 parts by mass or less, and may be 3 parts by mass or more and 70 parts by mass or less, 5 parts by mass or more and 65 parts by mass or less, 10 parts by mass or more and 60 parts by mass or less, 15 parts by mass or more and 55 parts by mass or less, or the like. When the content is 10 parts by mass or less, the long-term stability of the emulsion may deteriorate, and when the content is 80 parts by mass or more, the viscosity increases and the dispersibility may deteriorate.

[0076]

The content of the alkenyl group-containing silicone (B) is preferably 2 parts by mass or more and 20 parts by mass or less where the total solid content of the silicone (A) and the silicone (B) both containing alkenyl groups and the Si-H group-containing silicone (C) is 100 parts by mass, and may be, for example, 3 parts by mass or more and 18 parts by mass or less, 4 parts by mass or more and 15

parts by mass or less, 5 parts by mass or more and 10 parts by mass or less, or the like.

[0077]

(Si-H group-containing silicone (C))

Examples of the silicone (C) having a hydrogen atom directly bonded to a Si atom represented by an Si-H group (hereinafter, this may be referred to as "silicone (C)" or "Si-H group-containing silicone (C)") in the present invention include an organohydrogen polysiloxane having a structure represented by the following general formula (II).



(In the formula (II), R^3 represents a monovalent saturated hydrocarbon group having 1 to 16 carbon atoms selected from alkyl groups or aryl groups, c represents an integer of 0 to 2, d represents an integer of 1 to 3, provided that $c + d \leq 3$ is satisfied.)

[0078]

The Si-H group-containing silicone (C) may have either a linear structure or a branched structure.

[0079]

Examples of the alkyl group represented by R^3 include a methyl group, an ethyl group, a propyl group, and a butyl group, and examples of the aryl group include a phenyl group and a tolyl group. Among them, it is preferable that

50 mol% or more of the substituent of R³ is a methyl group from the viewpoint of light peelability.

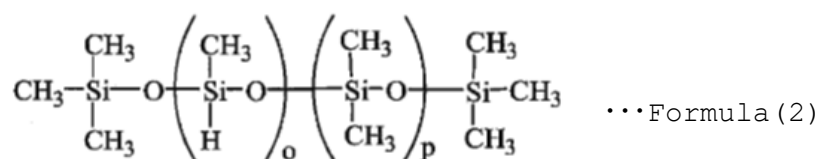
[0080]

From the viewpoint of curing characteristics, the Si-H group-containing silicone (C) preferably has at least three, preferably five or more, hydrogen atoms bonded to Si atoms in one molecule of the silicone.

[0081]

Examples of the Si-H group-containing silicone (C) include a silicone represented by the following Formula (2).

[Formula 3]



(In Formula (2), o is 30 and p is 35.)

[0082]

The Si-H group-containing silicone (C) can be produced by a known method. The Si-H group-containing silicone (C) in the present invention is preferably contained in the aforementioned composition in the form of an aqueous dispersion (aqueous dispersion (3)).

[0083]

When the Si-H group-containing silicone (C) is processed into an aqueous dispersion (aqueous dispersion

(3)), the content of the Si-H group-containing silicone (C) in 100 parts by mass of the aqueous dispersion (3) may be, for example, 1 part by mass or more and 80 parts by mass or less, and may be 3 parts by mass or more and 70 parts by mass or less, 5 parts by mass or more and 60 parts by mass or less, 8 parts by mass or more and 55 parts by mass or less, 10 parts by mass or more and 50 parts by mass or less, or the like. When the content is 10 parts by mass or less, the long-term stability of the emulsion may deteriorate, and when the content is 80 parts by mass or more, the viscosity increases and the dispersibility may deteriorate.

