

DESCRIPTION

TITLE OF THE INVENTION: RELEASE FILM

TECHNICAL FIELD

[0001]

The present invention relates to a release film.

BACKGROUND ART

[0002]

Hitherto, release films including a polyester film and a release layer have been used in a variety of applications. Release films are used not only, for example, for forming ceramic green sheets but also, for example, in the manufacture of adhesive sheets and cover films, polymer films, and optical lenses, and the like.

[0003]

Depending on the application of release films, various resins are used in the release layer of release films, and silicone resins are often used in release films for applications in which easy peeling properties are required. The release layer using a silicone resin, that is, the silicone release layer can be formed, for example, by crosslinking a silicone resin having an alkenyl group with a silicone crosslinking agent having a hydrosilyl group.

[0004]

When a liquid fluid (for example, a ceramic slurry or a liquid composition for polymer film formation) is applied to the silicone release layer, the edge of the applied fluid partly may partly recede, and as a result, a phenomenon in which distribution of the fluid becomes uneven, that is, cissing may occur. In addition to this, pinholes may be generated. Cissing and pinholes lead to a decrease in yield and an increase in defect rate.

[0005]

In order to suppress occurrence of cissing, a release film in which a resin (for example, an alkyd resin or an acrylic resin) other than a silicone resin as the base resin is used in the release layer has been proposed (see Patent Documents 1 and 2), but such a release film tends to have heavy peeling force (that is, large peeling force), and therefore it has to be said that the range of applications of such a release film is limited.

[0006]

Meanwhile, in Patent Document 3, in order to solve the problem that the edges of the applied ceramic slurry swells up, that is, the problem of cissing, a release film including a silicone release layer that is formed using a phenyl-modified polydimethylsiloxane having an alkenyl group has been proposed, but the phenyl-modified

polydimethylsiloxane having an alkenyl group has a limited structure in the sense that it is polydimethylsiloxane, and therefore the range of adjustment of the peeling force by this phenyl-modified polydimethylsiloxane is also limited. Considering this, it has to be said that the range of applications of release films is also limited. In fact, in Patent Document 3, the application of the release film is limited to the formation of ceramic green sheets. Under such circumstances, a new technique capable of suppressing the occurrence of cissing is required.

[0007]

Incidentally, in a release film including a polyester film and a silicone release layer provided on the polyester film, when the adhesion between the polyester film and the silicone release layer is poor, the silicone constituting the silicone release layer may fall off from the polyester film. For the reason that the fallen silicone may be transferred to an adherend (for example, a ceramic green sheet) that is disposed or formed on the release layer, falling off of the silicone release layer may lead to some troubles (for example, a decrease in yield and an increase in defect rate). In order to suppress falling off of the silicone release layer, it is known to add an adhesion imparting agent to the composition for silicone release layer formation (see Patent Document 4), a new technique

capable of improving the adhesion between a silicone release layer and a polyester film is still required.

PRIOR ART DOCUMENT

PATENT DOCUMENTS

[0008]

Patent Document 1: JP-B-5361589

Patent Document 2: JP-B-5191220

Patent Document 3: JP-B-5785706

Patent Document 4: JP-B-6460183

SUMMARY OF THE INVENTION

PROBLEMS TO BE SOLVED BY THE INVENTION

[0009]

An object of the present invention is to provide a release film that can reduce the degree of cissing or suppress the occurrence of cissing, improve the adhesion between a release layer and a polyester film, and prevent the peeling force from becoming excessively strong.

MEANS FOR SOLVING THE PROBLEMS

[0010]

In order to solve this problem, the present invention has the configuration of [1] below.

[1]

A release film including:
a polyester film; and
a release layer, wherein
the release layer is a layer formed by curing a
silicone composition containing an addition curable
silicone,
the silicone composition contains a resin that does
not contain a silicon atom or a nitrogen atom in a molecule
but contains a plurality of alkenyl groups and a plurality
of rings in the molecule, and
the rings are each independently at least one
selected from the group consisting of a monovalent aromatic
ring, a divalent aromatic ring, a monovalent aliphatic
ring, and a divalent aliphatic ring.

Here, an "addition curable silicone" is defined to
include a polysiloxane that contains a hydrosilyl group,
that is, a SiH group in the present specification. A
"silicone composition" is defined to be a composition that
can be cured at least by hydrosilylation.

[0011]

It is preferable that the present invention further
has the configuration of [2] and subsequent items below.

[0012]

[2]

The release film according to [1], wherein the

alkenyl group is an allyl group.

[0013]

[3]

The release film according to [1] or [2], wherein the rings are each independently at least one selected from the group consisting of a phenylene group, a naphthylene group, a cyclopentylene group, and a cyclohexylene group.

[0014]

[4]

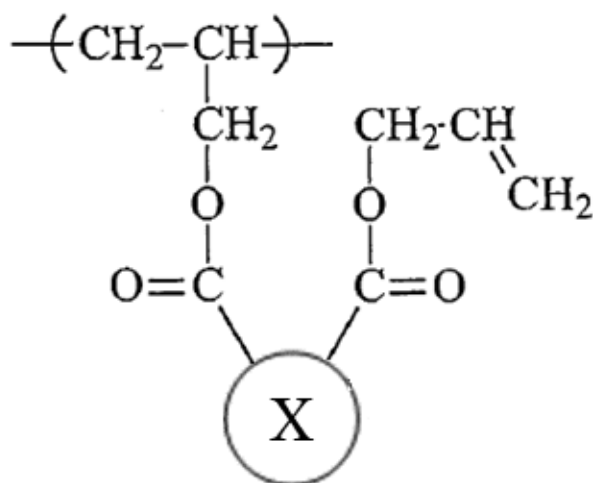
The release film according to any one item of [1] to [3], wherein the resin contains a plurality of ester bonds in the molecule.

[0015]

[5]

The release film according to any one item of [1] to [4], wherein the resin contains a plurality of structural units represented by the following formula (hereinafter sometimes referred to as "Formula C-U1") in the molecule:

[Formula 1]



(a plurality of X's are each independently at least one selected from the group consisting of a phenylene group, a naphthylene group, a cyclopentylene group, and a cyclohexylene group).

Among the release films referred to in [5], the release film citing [1] can be rephrased as follows:

A release film including:

a polyester film; and

a release layer, wherein

the release layer is a layer formed by curing a silicone composition containing an addition curable silicone, and

the silicone composition contains a resin that does not contain a silicon atom or a nitrogen atom in a molecule but contains a plurality of structural units represented by the formula (that is, Formula C-U1) in the molecule.

[0016]

[6]

The release film according to any one item of [1] to [5], wherein a weight average molecular weight of the resin is 4,000 or more.

[0017]

[7]

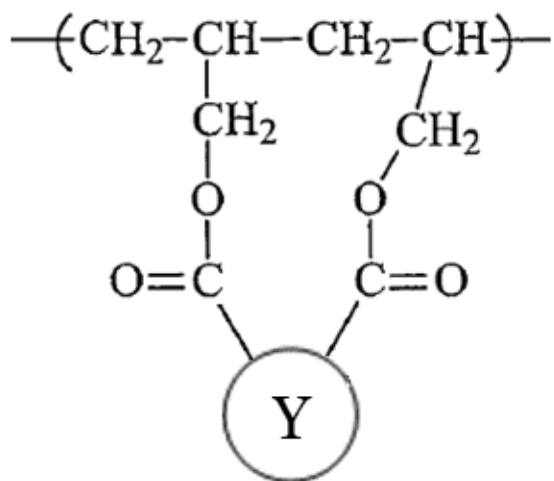
The release film according to any one item of [1] to [6], which is used to manufacture a ceramic green sheet.

[0018]

[8]

The release film according to any one item of [1] to [7], wherein the resin contains a plurality of structural units represented by the following formula (hereinafter sometimes referred to as "Formula C-U2") in the molecule as well as the structural units represented by Formula C-U1.

[Formula 2]



(a plurality of Y's are each independently at least

one selected from the group consisting of a phenylene group, a naphthylene group, a cyclopentylene group, and a cyclohexylene group).

EFFECT OF THE INVENTION

[0019]

According to the present invention, it is possible to provide a release film that can reduce the degree of cissing or suppress the occurrence of cissing, improve the adhesion between a release layer and a polyester film, and prevent the peeling force from becoming excessively strong.

MODE FOR CARRYING OUT THE INVENTION

[0020]

<1. Introduction>

A release film of the present embodiment includes a polyester film; and a release layer, wherein, the release layer is a layer formed by curing a silicone composition containing an addition curable silicone,

the silicone composition contains a resin that does not contain a silicon atom or a nitrogen atom in the molecule but contains a plurality of alkenyl groups and a plurality of rings in the molecule, and

the rings are each independently at least one selected from the group consisting of a monovalent aromatic ring, a divalent aromatic ring, a monovalent aliphatic ring, and a divalent aliphatic ring.