[0084]

The number average molecular weight of the Si-H group-containing silicone (C) is 10000 or less, and may be, for example, 8000 or less, 7000 or less, 6000 or less, or the like. When the number average molecular weight is 10000 or more, the function as a crosslinking agent is insufficient, and the crosslinking density is reduced. In addition, the lower limit of the number average molecular weight of the Si-H group-containing silicone (C) is not particularly limited as long as the operation of the present invention is exhibited, but may be set to, for example, 300 or more, 500 or more, 1000 or more, 2000 or more, or the like.

[0085]

The content of the Si-H group-containing silicone (C) is preferably 2 parts by mass or more and 20 parts by mass or less where the total solid content of the silicone (A) and the silicone (B) both containing alkenyl groups and the Si-H group-containing silicone (C) is 100 parts by mass, and may be, for example, 3 parts by mass or more and 18 parts by mass or less, 4 parts by mass or more and 15 parts by mass or less, 5 parts by mass or more and 10 parts by mass or less, or the like. When the content is less than 2 parts by mass, a curing reaction is difficult to proceed, so that sufficient coating film hardness may not be obtained, whereas when the content exceeds 20 parts by mass, Si-H is excessively precipitated on a surface, and strongly adheres to a green sheet, so that heavy peeling may be caused as a result.

[0086]

(Ratio of the number of Si-H groups to the number of alkenyl groups)

The ratio of the number of the Si-H groups to the number of the alkenyl groups (the number of the alkenyl groups in the silicone (A) and the silicone (B)) (the number of Si-H groups/the number of alkenyl groups) in the coating composition for release in the present invention is preferably in the range of 1.0 to 2.0. When the ratio is

less than the lower limit, since surplus alkenyl groups remain in the coating layer formed, the peeling strength is likely to change over time, and the crosslinking density decreases, so that the uniformity of peeling force and the residual adhesion rate may be lowered. When the ratio exceeds the upper limit, Si-H groups having high reactivity may remain in the formed coating layer, so that an increase in peeling force may be caused.

[0087]

(Silicone content)

In the coating composition for release in the present invention, the total of the alkenyl group-containing silicone solid content (the total of the solid contents of the silicone (A) and the silicone (B)) and the Si-H group-containing silicone (C) solid content is preferably 70% by mass or more based on the solid mass of the composition. Each of the silicone solid contents is more preferably 80% by mass or more and 97% by mass or less. Here, the silicone solid content refers to the amount excluding the aqueous solvent, and the solid mass of the composition refers to the total amount of the solid contents of the respective additives. When the total amount of the silicone solid contents is less than the lower limit, the area covered with silicone is reduced with respect to the film surface on which the coating film is formed, the

peeling force is increased, and unevenness may occur in the peeling force.

[0088]

(Aqueous solvent)

As the aqueous solvent for forming each of the aqueous silicone dispersions of the present invention, water is preferably used. By using the aqueous solvent, it is possible to form a silicone release layer without using an explosion-proof facility and an organic solvent recovery facility required for the organic solvent during the process of producing the release film.

[0089]

(Emulsifier)

Each aqueous dispersion is prepared using an emulsifier to increase the stability or the shear resistance of the aqueous dispersion. As the emulsifier, a nonionic emulsifier that does not affect the curing reaction of the silicone is preferable. An ionic emulsifier may affect the curing reaction of silicone, and may be localized in a coating film, for example, bleed out to the surface to affect releasability.

[0090]

The nonionic emulsifier preferably has an HLB value in the range of 8 or more and 18 or less, and examples thereof include at least one selected from among higher

alcohols and alkylene oxide adduct types including alkylene oxide adducts of higher fatty acids, esters of alkylene oxide adducts of higher fatty acids and alcohols, alkylene oxide adducts of alkanolamides, alkylene oxide adducts of sorbitan esters, and alkylene oxide adducts of higher fatty acid glycerides. These may be used alone or in combination of two or more kinds thereof. Here, the HLB value is a value calculated by Griffin's calculation formula.

[0091]

Examples of the alkylene oxide include ethylene oxide, propylene oxide, and butylene oxide, and either one of these or two or more of these may be used. When a plurality of alkylene oxides are used, the type of addition may be either block or random, and the HLB value is preferably in the range of 8 or more and 18 or less, and more preferably in the range of 10 or more and 15 or less. Among these nonionic emulsifiers, for example, polyoxyethylene lauryl ether, polyoxyethylene tridecyl ether, and the like are preferable. When a nonionic emulsifier having an HLB value outside the above range is used as an emulsifier of the aqueous silicone dispersion, the emulsifying and dispersing power and the stability of the aqueous dispersion may be deteriorated. The nonionic emulsifier is used preferably in a range of 0.1% by mass or more and 20% by mass or less, more preferably in a range of

0.2% by mass or more and 15% by mass or less, and still more preferably in a range of 0.5% by mass or more and 10% by mass or less, with respect to the total solid content. If it falls below this range, emulsification tends to fail, whereas if it exceeds this range, heavy peeling may occur.

[0092]

(Catalyst)

In the coating composition for release constituting the coating layer of the present invention, a catalyst is preferably used, and a platinum-based catalyst is particularly preferable in order to make the silicone (A) and/or the silicone (B) and the silicone (C) undergo an addition reaction.

[0093]

(Platinum-based catalyst)

Known platinum-based catalysts can be used, and examples thereof include platinum chloride and chloroplatinic acid. In consideration of the dispersibility of the platinum-based catalyst in the silicone, a 1,3-divinyl-1,1,3,3-tetramethyldisiloxane platinum complex (Karstedt catalyst) may be used, and uniform dispersibility can be secured by simultaneously dispersing silicone when emulsifying the silicone. These may be used alone or in combination of two or more kinds thereof.

[0094]

The platinum-based catalyst is preferably contained in an amount such that the mass of the platinum element is within a range of 120 ppm or more and 800 ppm or less with respect to the total mass of the aqueous dispersion (1) of the silicone (A), the aqueous dispersion (2) of the silicone (B), and the aqueous dispersion (3) of the silicone (C). Within the above range, the silicone can be sufficiently cured. In addition, generation of a silicone aggregate can be inhibited, and a release polyester film superior in surface properties can be obtained. When the mass ratio of platinum element exceeds the above range, the addition reaction between an alkenyl group and an Si-H group is accelerated, and a silicone aggregate tends to be generated. From the above viewpoint, the amount of the platinum-based catalyst is, for example, 600 ppm or less, 500 ppm or less, 300 ppm or less, 250 ppm or less, or the like. When the mass ratio of platinum element is less than the lower limit, the addition reaction does not proceed, and poor curing of silicone tends to be caused. From the above viewpoint, the amount of the platinum catalyst is, for example, 130 ppm or more, 140 ppm or more, 150 ppm or more, 200 ppm or more, or the like.

[0095]

(Crosslinking reaction inhibitor)

A crosslinking reaction inhibitor is preferably contained in the aqueous coating composition in order to suppress the activity of the platinum-based catalyst at room temperature. The crosslinking reaction inhibitor is preferably a crosslinking reaction inhibitor having an alkynyl group. The crosslinking reaction inhibitor having an alkynyl group is not particularly limited as long as the reaction inhibitor has an alkynyl group, and specific examples thereof include 1-ethynyl-1-cyclohexanol, 4-ethyl-1-octyn-3-ol, 3-methyl-1-dodecyn-3-ol, 3,7,11-trimethyl-1-dodecyn-3-ol, 1,1-diphenyl-2-propyn-3-ol, 3-ethyl-6-ethyl-1-nonyn-3-ol, 3-methyl-1-pentadecyn-3-ol, 2,5-dimethyl-3-hexyne-2,5-diol, and 3-phenyl-1-butyn-3-ol. Preferable examples of the alkynyl group include an ethynyl group. These may be used alone or in combination of two or more kinds thereof. In the present invention, since an aqueous emulsion coating composition is adopted, use of any of the crosslinking reaction inhibitors having an alkynyl group and a hydroxyl group disclosed above as examples is preferable in terms of boiling point and balance between affinity solubility in water and coordination ability to platinum.