[0021]

In the release film of the present embodiment, since the resin in the silicone composition contains a plurality of rings, it is possible to reduce the degree of cissing that may occur when a liquid fluid such as a ceramic slurry is applied to the release film or to suppress the occurrence of cissing. This is considered to be because greatly minute unevenness are formed on the surface of the release layer by the plurality of rings of the resin and, as a result, the adhesion energy (specifically, adhesion energy determined by measuring the sliding angle using water. Hereinafter, the adhesion energy may be referred to as "water adhesion energy") is improved. This (specifically, the degree of cissing can be reduced or the occurrence of cissing can be suppressed by the plurality of rings of the resin) is also considered to be because the arrangement of the organic group (for example, a methyl group) of the polysiloxane in the silicone composition is disordered on the surface of the release layer by the plurality of rings of the resin and the adhesion energy is thus improved.

[0022]

Moreover, since the resin in the silicone composition contains a plurality of alkenyl groups, the adhesion between the release layer and the polyester film can be improved. This is considered to be because it is considered that the resin in the silicone composition (specifically, the resin containing a plurality of alkenyl groups) is present to be somewhat biased toward the polyester film and therefore the alkenyl groups in the resin present near the polyester film can undergo an addition reaction (that is, hydrosilylation) with the hydrosilyl group in the silicone composition.

[0023]

Furthermore, the resin in the silicone composition does not contain a silicon atom or a nitrogen atom in the molecule, that is, is neither a melamine resin nor a silane coupling agent. As described above, according to the release film of the present embodiment, it is possible to reduce the degree of cissing, suppress the occurrence of cissing, or improve the adhesion between the release layer and the polyester film without using a melamine resin or a silane coupling agent.

[0024]

In addition to this, since the resin in the silicone composition is not a monomer but is a resin, it is possible

to prevent the peeling force when the coating film is peeled off from the release film (for example, the peeling force when a coating film formed by applying a liquid fluid such as a ceramic slurry to the release film, drying the liquid fluid, and curing the liquid fluid if necessary is peeled off from the release film) from becoming excessively strong. In other words, excessively heavy peeling can be avoided. This is considered to be because the resin in the silicone composition is less likely to migrate to the surface of the release layer and is less likely to precipitate on the surface of the release layer compared to a monomer. This will be explained. If a monomer is used instead of a resin, the monomer is likely to migrate to the surface of the release layer and is likely to expose to the surface of the release layer. Hence, the monomer may cause excessively heavy peeling. In contrast, in the release film of the present embodiment, since the resin in the silicone composition is not a monomer but is a resin, the resin is less likely to migrate to the surface of the release layer and is less likely to precipitate on the surface of the release layer. Therefore, according to the release film of the present embodiment, since the resin in the silicone composition is not a monomer but is a resin, that is, is a polymer, excessively heavy peeling can be avoided.

[0025]

Hereinafter, embodiments of the present invention will be described in more detail.

[0026]

<2. Release film>

The release film of the present embodiment includes a polyester film and a release layer. Specifically, the release film of the present embodiment includes a polyester film and a release layer provided on at least one surface of the polyester film.

[0027]

An easily adhesive layer, an anti-static layer, a smoothing layer, and the like may be provided between the release layer and the polyester film. In the present embodiment, favorable adhesion is easily obtained even without the interposition of an easily adhesive layer or the like. In other words, as a preferred aspect, a release film in which a release layer is directly provided on a polyester film is exemplified.

[0028]

<2.1. Release layer>

The release layer is a layer formed by curing a silicone composition. Here, the silicone composition is a composition that contains an addition curable silicone and can be cured at least by hydrosilylation. Hydrosilylation

is a reaction in which a polysiloxane containing a SiH group is added to an unsaturated bond, such as a carbon-carbon double bond, with cleavage of the Si-H bond.

[0029]

The addition curable silicone contained in the silicone composition includes a polysiloxane containing a hydrosilyl group, that is, a SiH group. The addition curable silicone preferably includes, for example, a polysiloxane A containing two or more alkenyl groups in the molecule and a polysiloxane B containing two or more hydrosilyl groups in the molecule. In other words, the silicone composition preferably contains a polysiloxane A containing two or more alkenyl groups in the molecule and a polysiloxane B containing two or more hydrosilyl groups in the molecule.

[0030]

<2.1.1. Polysiloxane A>

The polysiloxane A may contain two or more alkenyl groups at the side chain and/or the terminal, and is preferably a polyorganosiloxane containing an alkenyl group at least at the side chain, more preferably a polyorganosiloxane containing an alkenyl group only at the side chain. The polysiloxane A is preferably a copolymer containing a siloxane unit containing an alkenyl group and a dialkylsiloxane unit or an alkylphenylsiloxane unit since

it is easy to adjust the amount of alkenyl groups in one molecule while exhibiting releasability. The silicon atom at the terminal preferably has a trialkylsilane structure such as trimethylsilane.

[0031]

Examples of the alkenyl group include an alkenyl group having 2 or more and 10 or less carbon atoms. By containing such an alkenyl group, the strength of the release layer becomes excellent. The alkenyl group is preferably an alkenyl group having 2 or more and 8 or less carbon atoms, more preferably an alkenyl group having 2 or more and 6 or less carbon atoms, and particularly preferably a vinyl group or a hexenyl group. A plurality of alkenyl groups may be bonded to the silicon atom to which the alkenyl group is bonded, but it is preferable that the alkenyl group and the alkyl group are bonded. The alkyl group in this case is preferably a methyl group or the like.

[0032]

Preferred examples of the dialkylsiloxane unit and the like contained in the polysiloxane A in addition to the siloxane unit containing an alkenyl group include a dimethylsiloxane unit and a phenylmethylsiloxane unit.

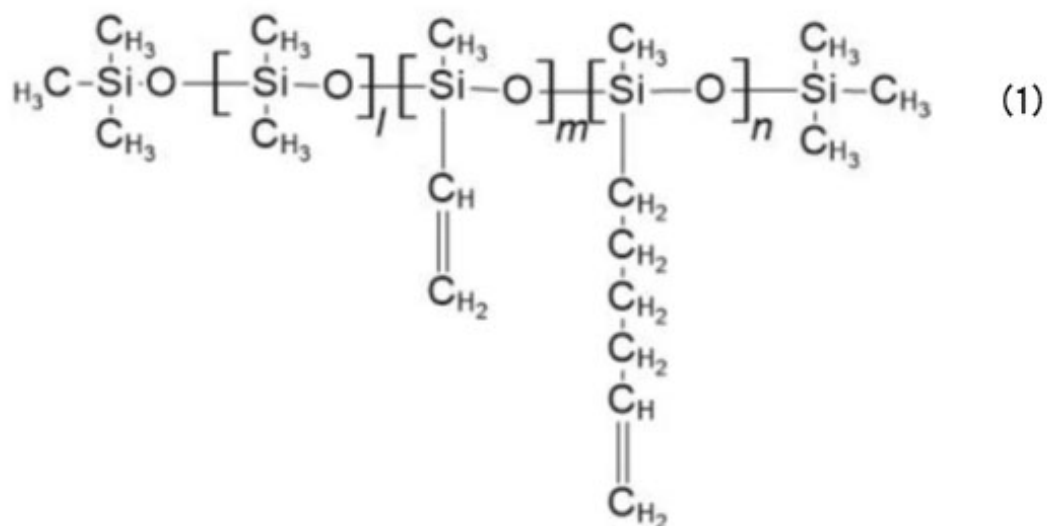
[0033]

Examples of the polysiloxane as described above

include polysiloxanes represented by the following
Structural Formula (1).

[0034]

[Formula 3]



In Formula (1), l , m , and n are integers of 0 or more (provided that $m + n$ is 2 or more), but it is preferable that l is in a range of 1000 or more and 10,000 or less and $m + n$ is in a range of 2 or more and 100 or less since the crosslinking reaction suitably proceeds while sufficient releasability is exhibited, and thus strength of the release layer is improved. From the same viewpoint, $(m + n)/(l + m + n + 2)$ is preferably 0.006 or more and 0.03 or less, and more preferably 0.01 or more and 0.024 or less.

[0035]

The formula does not mean an aspect of a block copolymer, but merely indicates that the total number of units is l , m , or n . Therefore, the polysiloxane in the

formula may be a random copolymer or a block copolymer.

[0036]

In the present embodiment, as the polysiloxane A, one of the above-mentioned polysiloxanes may be used alone, a polysiloxane having two or more different alkenyl groups in one molecule may be used, or two or more polysiloxanes having different structures, such as containing different alkenyl groups, may be used in combination.

[0037]

The weight average molecular weight of the polysiloxane A is preferably 300,000 or more and 600,000 or less, and particularly preferably 400,000 or more and 550,000 or less. The weight average molecular weight in the present specification is a value in terms of standard polystyrene measured by a gel permeation chromatography (GPC) method.

[0038]

When the weight average molecular weight of the polysiloxane A is 300,000 or more, the release layer after crosslinking has appropriate coating film strength, and thus the falling off of the coating film can be more effectively prevented. When the weight average molecular weight is 600,000 or less, the flatness of the coating film after drying is improved.

[0039]

<2.1.2. Polysiloxane B>

The polysiloxane B may contain two or more hydrosilyl groups (groups in which a hydrogen atom is directly bonded to a silicon atom) at the side chain and/or the terminal, and hydrogen polysiloxane containing a hydrosilyl group at least at the side chain is preferable, and hydrogen polysiloxane containing a hydrosilyl group only at the side chain is more preferable. The polysiloxane B is preferably a copolymer containing a siloxane unit containing a hydrosilyl group and a dialkylsiloxane unit or an alkylphenylsiloxane unit since it is easy to adjust the amount of hydrosilyl groups in one molecule while exhibiting releasability. A plurality of hydrogen atoms may be directly bonded to the silicon atom to which the hydrogen atom is directly bonded, but it is preferable that the hydrogen atom and the alkyl group are bonded. The alkyl group in this case is preferably a methyl group or the like. The silicon atom at the terminal preferably has a trialkylsilane structure such as trimethylsilane.

[0040]

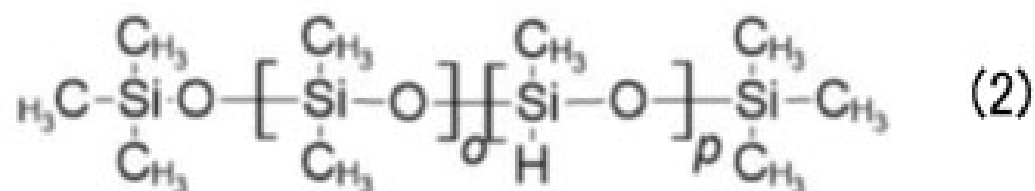
Preferred examples of the dialkylsiloxane unit and the like contained in the polysiloxane B in addition to the siloxane unit containing a hydrosilyl group include a dimethylsiloxane unit and a phenylmethylsiloxane unit.

[0041]

Examples of the hydrogen polysiloxane include polysiloxanes represented by the following Structural Formula (2).

[0042]

[Formula 4]



In Formula (2), o is an integer of 0 or more, and p is an integer of 2 or more, but it is preferable that o is in a range of 0 or more and 120 or less, p is in a range of 2 or more and 120 or less, and o + p is in a range of 2 or more and 240 or less since the crosslinking reaction suitably proceeds, and thus the strength of the release layer is improved. From the same viewpoint, (p)/(o + p + 2) is preferably 0.3 or more and 1 or less.

[0043]

The formula does not mean an aspect of a block copolymer, but merely indicates that the total number of units is o or p. Therefore, the hydrogen polysiloxane in the formula may be a random copolymer or a block copolymer.

[0044]

As the polysiloxane B, one of the hydrogen polysiloxanes as described above may be used alone, or two

or more hydrogen polysiloxanes having different structures, such as different numbers of hydrosilyl groups in one molecule, may be used in combination.

[0045]

The weight average molecular weight of the polysiloxane B is preferably 5000 or more and 100,000 or less, and particularly preferably 7000 or more and 20,000 or less. When the weight average molecular weight of the polysiloxane B is 5000 or more, the release layer after crosslinking has appropriate coating film strength, and the falling off of the coating film can be prevented. When the weight average molecular weight is 100,000 or less, the flatness of the coating film after drying is improved.

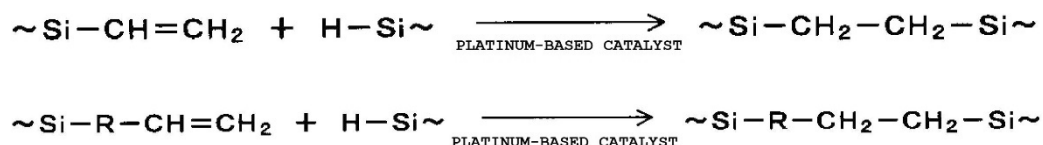
[0046]

In the present embodiment, preferably a product obtained by the addition polymerization of the polysiloxane A and polysiloxane B preferably in the presence of a platinum-based catalyst or the like to be described later is a main component of the release layer. The addition polymerization referred to herein is a reaction in which a functional group at a molecular terminal or in a molecular side chain in the polysiloxane A represented by $-\text{Si}-\text{CH}=\text{CH}_2$ or $-\text{Si}-\text{R}-\text{CH}=\text{CH}_2$ and a functional group at a molecular terminal or in a molecular side chain in the polysiloxane B represented by $\text{H}-\text{Si}-$ become $-\text{Si}-\text{CH}_2\text{CH}_2-\text{Si}-$ or $-\text{Si}-\text{R}-\text{CH}_2\text{CH}_2-$

Si-. However, "-" in the functional group indicates that the molecules are further connected. When the reaction at this time is expressed as a reaction formula, the reaction is represented as the following formula. Here, R represents an alkylene group having 1 or more and 8 or less carbon atoms.

[0047]

[Formula 5]



[0048]

<2.1.3. Mixing mass ratio and total content of polysiloxanes A and B>

In the silicone composition, the mixing mass ratio (B/A) of the polysiloxane A to the polysiloxane B can be appropriately set.

[0049]

The total content of the polysiloxane A and polysiloxane B is preferably 20% by mass or more, more preferably 40% by mass or more, still more preferably 60% by mass or more, still more preferably 70% by mass or more in 100% by mass of solids in the silicone composition. Meanwhile, the total content of the polysiloxane A and polysiloxane B is preferably 95% by mass or less, more

preferably 90% by mass or less, still more preferably 85% by mass or less, still more preferably 80% by mass or less.

[0050]

<2.1.4. Resin not containing silicon atom or nitrogen atom in molecule but containing plurality of alkenyl groups and plurality of rings in molecule (resin C)>

The silicone composition contains a resin that does not contain a silicon atom or a nitrogen atom in the molecule but contains a plurality of alkenyl groups and a plurality of rings in the molecule (hereinafter sometimes referred to as "resin C"). In other words, the silicone composition contains a polymer that does not contain a silicon atom or a nitrogen atom but contains a plurality of alkenyl groups and a plurality of rings.

[0051]

Since the resin C contains a plurality of rings, it is possible to reduce the degree of cissing that may occur when a liquid fluid such as a ceramic slurry is applied to the release film or to suppress the occurrence of cissing. This is considered to be because greatly minute unevennesses are formed on the surface of the release layer by the plurality of rings of the resin C and, as a result, the adhesion energy (specifically, water adhesion energy) is improved. This (specifically, the degree of cissing can be reduced or the occurrence of cissing can be suppressed

by the plurality of rings of the resin) is also considered to be because the arrangement of the organic group (for example, a methyl group) of the polysiloxane in the silicone composition is disordered on the surface of the release layer by the plurality of rings of the resin C and the adhesion energy is thus improved.

[0052]

Moreover, since the resin C contains a plurality of alkenyl groups, the adhesion between the release layer and the polyester film can be improved. This is considered to be because it is considered that the resin C is present to be somewhat biased toward the polyester film and therefore the alkenyl group in the resin C present near the polyester film can undergo an addition reaction (that is, hydrosilylation) with the hydrosilyl group in the silicone composition.

[0053]

Furthermore, since the resin C contains a plurality of alkenyl groups, the strength of the release layer (that is, the amount of deformation until fracture) can also be increased, as compared to the case where an alkenyl group is not contained at all. This is considered to be because the resin C contains a plurality of alkenyl groups and thus hydrosilylation and crosslinking between molecules in the resin C (that is, polymers) are possible.

[0054]

Furthermore, the resin C does not contain a silicon atom or a nitrogen atom in the molecule, that is, is neither a melamine resin nor a silane coupling agent. As described above, according to the release film of the present embodiment, it is possible to reduce the degree of cissing, suppress the occurrence of cissing, or improve the adhesion between the release layer and the polyester film without using a melamine resin or a silane coupling agent.