[0096]

The content of the crosslinking reaction inhibitor is preferably 5 ppm or more and 1,000 ppm or less, more

preferably 10 ppm or more and 700 ppm or less, and still more preferably 20 ppm or more and 500 ppm or less, with respect to the mass of the aqueous coating composition to be used for the formation of the release layer. When the content of the crosslinking reaction inhibitor is equal to or greater than the lower limit, the pot life tends to be long, the addition curing reaction of silicone tends to hardly proceed at room temperature, and silicone aggregates tend to be hardly generated. When the content of the crosslinking reaction inhibitor is equal to or less than the upper limit, silicone is less likely to migrate to a mating material after the mating material is peeled off, and the amount of the reaction inhibitor volatilized during a heat treatment is reduced, so that contamination inside an oven is less likely to occur.

[0097]

The content of the crosslinking reaction inhibitor based on the mass of platinum element is preferably, for example, 6 times or less, more preferably 5 times or less, particularly preferably 4 times or less the mass of platinum element.

[0098]

The crosslinking reaction inhibitor having an ethynyl group is not particularly limited as long as it has an ethynyl group, but since an aqueous coating composition is

adopted in the present invention, it is preferable to use a crosslinking reaction inhibitor having an ethynyl group and a hydroxyl group typified by 1-ethynylcyclohexanol from the viewpoint of volatility and balance between solubility in water and coordination ability to platinum.

[0099]

(Other components)

To the coating composition for release of the present invention may be further added, for example, an agent for imparting adhesiveness to a substrate, a coloring agent, an ultraviolet absorber, particles, or an anti-static agent as long as the object of the present invention is not impaired.

[0100]

(Preparation of aqueous silicone dispersion)

In preparing each of the aqueous silicone dispersions of the present invention, a method of emulsifying the silicone component, the aqueous solvent, and the emulsifier described above can be employed. A known method can be used for emulsifying these components, and examples thereof include a method in which a silicone prepared in advance, an emulsifier, and other components as necessary are mechanically emulsified in an aqueous medium using a stirring device such as a homogenizer, an Agi Homo Mixer, or an Ultra Planetary Mixer.

[0101]

In addition, the particle size of the aqueous dispersion can be adjusted by adjusting the size of the stirring blade, the stirring speed, and the stirring time. The average particle diameter of each of the aqueous silicone dispersions of the present invention is preferably 200 nm or less, and more preferably 100 nm or more and 200 nm or less.

[0102]

[Coating layer]

In the present invention, a coating layer (release layer) is formed on at least one surface of a polyester film using the coating composition for release of the present invention. The coating layer (release layer) of the present invention is formed by applying the coating composition for release onto the polyester film, and then drying it.

[0103]

In the present invention, the thickness of the coating layer is preferably 5 nm or more and 70 nm or less in terms of a thickness after drying. When the thickness of the coating layer is less than the lower limit, the release characteristics may be insufficient, and when the thickness exceeds the upper limit, the peeling strength increases, and it is necessary to increase the

concentration of the coating liquid or to increase the coating amount, so that it tends to be difficult to perform coating.

[0104]

When the coating composition for release of the present invention is applied onto a polyester film, an aqueous coating liquid containing the composition is prepared, and the solid concentration of the aqueous coating liquid is preferably 20% by mass or less, more preferably 1% by mass or more and 10% by mass or less based on the mass of the coating liquid. When the solid concentration in the aqueous coating liquid is less than the lower limit, the wettability to the polyester film may be insufficient. When the solid concentration exceeds the upper limit, the stability of the coating liquid and the appearance of the coating layer may be deteriorated. Water is preferably used as the aqueous solvent for adjusting the solid concentration.

[0105]

The aqueous coating liquid can be applied to the polyester film at any stage, but is preferably applied in the process of producing the polyester film, and is preferably applied to the polyester film before oriented crystallization is completed.