[0055]

In addition to this, since the resin C is not a monomer but is a resin, it is possible to prevent the peeling force when the coating film is peeled off from the release film (for example, the peeling force when a coating film formed by applying a liquid fluid such as a ceramic slurry to the release film, drying the liquid fluid, and curing the liquid fluid if necessary is peeled off from the release film) from becoming excessively strong. In other words, excessively heavy peeling can be avoided. This is considered to be because the resin C is less likely to migrate to the surface of the release layer and is less likely to precipitate on the surface of the release layer compared to a monomer. This will be explained. If a monomer is used instead of the resin C, the monomer is likely to migrate to the surface of the release layer and

is likely to expose to the surface of the release layer. Hence, the monomer may cause excessively heavy peeling. In contrast, in the release film of the present embodiment, since the resin C is not a monomer but is a resin, the resin is less likely to migrate to the surface of the release layer and is less likely to precipitate on the surface of the release layer. Therefore, according to the release film of the present embodiment, since the resin C is not a monomer but is a resin, excessively heavy peeling can be avoided.

[0056]

The alkenyl groups contained in the molecule of the resin C are preferably each independently an alkenyl group having 2 to 6 carbon atoms. Examples of such an alkenyl group include a vinyl group and an allyl group. Among these, an allyl group is more preferable since the products used in Examples described later are commercially available and are basically easily procured.

[0057]

The rings contained in the molecule of the resin C are each independently at least one selected from the group consisting of a monovalent aromatic ring, a divalent aromatic ring, a monovalent aliphatic ring, and a divalent aliphatic ring. Examples of the monovalent aromatic ring, that is, an aryl group include a phenyl group and naphthyl

groups (for example, a 1-naphthyl group and a 2-naphthyl group). Examples of the divalent aromatic ring, that is, an arylene group include phenylene groups (for example, an o-phenylene group, an m-phenylene group, and a p-phenylene group) and a naphthylene group (for example, a 2,6-naphthylene group). Examples of the monovalent aliphatic ring, that is, a cycloalkyl group include a cyclopentyl group and a cyclohexyl group. Examples of the divalent aliphatic ring, that is, a cycloalkylene group include cyclopentylene groups (for example, a 1,2-cyclopentylene group and a 1,3-cyclopentylene group) and cyclohexylene groups (for example, a 1,2-cyclohexylene group, a 1,3-cyclohexylene group, and a 1,4-cyclohexylene group). Among these, a divalent aromatic ring and a divalent aliphatic ring are preferable since the products used in Examples described later are commercially available and are basically easily procured. In other words, the rings in the molecule are preferably each independently a divalent aromatic ring or a divalent aliphatic ring. In particular, for the reason that the rings are stable and the effect of reducing or suppressing cissing can be stably exerted, a phenylene group, a naphthylene group, a cyclopentylene group, and a cyclohexylene group are preferable and a phenylene group and a cyclohexylene group are more preferable. In other words, the rings in the molecule are

preferably each independently at least one selected from the group consisting of a phenylene group, a naphthylene group, a cyclopentylene group, and a cyclohexylene group, more preferably a phenylene group or a cyclohexylene group.

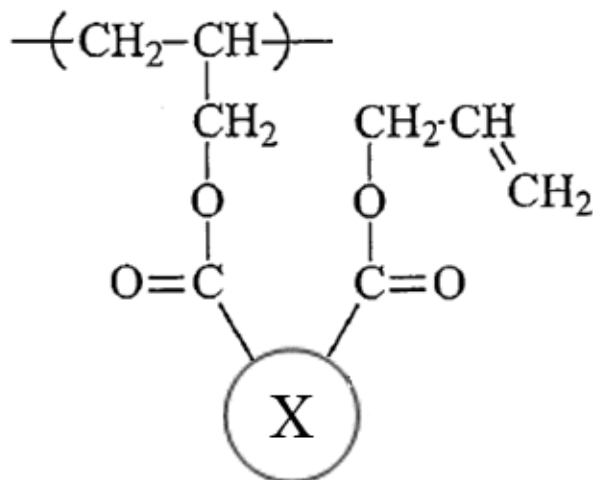
[0058]

The resin C preferably contains a plurality of ester bonds, that is, a plurality of ester groups in the molecule. As the resin C contains ester bonds, it is possible to induce electrostatic attraction between the ester bonds and the polar groups (for example, a carboxyl group and a hydroxyl group) present on the surface (for example, the surface subjected to corona discharge treatment) of the polyester film, and thus to further improve the adhesion between the release layer and the polyester film.

[0059]

To specifically explain a suitable example of the resin C, the resin C preferably contains a plurality of structural units represented by the following formula (hereinafter sometimes referred to as "Formula C-U1") in the molecule.

[Formula 6]



A plurality of X's are each independently a divalent aromatic ring or a divalent aliphatic ring. The plurality of X's are preferably each independently a phenylene group, a naphthylene group, a cyclopentylene group, or a cyclohexylene group, more preferably a phenylene group or a cyclohexylene group. It is still more preferable that the plurality of X's are all phenylene groups or all cyclohexylene groups. In a case where the plurality of X's are all phenylene groups, the two ester bonds adjacent to the phenylene group may be at the ortho positions, meta positions, or para positions.

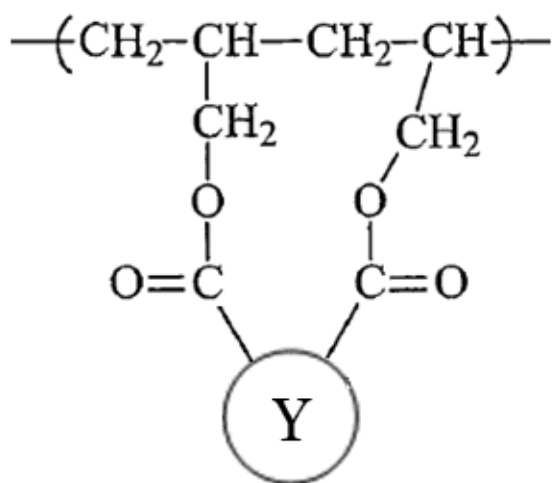
[0060]

As the resin C contains a plurality of structural units represented by Formula C-U1, the occurrence of cissing can be further suppressed as well as the adhesion between the release layer and the polyester film can be further improved.

[0061]

The resin C may contain a plurality of structural units represented by the following formula (hereinafter sometimes referred to as "Formula C-U2") in the molecule as well as the structural units represented by Formula C-U1.

[Formula 7]



A plurality of Y's are each independently a divalent aromatic ring or a divalent aliphatic ring. The plurality of Y's are preferably each independently a phenylene group, a naphthylene group, a cyclopentylene group, or a cyclohexylene group, more preferably a phenylene group or a cyclohexylene group. It is still more preferable that the plurality of Y's are all phenylene groups or all cyclohexylene groups. In a case where the plurality of Y's are all phenylene groups, the two ester bonds adjacent to the phenylene group may be at the ortho positions, meta positions, or para positions.

[0062]

In a case where the resin C contains structural units represented by Formula C-U1 and structural units represented by Formula C-U2 in the molecule, it is preferable that both the plurality of X's and the plurality of Y's are phenylene groups or that both the plurality of X's and the plurality of Y's are cyclohexylene groups.

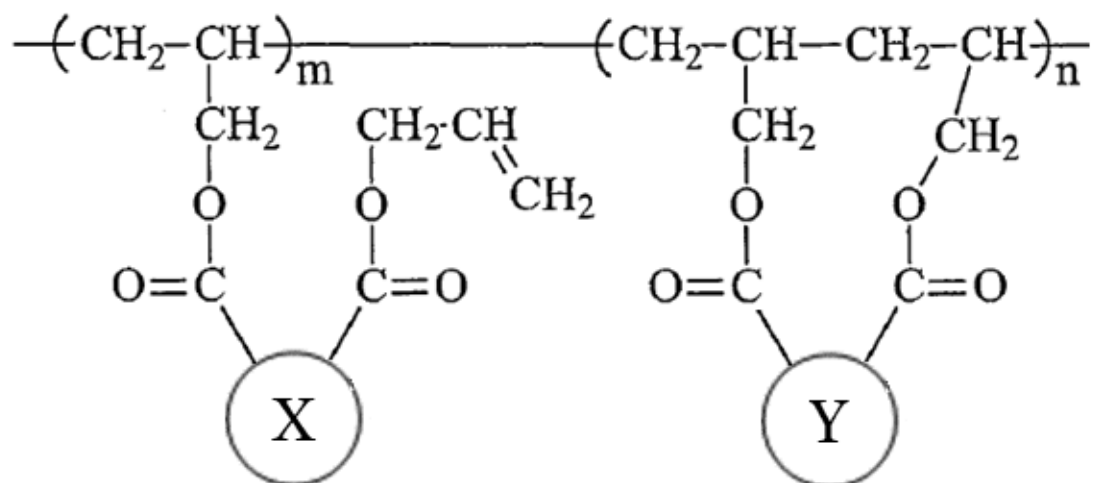
[0063]

The molar ratio of the structural units represented by Formula C-U1 to the structural units represented by Formula C-U2, specifically, the number of moles of the structural units represented by Formula C-U1/the number of moles of the structural units represented by Formula C-U2 may be 0.5 or more, 0.7 or more, or 0.8 or more. This molar ratio may be, for example, 1.5 or less, 1.3 or less, or 1.2 or less.

[0064]

The resin C preferably contains a structure represented by the following formula (hereinafter sometimes referred to as "Formula C-P").

[Formula 8]



A plurality of X's are each independently a divalent aromatic ring or a divalent aliphatic ring. The plurality of X's are preferably each independently a phenylene group, a naphthylene group, a cyclopentylene group, or a cyclohexylene group, more preferably a phenylene group or a cyclohexylene group. It is still more preferable that the plurality of X's are all phenylene groups or all cyclohexylene groups. In a case where the plurality of X's are all phenylene groups, the two ester bonds adjacent to the phenylene group may be at the ortho positions, meta positions, or para positions.

[0065]

A plurality of Y's are each independently a divalent aromatic ring or a divalent aliphatic ring. The plurality of Y's are preferably each independently a phenylene group, a naphthylene group, a cyclopentylene group, or a cyclohexylene group, more preferably a phenylene group or a

cyclohexylene group. It is still more preferable that the plurality of Y's are all phenylene groups or all cyclohexylene groups. In a case where the plurality of Y's are all phenylene groups, the two ester bonds adjacent to the phenylene group may be at the ortho positions, meta positions, or para positions.

[0066]

It is particularly preferable that both the plurality of X's and the plurality of Y's are phenylene groups or that both the plurality of X's and the plurality of Y's are cyclohexylene groups.

[0067]

m is an integer 2 or more and n is also an integer 2 or more. The structure represented by Formula C-P contains structural units represented by Formula C-U1 and structural units represented by Formula C-U2, and the molar ratio of the structural units represented by Formula C-U1 to the structural units represented by Formula C-U2 (specifically, the number of moles of the structural units represented by Formula C-U1/the number of moles of the structural units represented by Formula C-U2) may be 0.5 or more, 0.7 or more, or 0.8 or more. This molar ratio may be, for example, 1.5 or less, 1.3 or less, or 1.2 or less.

[0068]

Formula C-P does not mean an aspect of a block

copolymer, but merely indicates that the total number of units is m or n. Therefore, the polymer containing a structure represented by Formula C-P may be a random copolymer or a block copolymer. Among these, a random copolymer is preferable.

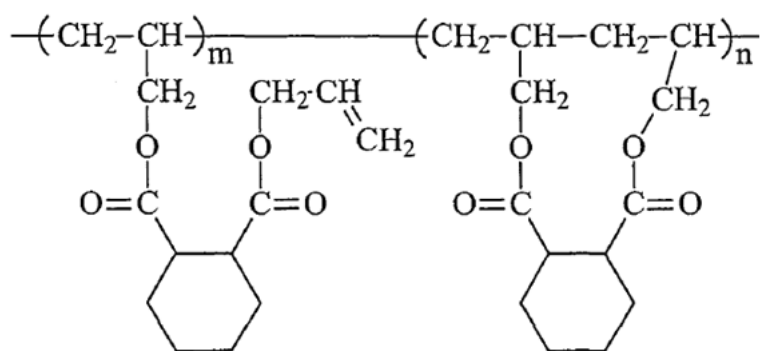
[0069]

Suitable examples of the resin C include a diallyl phthalate resin and a diallyl cyclohexane resin. When the resin C is a diallyl phthalate resin or a diallyl cyclohexane resin, the occurrence of cissing can be further suppressed as well as the adhesion between the release layer and the polyester film can be further improved. Examples of the diallyl phthalate resin include a resin containing a plurality of structural units represented by Formula C-U1, where X is a phenylene group, in the molecule. Examples of the diallyl phthalate resin also include a resin containing a structure represented by Formula C-P, where both X and Y are phenylene groups. Examples of commercially available products of the diallyl phthalate resin include DAP-K manufactured by OSAKA SODA CO., LTD., ISODAP manufactured by OSAKA SODA CO., LTD., and DAP-A manufactured by OSAKA SODA CO., LTD.. Examples of the diallyl cyclohexane resin include a resin containing a plurality of structural units represented by Formula C-U1, where X is a cyclohexylene group, in the molecule.

Examples of the diallyl phthalate resin also include a resin containing a structure represented by Formula C-P, where both X and Y are cyclohexylene groups. Examples of commercially available products of the diallyl cyclohexane resin include AD-032 manufactured by OSAKA SODA CO., LTD.. [0070]

The diallyl cyclohexane resin is preferably a polymer containing a structure represented by the following formula (hereinafter sometimes referred to as "Formula C1").

[Formula 9]

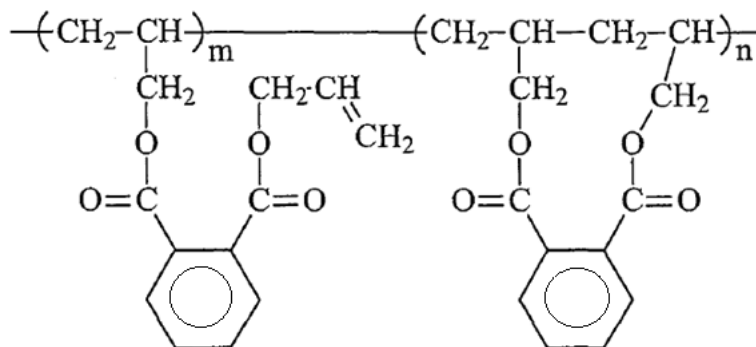


In Formula C1, m is an integer 2 or more and n is also an integer 2 or more. The structure represented by Formula C1 contains the structural unit shown on the left (that is, an example of the structural units represented by Formula C-U1) and the structural unit shown on the right (that is, an example of the structural units represented by Formula C-U2), and the molar ratio of the former structural unit to the latter structural unit may be 0.5 or more, 0.7 or more, or 0.8 or more. This molar ratio may be, for

[0071]

[0072]

[Formula 10]



35

Formula C-U2), and the molar ratio of the former structural unit to the latter structural unit may be 0.5 or more, 0.7 or more, or 0.8 or more. This molar ratio may be, for example, 1.5 or less, 1.3 or less, or 1.2 or less.

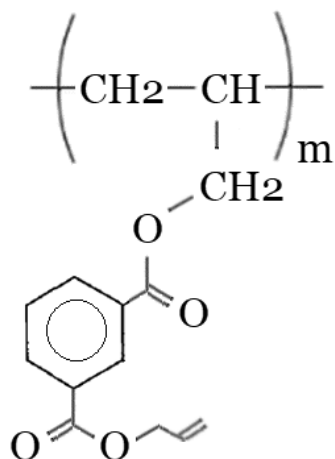
[0073]

Formula C2 does not mean an aspect of a block copolymer, but merely indicates that the total number of units is m or n. Therefore, the polymer containing a structure represented by Formula C2 may be a random copolymer or a block copolymer. Among these, a random copolymer is preferable.

[0074]

The diallyl phthalate resin is preferably a polymer containing a structure represented by the following formula (hereinafter sometimes referred to as "Formula C3").

[Formula 11]



In Formula C3, m is an integer 2 or more.

[0075]

The polymer containing the structure represented by Formula C1, Formula C2, or Formula C3 may contain structural units other than the structural units shown in that formula.

[0076]

The weight average molecular weight of the resin C is preferably 4,000 or more, more preferably 5,000 or more, still more preferably 10,000 or more, still more preferably 15,000 or more. When the weight average molecular weight is 4,000 or more, it is possible to further prevent the peeling force when the coating film is peeled off from the release film (for example, the peeling force when a coating film formed by applying a liquid fluid such as a ceramic slurry to the release film, drying the liquid fluid, and curing the liquid fluid if necessary is peeled off from the release film) from becoming excessively strong. This is considered to be because the resin C is far less likely to migrate to the surface of the release layer and is far less likely to precipitate on the surface of the release layer when the weight average molecular weight is 4,000 or more. Meanwhile, the weight average molecular weight of the resin C may be, for example, 200,000 or less, 100,000 or less, 80,000 or less, or 60,000 or less. The weight average molecular weight in the present specification is a value in terms of standard polystyrene measured by a gel permeation

chromatography (GPC) method.

[0077]

The content of the resin C in the silicone composition is preferably 5 parts by mass or more, more preferably 10 parts by mass or more, still more preferably 15 parts by mass or more, still more preferably 20 parts by mass or more when the total amount of the polysiloxane A and polysiloxane B is set to 100 parts by mass. When the content is 5 parts by mass or more, it is possible to further reduce the degree of cissing, further suppress the occurrence of cissing, or further improve the adhesion between the release layer and the polyester film.