[0106]

Here, the polyester film before oriented crystallization is completed orientation includes an unstretched film, a uniaxially oriented film obtained by orienting an unstretched film in either the machine direction (hereinafter, this direction may be referred to as a continuous film formation direction, a machine direction, or an MD direction) or the transverse direction (hereinafter, this direction may be referred to as a direction orthogonal to the machine direction, a transverse direction, or a TD direction), and a film obtained by subjecting an unstretched film to a low stretch orientation in two directions, namely, the machine direction and the transverse direction (a biaxially stretched film obtained before the film is finally restretched in the machine direction or the transverse direction to complete oriented crystallization). Among them, preferred is so-called in-line coating, in which an aqueous coating liquid of the composition described above is applied to an unstretched film or a uniaxially stretched film oriented in one direction, and stretching in the machine direction and/or stretching in the transverse direction and heat setting are immediately performed. The coating layer may be dried by the stretching step or the heat setting treatment after the coating, and a drying step may be further added, as necessary. When the composition is cured using a catalyst

to obtain a cured film, the composition may be cured by the stretching step or the heat setting treatment, but a curing step may be further added, as necessary.

[0107]

When the aqueous coating liquid is applied to the polyester film, for example, it is preferable to subject the film surface to a physical treatment, such as a corona surface treatment, a flame treatment, or a plasma treatment, as a preliminary treatment for improving coatability, or to use the above-described emulsifier as a wetting agent together with the composition.

[0108]

As an application method, any known coating method can be applied. For example, a roll coating method, a gravure coating method, a roll brushing method, a spray coating method, an air knife coating method, an impregnation method, a curtain coating method, and the like may be used alone or in combination.

[0109]

<Method for producing silicone-release polyester film>

The method for producing a silicone-release polyester film of the present invention comprises:

a step of forming a coating layer formed using a coating composition for release including:

an aqueous dispersion (1) of a silicone (A) having a

number average molecular weight of 25000 or more and containing three or more alkenyl groups in one molecule;

an aqueous dispersion (2) of a silicone (B) having a number average molecular weight of 25000 or less and having an alkenyl group at only both ends in one molecule;

an aqueous dispersion (3) of a silicone (C) having a number average molecular weight of 10000 or less and having a hydrogen atom directly bonded to an Si atom represented by an Si-H group; and

a platinum-based catalyst,

wherein where a total solid content of the silicone (A), the silicone (B), and the silicone (C) is 100 parts by mass, the coating composition for release contains the silicone (A) in an amount of 80 parts by mass or more, the silicone (B) in an amount of 2 parts by mass or more and 20 parts by mass or less, and the silicone (C) in an amount of 2 parts by mass or more and 20 parts by mass or less.

[0110]

The method for producing a silicone-release polyester film of the present invention makes it possible to efficiently and easily obtain a silicone-release polyester film having the characteristics described above. Note that the producing method described below is an example, and the present invention is not limited thereto.

[0111]

In the producing method, for each configuration, the description regarding the silicone-release polyester film and the like in the present specification can be applied appropriately.

[0112]

As the step of forming the coating layer using the coating composition for release of an aqueous dispersion in the producing method, a known method can be appropriately used as long as it is a method of forming the coating layer on the film using the coating composition for release of an aqueous dispersion.

EXAMPLES

[0113]

The present invention will be described specifically by way of Examples, but the present invention is not limited to the following Examples. Physical properties and characteristics in Examples were measured or evaluated by the following methods. The indication with "part" means "part by mass".

[0114]

Each measurement, evaluation, and the like in Examples were performed as follows.

[0115]

Ceramic sheet peelability

100 parts by mass of barium titanate (BaTiO_3), 7 parts by mass of polyvinyl butyral, and 3 parts by mass of dioctyl phthalate were added to a mixed solvent of toluene : ethanol = 1 : 1 (volume ratio), and dispersed with a ball mill to prepare a slurry.