Meanwhile, the content of the resin C is preferably 80 parts by mass or less, more preferably 60 parts by mass or less, still more preferably 40 parts by mass or less, still more preferably 30 parts by mass or less when the total amount of the polysiloxane A and polysiloxane B is set to 100 parts by mass. When the content is 80 parts by mass or less, it is possible to further prevent the peeling force when the coating film is peeled off from the release film (for example, the peeling force when a coating film formed by applying a liquid fluid such as a ceramic slurry to the release film, drying the liquid fluid, and curing the liquid fluid if necessary is peeled off from the release film) from becoming excessively strong.

[0078]

<2.1.5. Catalyst>

The silicone composition preferably further contains a catalyst. The catalyst is not particularly limited as long as the catalyst can promote the curing reaction of the silicone composition, and among others, a platinum group metal-based compound is preferable.

[0079]

Examples of the platinum group metal-based compound include particulate platinum, particulate platinum adsorbed on a carbon powder carrier, chloroplatinic acid, alcohol-modified chloroplatinic acid, an olefin complex of chloroplatinic acid, palladium, and rhodium. When the silicone composition contains such a catalyst, the curing reaction of the silicone composition can be more efficiently advanced.

[0080]

The content of the catalyst in the silicone composition is preferably about 1 ppm or more and 1000 ppm or less with respect to the total amount of the polysiloxane A and polysiloxane B.

[0081]

<2.1.6. Photopolymerization initiator>

The silicone composition preferably further contains a photopolymerization initiator. In particular, in a case

where the content of the resin C is large (for example, in a case where the resin C is 50 parts by mass or more when the total amount of the polysiloxane A and polysiloxane B is set to 100 parts by mass), it is preferable to contain a photopolymerization initiator. The reason is that the catalyst, such as a platinum group metal-based compound, is considered to be present in a compatible manner with the polysiloxane A and polysiloxane B, and thus the catalyst may not work efficiently in the self-crosslinking reaction of the resin C. Examples of the photopolymerization initiator include an alkylphenone-based photopolymerization initiator. Specific examples thereof include Omnirad185 and Omnirad907.

[0082]

The content of the photopolymerization initiator in the silicone composition is preferably about 1 ppm or more and 1000 ppm or less with respect to the total amount of all solids other than the photopolymerization initiator.

[0083]

<2.1.7. Other components>

In addition to the above components, the silicone composition may contain a reaction inhibitor, a solvent, a silicone resin not having a reactive functional group, an anti-static agent, a melamine resin, a silane coupling agent, and the like.

[0084]

<2.1.8. Thickness of release layer>

The thickness of the release layer is preferably 0.005 μm or more, more preferably 0.01 μm or more. When the thickness of the release layer is 0.005 μm or more, the function as a release layer can be effectively exerted. Meanwhile, the thickness of the mold layer is preferably 0.5 μm or less, more preferably 0.1 μm or less, still more preferably 0.05 μm or less. When the thickness of the release layer is 0.5 μm or less, the occurrence of fracture in the release layer, that is, the occurrence of cohesive fracture can be suppressed.

[0085]

<2.2. Polyester film>

In the present embodiment, the polyester film used as the substrate film (hereinafter, sometimes referred to as substrate) is a film containing polyester as a resin component, and is preferably a film containing polyester in the largest amount (for example, 90% by mass or more) in the resin component.

[0086]

Polyester constituting the polyester film is not particularly limited, and film-formed polyester which is generally used as a substrate for a release film can be used. The polyester is preferably crystalline linear

saturated polyester composed of an aromatic dibasic acid component and a diol component, and for example, polyethylene terephthalate, polyethylene-2,6-naphthalate, polybutylene terephthalate, polytrimethylene terephthalate, or a copolymer containing constituent components of these resins as main components is more suitable.

[0087]

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, one manufactured from only terephthalic acid and ethylene glycol is preferable. Known additives, for example, an antioxidant, a light stabilizer, an ultraviolet absorber, and a crystallizing agent may be added to the polyester film. The polyester film is preferably a biaxially oriented polyester film because of its elastic modulus in both directions, and the like.

[0088]

The intrinsic viscosity of the polyethylene terephthalate film is preferably 0.50 dl/g or more and 0.70 dl/g or less, more preferably 0.52 dl/g or more and 0.62

dl/g or less. When the intrinsic viscosity is 0.50 dl/g or more, the frequency of occurrence of fracture during the stretching step can be reduced. Meanwhile, when the intrinsic viscosity is 0.70 dl/g or less, the cuttability when the film is cut into a predetermined product width is favorable, and therefore the frequency of occurrence of dimensional error can be reduced. Incidentally, it is preferable that the raw material pellets are sufficiently vacuum-dried.

[0089]

In the present specification, the term "polyester film" may simply mean 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).

[0090]

The method for manufacturing the polyester film is not particularly limited, and methods generally used conventionally can be used. For example, the polyester film can be obtained by melting the polyester with an extruder, extruding the melted product into a film form, cooling the extruded product with a rotary cooling drum to obtain an un-stretched film, and uniaxially or biaxially stretching the un-stretched 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 un-stretched film is simultaneously stretched biaxially in the machine direction and the transverse direction.

[0091]

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

[0092]

The thickness of the polyester film is preferably 12 μm or more and 50 μm or less, more preferably 15 μm or more and 38 μm or less, and still more preferably 19 μm or more and 33 μm or less. It is preferable that the thickness of the film is 12 μm or more since there is no risk of deformation due to heat during film production, processing steps, and forming. Whereas, the thickness of the film of 50 μm or less is preferable for saving the environmental load, because the amount of the film to be disposed after being used is not extremely large.

[0093]

The polyester film may be composed of a single layer

or multi layers of two layers or more. For example, the polyester film may include 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. It is preferable that the surface layer A is substantially free of inorganic particles having a particle size of 1.0 μm or more.

[0094]

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. As the surface layer A is substantially free of particles having a particle size of 1.0 μm or more, for example, inorganic particles, and therefore the occurrence of defects due to the transfer of the particle shape in the substrate to the resin sheet can be reduced.

[0095]

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 more effectively suppressed.

[0096]

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 more effectively suppress the occurrence of defects due to the transfer of the particle shape in the substrate to the resin sheet.

[0097]

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.

[0098]

Here, in the present invention, the phrase "substantially free of particles" means, for example, in the case of inorganic 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 manufacturing 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 actively contained.

[0099]

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.

[0100]

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 not contain inorganic particles. In that case, a coat layer D 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.

[0101]

In the polyester film substrate in 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 in particular, 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.

[0102]

At this time, the average area surface roughness (Sa) 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 5 nm or more and 35 nm or less. In a case where the total content of silica particles and/or calcium carbonate particles is 5000 ppm or more and the Sa is 1 nm or more, air can be uniformly released when the film is wound into a roll, and the film has a favorable winding appearance and favorable flatness, so that the film is suitable for the manufacture of an ultrathin ceramic green sheet. It is preferable that 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 since the aggregation of lubricant is less likely to occur, coarse protrusions cannot be formed, and the quality is stable during the manufacture of ultrathin ceramic green sheet.

[0103]

As the particles contained in the layer B, inert inorganic particles other than silica and/or calcium

carbonate 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.

[0104]

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 0.5 μm or more and 1.0 μm or less. It is preferable that the average particle diameter of the inorganic particles is 0.1 μm or more since the slipperiness of the release film is favorable. It is preferable that the average particle diameter is 2.0 μm or less since 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. The average particle diameter of the particles can be measured by a method in which particles in the cross section of a processed film are observed with a scanning electron microscope, 100 particles are observed, and the average value thereof is taken as the average particle diameter. The shape of the particles is not particularly limited as long as the shape of the particles satisfies the object of the present invention, and spherical particles and non-spherical particles having an indefinite shape can be used. The particle diameter of the particles having an indefinite shape can be calculated as an equivalent circle diameter. The equivalent circle diameter is a value obtained by dividing the area of the observed particles by the circular constant (π), calculating the square root, and doubling the square root.

[0105]

From the viewpoint of reducing pinholes, it is preferable not to use a recycled raw material or the like for the surface layer A, which is a layer on which the release layer is to be provided, in order to prevent the contamination of inorganic particles such as a lubricant.

[0106]

The thickness ratio of the surface layer A, which is a layer on which the release layer is provided, is

preferably 20% or more and 50% or less of the total thickness of all the layers of the substrate film. It is preferable that the thickness ratio of the surface layer A is 20% or more since the film is hardly affected from the inside of the film by particles contained in the surface layer B or the like, and the average area surface roughness S_a easily satisfies the above range. It is preferable that the thickness ratio of the surface layer A is 50% or less of the total thickness of all the layers of the substrate film since the use ratio of a recycled raw material in the surface layer B can be increased, so that the environmental load is reduced.

[0107]

From the viewpoint of economic performance, for the layer other than the surface layer A (the surface layer B or the above-mentioned intermediate layer C), 50 to 90% by mass of film scraps or reused materials for PET bottles can be used. Even in this case, it is preferable that the type, the amount, and the particle size of the lubricant contained in the layer B, and the average area surface roughness (S_a) of the surface layer B satisfy the above ranges.

[0108]

In order to improve the adhesion of the release layer or the like to be applied later, or in order to prevent

electric charge, a coat layer D may be provided on the surface of the surface layer A and/or the surface of the surface layer B before the film is subjected to stretching or after the film is subjected to uniaxial stretching in the film forming process, or the film may be subjected to a corona treatment or the like.

[0109]

In a case where the surface layer B is free of particles, it is also preferable to impart slipperiness to the surface layer B with a coat layer D containing particles. Means for providing the coat layer D is not particularly limited, but it is preferable to provide the coat layer D by a so-called in-line coating method in which coating is performed during the formation of a polyester film. In a case where a coat layer D that imparts slipperiness is provided on the surface of the polyester film on which the release layer is not laminated, the polyester film does not need to include the surface layers A and B, and may be a single-layer polyester film substantially free of inorganic particles.

[0110]

The average area surface roughness (S_a) of the surface layer B is preferably 40 nm or less, more preferably 35 nm or less, and still more preferably 30 nm or less. In a case where slipperiness is imparted to the

surface of the surface layer B or the single layer polyester film on which the release layer is not laminated with the coat layer D, the Sa of the surface is measured for the surface on which the coat layer D is laminated, and is preferably in the same range as the average area surface roughness (Sa) of the surface layer B.

[0111]

It is preferable that at least a binder resin and particles are contained in the coat layer D on the surface of the polyester film on which the release layer is not laminated.

[0112]

(Binder resin of coat layer D)

The binder resin constituting the easy-to-slip coating layer is not particularly limited. Specific examples of the polymer include a polyester resin, an acrylic resin, an urethane resin, a polyvinyl-based resin (polyvinyl alcohol and the like), polyalkylene glycol, polyalkyleneimine, methylcellulose, hydroxycellulose, and starches. Among these, from the viewpoints of retention and adhesion of the particles, a polyester resin, an acrylic resin, and an urethane resin are preferably used. In consideration of the compatibility of the binder resin with the polyester film, the polyester resin is particularly preferable. The polyester of the binder is

preferably a copolyester in order to achieve solubility and dispersibility in a solvent, and adhesion with a substrate film and other layer. The polyester resin may be modified with polyurethane. Other preferable examples of the binder resin constituting the easy-to-slip coating layer on the polyester substrate film include an urethane resin.

Examples of the urethane resin include a polycarbonate polyurethane resin. Furthermore, the polyester resin and the polyurethane resin may be used in combination, and the above-mentioned other binder resins may be used in combination.

[0113]

(Crosslinking agent of coat layer D)

In order to form a crosslinked structure in the easy-to-slip coating layer, the easy-to-slip coating layer may be formed so as to contain a crosslinking agent. The easy-to-slip coating layer contains the crosslinking agent, which makes it possible to further improve the adhesion under high temperature and high humidity. Specific examples of the crosslinking agent include urea-based, epoxy-based, melamine-based, isocyanate-based, oxazoline-based, and carbodiimide-based crosslinking agents, and aziridine. In order to promote a crosslinking reaction, a catalyst and the like may be appropriately used, if necessary.

[0114]

(Particles in coat layer D)

The easy-to-slip coating layer preferably contains lubricant particles in order to impart slipperiness to the surface of the easy-to-slip coating layer. The particles may be inorganic particles or organic particles, and are not particularly limited. Examples thereof include (1) inorganic particles made of silica, kaolinite, talc, light calcium carbonate, heavy calcium carbonate, zeolite, alumina, barium sulfate, carbon black, zinc oxide, zinc sulfate, zinc carbonate, zirconium oxide, titanium dioxide, satin white, aluminum silicate, diatomaceous earth, calcium silicate, aluminum hydroxide, hydrous halloysite, calcium carbonate, magnesium carbonate, calcium phosphate, hydroxide magnesium, and barium sulfate and the like, and (2) acrylic or methacrylic, vinyl chloride-based, vinyl acetate-based, nylon, styrene/acrylic, styrene/butadiene-based, polystyrene/acrylic, polystyrene/isoprene-based, polystyrene/isoprene-based, methyl methacrylate/butyl methacrylate-based, melamine-based, polycarbonate-based, urea-based, epoxy-based, urethane-based, phenol-based, diallyl phthalate-based, and polyester-based organic particles. Silica is particularly preferably used in order to impart appropriate slipperiness to the coating layer.

[0115]

The average particle size of particles is preferably 10 nm or more, more preferably 20 nm or more, and still more preferably 30 nm or more. It is preferable that the average particle size of particles is 10 nm or more since the particles are less likely to aggregate and slipperiness may be secured.

[0116]

The average particle size of the particles is preferably 1000 nm or less, more preferably 800 nm or less, still more preferably 600 nm or less. It is preferable that the average particle size of the particles is 1000 nm or less since the transparency is maintained and the particles do not fall off.

[0117]

For example, the mixture of small particles having an average particle size of about 10 nm or more and 270 nm or less and large particles having an average particle size of about 300 nm or more and 1000 nm or less is also preferable in order to reduce an average length of a roughness curve element (RSm) to achieve both slipperiness and smoothness while keeping average area surface roughness (Sa) and a maximum protrusion height (RP) to be described later small. Particularly preferably, small particles of 30 nm or more and 250 nm or less and large particles having an average particle size of 350 nm or more and 600 nm or less are used

in combination. When small particles and large particles are mixed, the mass content rate of the small particles is preferably greater than the mass content rate of the large particles with respect to the entire solid content of the coating layer.

[0118]

<2.3. Formation of release layer>

In the present invention, the method for forming the release layer is not particularly limited, and the following method is used. A coating liquid in which a release compound is dissolved or dispersed is spread on one surface of the polyester film of the substrate by coating and the like. A solvent or the like is removed by drying, followed by curing. A method in which curing with heat is performed simultaneously with solvent removal may also be used.

[0119]

A drying temperature for solvent drying when the release layer of the present invention is applied on the substrate film by solution application is preferably 50°C or higher and 120°C or lower, and more preferably 60°C or higher and 100°C or lower. A heating time is preferably 30 seconds or less, and more preferably 20 seconds or less. Furthermore, after the solvent drying, the irradiation of active energy rays preferably advances the curing reaction.

As the active energy rays used at this time, ultraviolet rays, electron beams, and X-rays and the like can be used, but ultraviolet rays are likely to be used, which are preferable. The amount of light of ultraviolet rays with which the composition is irradiated is preferably 30 mJ/cm² or more and 300 mJ/cm² or less, and more preferably 30 mJ/cm² or more and 200 mJ/cm² or less. By setting the amount of light to 30 mJ/cm² or more, the curing of the composition can be sufficiently advanced. Meanwhile, by setting the amount of light to 300 mJ/cm² or less, the speed during processing can be improved, whereby the release film can be economically manufactured.

[0120]

The surface tension of the coating liquid when the release layer is applied is not particularly limited, but is preferably 30 mN/m or less. By setting the surface tension as described above, wettability after coating is improved, and the unevenness of the surface of the coating film after drying can be reduced.

[0121]

As the applying method of the coating liquid, any known applying methods can be applied. For example, conventionally known methods such as a roll coating method (such as a gravure coating method or a reverse coating method), a bar coating method (such as a wire bar), a die

coating method, a spray coating method, and an air knife coating method can be utilized.

[0122]

<2.4. Physical properties of release film>

The water adhesion energy of the release layer surface, that is, the adhesion energy determined by measuring the sliding angle using water, is, for example, preferably 7.0 mJ/m² or more, more preferably 7.5 mJ/m² or more. The water adhesion energy of the release layer surface may be, for example, 8.0 mJ/m² or more, 8.1 mJ/m² or more, or 8.2 mJ/m² or more. The water adhesion energy of the release layer surface is measured by the method described in Examples later.

[0123]

The rate of change in rub off after heat-moisture treatment (that is, peeling force of rubbed portion/peeling force of unrubbed portion) as an index of adhesion is, for example, preferably less than 5 times, more preferably less than 4 times, still more preferably less than 3 times. The rate of change in rub off after heat-moisture treatment is measured by the method described in Examples later.