[0116]

The resulting slurry was uniformly applied onto a coating layer of a release polyester film such that the thickness after drying was 2 μm , and then dried to form a ceramic sheet. The release polyester film on which the ceramic sheet was formed was cut into a size of 25 mm $\times$ 150 mm, and an adhesive tape (trade name "31B Tape" produced by Nitto Denko Corporation) was bonded to the ceramic sheet side to prepare a test piece.

[0117]

The test piece obtained was subjected to humidity control for 24 hours under conditions of 23°C and a humidity of 50%, and then the ceramic sheet (31B tape side) was peeled off at a peeling angle of 90° and a peeling rate of 10 m/min using a tensile tester, and the peeling strength was measured. The peeling strength of the ceramic sheet was evaluated according to the following indexes.

○: Peeling strength is less than 0.60 N/mm

×: Peeling strength is 0.60 N/mm or more

[0118]

[Examples 1 to 2, Comparative Examples 1 to 5]

Molten polyethylene terephthalate ($[\eta] = 0.64 \text{ dl/g}$, $T_g = 78^\circ\text{C}$) containing 0.1% by mass of calcium carbonate particles having an average particle diameter of $0.7 \text{ }\mu\text{m}$ was extruded from a die, cooled with a cooling drum by a conventional method to form an unstretched film, which was subsequently stretched 3.6 times in the machine direction. Then, an aqueous coating liquid (aqueous dispersion having a solid concentration of 3% by mass) prepared by mixing the components to have the solid content ratio given in Table 1 was uniformly applied to the surface of the film with a roll coater.

[0119]

Subsequently, this coated film was dried at 115°C over about 5 seconds, stretched 4.5 times in the transverse direction at 145°C , and further heat-set at 230°C for about 5 seconds, affording a $25 \text{ }\mu\text{m}$ biaxially stretched polyester film having the coating layer shown in Table 1.

[0120]

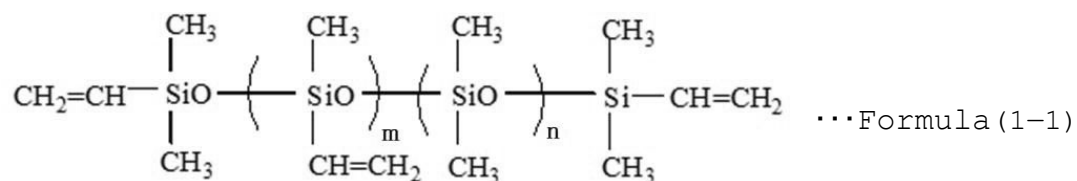
(Aqueous dispersion (1) of alkenyl group-containing silicone (A))

Using an emulsifying device (produced by N.P. Labo Co., Ltd., device name: "Ultra Planetary Mixer") capable of stirring the entire container, a raw material composed of 98% by mass of a silicone having an alkenyl group

represented by the following formula (1-1) (number average molecular weight: 28000) and 2% by mass of polyoxyethylene lauryl ether (produced by Kao Corporation, trade name: "EMULGEN 109P") as a surfactant was mechanically emulsified in an aqueous medium, affording an aqueous alkenyl group-containing silicone dispersion having a solid content of 20% by mass. In addition, the emulsion particle diameter was adjusted by adjusting the stirring speed and the stirring time at the time of emulsification.

[0121]

[Formula 4]



(In Formula (1-1), m is 2.5, and n is 400.)

[0122]

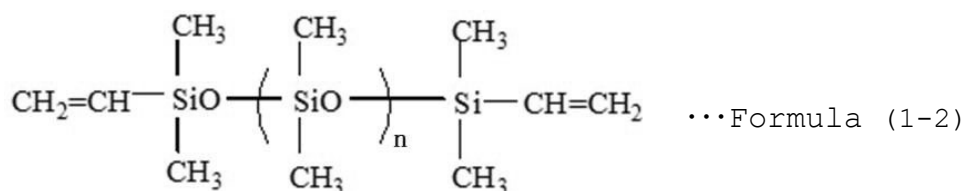
(Aqueous dispersion (2) of alkenyl group-containing silicone (B))

Using an emulsifying device (produced by N.P. Labo Co., Ltd., device name: "Ultra Planetary Mixer") capable of stirring the entire container, a raw material composed of 98% by mass of a silicone having an alkenyl group represented by the following formula (1-2) (number average molecular weight: 14000) and 2% by mass of polyoxyethylene lauryl ether (produced by Kao Corporation, trade name:

"EMULGEN 109P") as a surfactant was mechanically emulsified in an aqueous medium, affording an aqueous alkenyl group-containing silicone dispersion having a solid content of 20% by mass. In addition, the emulsion particle diameter was adjusted by adjusting the stirring speed and the stirring time at the time of emulsification.

[0123]

[Formula 5]



(In Formula (1-2), n is 200.)

[0124]

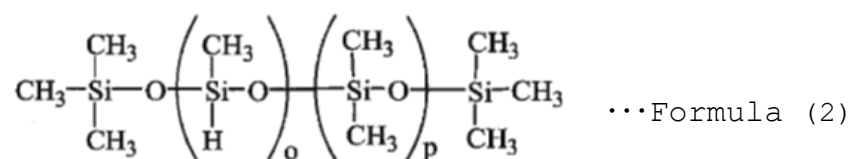
(Aqueous dispersion (3) of silicone (C) having Si-H group)

Using an emulsifying device (produced by N.P. Labo Co., Ltd., device name: "Ultra Planetary Mixer") capable of stirring the entire container, a raw material composed of 98% by mass of a silicone having a hydrogen group represented by the following formula (2) (number average molecular weight: 5000) and 2% by mass of polyoxyethylene lauryl ether (produced by Kao Corporation, trade name: "EMULGEN 109P") as a surfactant was mechanically emulsified in an aqueous medium, affording an aqueous Si-H group-containing silicone dispersion having a solid content of

10% by mass. In addition, the emulsion particle diameter was adjusted by adjusting the stirring speed and the stirring time at the time of emulsification.

[0125]

[Formula 6]



(In Formula (2), o is 30 and p is 35.)

[0126]

(Platinum-based catalyst)

· Reaction inhibitor-containing platinum-based catalyst: An aqueous dispersion having a solid content of 10% by mass was prepared using a solution of chloroplatinic acid in isopropyl alcohol (an amount at which platinum metal was contained at 500 ppm by mass in the present composition), 99.75% by mass of polyoxyethylene lauryl ether (produced by Kao Corporation, trade name: "EMULGEN 109P") as a surfactant, 0.2% by mass of a crosslinking reaction inhibitor (1-ethynylcyclohexanol), and pure water. In this platinum-based catalyst, the crosslinking reaction inhibitor is preferentially coordinated, so that the catalytic effect can be delayed until the reaction inhibitor volatilizes.

[0127]

(Preparation of silicone coating liquid)

A coating liquid was prepared by using, as a coating composition for release, a composition composed of the alkenyl group-containing silicone aqueous dispersions/the Si-H group-containing silicone aqueous dispersion/the platinum-based catalyst according to the compounding composition shown in Table 1, and diluting the composition with water to achieve a solid concentration of the coating liquid of 10% for leading to a layer thickness of 50 nm.

[0128]

The formulation and the results are shown in Table 1. The numerical values of the respective silicones each indicate % by mass of the solid content.

[0129]

[Table 1]

Table 1

	Unit	Example 1	Example 2	Comparative Example 1	Comparative Example 2	Comparative Example 3	Comparative Example 4	Comparative Example 5	Comparative Example 6	Comparative Example 7
Solid content ratio of silicone (A)	wt%	80	90	80	80	90	90	50	50	80
Solid content ratio of silicone (B)	wt%	10	5	20	0	10	0	40	10	10
Solid content ratio of silicone (C)	wt%	10	5	0	20	0	10	10	40	10
Platinum-based catalyst	ppm	140	140	140	140	140	140	140	140	90
Ceramic sheet peelability	mN/mm	0.49	0.52	NG (Uncured)	0.63	NG (Uncured)	0.65	0.74	0.98	0.61

[0130]

As can be seen from Table 1, the films of Examples of the present invention were superior in peelability even with respect to a very thin ceramic sheet as thin as 2 μm . This is presumed to be because a film superior in peelability was obtained owing to the use of a specific configuration including the prescribed crosslinkable high-molecular-weight silicone, low-molecular-weight silicone, and Si-H group-containing silicone. On the other hand, in Comparative Examples 1 to 7, crosslinking was insufficient, resulting in an uncured state, or appropriate light peelability was not obtained.

CLAIMS

1. A silicone-release polyester film having a coating layer formed using a coating composition for release including:

an aqueous dispersion (1) of a silicone (A) having a number average molecular weight of 25000 or more and containing three or more alkenyl groups in one molecule;

an aqueous dispersion (2) of a silicone (B) having a number average molecular weight of 25000 or less and having an alkenyl group at only both ends in one molecule;

an aqueous dispersion (3) of a silicone (C) having a number average molecular weight of 10000 or less and having a hydrogen atom directly bonded to an Si atom represented by an Si-H group; and

a platinum-based catalyst,

wherein where a total solid content of the silicone (A), the silicone (B), and the silicone (C) is 100 parts by mass, the coating composition for release contains the silicone (A) in an amount of 80 parts by mass or more, the silicone (B) in an amount of 2 parts by mass or more and 20 parts by mass or less, and the silicone (C) in an amount of 2 parts by mass or more and 20 parts by mass or less.

2. The silicone-release polyester film according to

claim 1, wherein the silicone (A) has alkenyl groups at both ends and in a side chain in one molecule.

3. The silicone-release polyester film according to claim 1 or 2, wherein the alkenyl groups of the silicone (A) are vinyl groups.

4. The silicone-release polyester film according to claim 1 or 2, wherein the alkenyl groups of the silicone (B) are vinyl groups.

5. The silicone-release polyester film according to claim 1 or 2, wherein the alkenyl groups of the silicone (A) and the silicone (B) are vinyl groups.

6. The silicone-release polyester film according to claim 1 or 2, wherein a content of the platinum-based catalyst is 120 ppm or more based on a total amount of the silicone (A) and the silicone (B).

7. The silicone-release polyester film according to claim 1 or 2, which is to be used for ceramic green sheet forming in production of a stacked ceramic capacitor.

8. A method for producing a silicone-release

polyester film, the method comprising:

a step of forming a coating layer formed using a coating composition for release including:

an aqueous dispersion (1) of a silicone (A) having a number average molecular weight of 25000 or more and containing three or more alkenyl groups in one molecule;

an aqueous dispersion (2) of a silicone (B) having a number average molecular weight of 25000 or less and having an alkenyl group at only both ends in one molecule;

an aqueous dispersion (3) of a silicone (C) having a number average molecular weight of 10000 or less and having a hydrogen atom directly bonded to an Si atom represented by an Si-H group; and

a platinum-based catalyst,

wherein where a total solid content of the silicone (A), the silicone (B), and the silicone (C) is 100 parts by mass, the coating composition for release contains the silicone (A) in an amount of 80 parts by mass or more, the silicone (B) in an amount of 2 parts by mass or more and 20 parts by mass or less, and the silicone (C) in an amount of 2 parts by mass or more and 20 parts by mass or less.

9. The method according to claim 8, wherein the silicone (A) has alkenyl groups at both ends and in a side chain in one molecule.

10. The method according to claim 8 or 9, wherein the alkenyl groups of the silicone (A) and the silicone (B) are vinyl groups.