[0124]

The peeling force measured by a T-type peeling method at 23°C and 0.3 m/min after the adhesive tape is pasted to the release film is, for example, preferably 100 mN/50 mm

or less, more preferably 95 mN/50 mm or less. The peeling force is measured by the method described in Examples later.

[0125]

These physical properties (specifically, water adhesion energy, rate of change in rub off after heat-moisture treatment, and peeling force) can be appropriately set depending on the application of the release film. Needless to say, these physical property values may deviate from the above-mentioned suitable numerical ranges.

[0126]

<2.5. Applications of release film>

The applications of the release film of the present embodiment are not particularly limited. The release film can be used not only for manufacturing ceramic green sheets but also in the manufacture of, for example, adhesive sheets and cover films, polymer films, optical lenses, and multilayer printed wiring boards, and the like. In the ceramic green sheet manufacturing applications, the release film of the present embodiment can be used, for example, to manufacture ceramic green sheets for laminated ceramic capacitors. In other words, the release film of the present embodiment can be used to manufacture a laminated ceramic capacitor. In the multilayer printed wiring board manufacturing applications, the release film of the present

embodiment can be used, for example, as a support film to support an insulating layer when a multilayer printed wiring board is manufactured by the build-up method. The release film of the present embodiment can be particularly suitably used in the manufacture of ceramic green sheets.

[0127]

A ceramic green sheet can be manufactured according to the procedure in which a ceramic slurry for forming the ceramic green sheet is applied to the release layer of the release film of the present embodiment, and then dried.

[0128]

The ceramic green sheet can contain an inorganic compound. Examples of the inorganic compound include metal particles, metal oxides, and minerals. Examples thereof include calcium carbonate, silica particles, aluminum particles, and barium titanate particles.

[0129]

The ceramic green sheet can contain a resin component. The resin component can be appropriately selected depending on the application. Examples of the resin component include a polyvinyl butyral-based resin.

[0130]

The thickness of the ceramic green sheet may be, for example, 0.2 μm or more and 1.0 μm or less.

[0131]

Incidentally, in general, a laminated ceramic capacitor includes a rectangular parallelepiped ceramic body. Inside the ceramic body, first internal electrodes and second internal electrodes are provided alternately along a thickness direction. The first internal electrodes are exposed to the first end surface of the ceramic body. First external electrodes are provided on the first end surface. The first internal electrodes are electrically connected to the first external electrodes at the first end surface. The second internal electrodes are exposed to the second end surface of the ceramic body. Second external electrodes are provided on the second end surface. The second internal electrodes are electrically connected to the second external electrodes at the second end surface.

[0132]

A laminated ceramic capacitor can be manufactured, for example, according to the following procedure. First, the release film of the present embodiment is used as a carrier film, and a ceramic slurry for constituting a ceramic body is applied and dried. An extremely thin ceramic green sheet having a thickness of 0.2 μm or more and 1.0 μm or less has been required. A conductive layer for constituting a first or second internal electrode is printed on the applied and dried ceramic green sheet. A ceramic green sheet, a ceramic green sheet on which a

conductive layer for constituting a first internal electrode is printed, and a ceramic green sheet on which a conductive layer for constituting a second internal electrode is printed are appropriately laminated and pressed to obtain a mother laminated body. The mother laminated body is divided into a plurality of raw ceramic bodies. The raw ceramic body is fired to obtain a ceramic body. Thereafter, the laminated ceramic capacitor can be completed by forming first and second external electrodes.

EXAMPLES

[0133]

Hereinafter, the present invention will be more specifically described by reference to Examples and Comparative Examples. In the present invention, physical properties and the like were measured or evaluated by the following methods. Hereinafter, unless otherwise specified, "part" means "part by mass", and "%" means "% by mass".

[0134]

<Methods for measuring respective physical properties>

(Weight average molecular weight)

A sample solution with a sample concentration adjusted to 0.2% was filtered through a 0.2 μm membrane filter, and subjected to gel permeation chromatography

(GPC) analysis under the following conditions to determine the weight average molecular weight of a sample. The molecular weight was calculated in terms of standard polystyrene.

Apparatus: TOSOH HLC-8320GPC

Column: TSKgel SuperHM-H × 2 + TSKgel SuperH 2000
(TOSOH)

Solvent: Chloroform 100%

Flow rate: 0.6 ml/min

Concentration: 0.2%

Injection volume: 20 μ L

Temperature: 40°C

Detector: RI

[0135]

(Thickness of release layer)

A release film was embedded in a resin, and ultrathinly sectioned using an ultramicrotome. Thereafter, the cross section of a release film was observed using a JEM 2100 transmission electron microscope manufactured by JEOL Ltd., and the film thickness of a release layer was measured from the observed TEM image. When the thickness was too thin to accurately evaluate by cross-section observation, the Si intensity was measured with an X-ray fluorescence apparatus (ZSX PRIMUSII manufactured by Rigaku Corporation), and the coating amount was calculated by a

calibration curve method.

[0136]

(Tape peeling force of release layer)

The adhesive layer surface of 50 mm wide acrylic adhesive tape No. 31B (manufactured by Nitto Denko Corporation) was pasted to the release layer surface of the release film using a hand roller to fabricate a laminated body. This laminated body was stored at 23°C for 24 hours, and then pulled at a speed of 0.3 m/min using a tensile tester with the release film facing downward and the adhesive tape facing upward to measure the peeling force (mN/50 mm) in an atmosphere of 23°C, and the measured peeling force was recorded.

[0137]

(Scraped adhesion after heat-moisture treatment of release layer (rub off after heat-moisture treatment))

The release film was stored in an environment of 60°C and 90% RH for 3 days. Next, pearl paper (Toyobo Ester Film P4255-35 manufactured by Toyobo Co., Ltd.) was attached to the load head portion (that is, the friction block) of a Gakushin-Type Rubbing Tester (manufactured by amaguchi Scientific Industry Co., Ltd.) via gauze (Hakujuji gauze manufactured by Hakujuji Co., Ltd.), and then the release layer of the release film was rubbed by moving the load head portion with pearl paper back and forth 10 times

under a load of 200 gf/25 mm² (5 mm × 5 mm) (that is, 0.0785 MPa). Adhesive tape (Nitto-31B manufactured by Nitto Denko Corporation) was pasted to the rubbed portion and unrubbed portion of the release layer, stored for 20 hours, and subjected to T-peel at a speed of 300 mm/min using an autograph to measure the peeling force. The rate of change (that is, peeling force of rubbed portion/peeling force of unrubbed portion) was determined from the peeling force of the rubbed portion and the peeling force of the unrubbed portion, and judged as follows. The rate of change are presented in Table 1 together with the judgement results. As this rate of change is smaller, the adhesion between the release layer and the polyester film (this can also be rephrased as adhesion durability) is superior.

Favorable: Peeling force of rubbed portion is less than three times that of unrubbed portion

Acceptable: Peeling force of rubbed portion is three times or more and less than ten times that of unrubbed portion

Poor: Peeling force of rubbed portion is ten times or more that of unrubbed portion

[0138]

(Water adhesion energy of release layer)

The water adhesion energy of the release film was measured using Fully Automatic Contact Angle Meter DM-701

(manufactured by Kyowa Interface Science Co., Ltd.). Specifically, the adhesion energy (mJ/m^2) was determined using the following equation from the droplet sliding angle, droplet landing radius, droplet mass, and gravitational acceleration when the release film was brought to rest (that is, fixed) on a flat glass substrate in an environment having a temperature of 23 degrees and a humidity of 50%, then a droplet of water of 7.0 μl was dropped onto the release layer surface of the release film at a glass substrate slope of 0 degrees (that is, horizontal), the glass substrate was tilted at a speed of 1 degree/second three seconds after the droplet was at rest, and thus the end point of the droplet left the resting position.

$$E = (m \times g \times \sin\alpha) / (2 \times \pi \times r)$$

In this equation, E is the adhesion energy, m is the droplet mass, g is the gravitational acceleration, α is the sliding angle, and r is the droplet landing radius.

[0139]

(Si element ratio in outermost surface of release layer)

The Si element ratio in the outermost surface of the release layer of the release film was measured by ESCA (electron spectroscopy for chemical analysis). K-Alpha⁺ (manufactured by Thermo Fisher Scientific) was used as the instrument. Details of the measurement conditions are

presented below. Using this instrument, narrow scanning was performed for five elements C, O, N, S, and Si on the release layer surface, and the Si element ratio (at%) was calculated from the results by the following equation. In other words, here, the Si element ratio is the proportion (at%) of Si among the five elements C, O, N, S, and Si.

$$\text{Si element ratio (at\%)} = \{\text{Si}/(\text{C} + \text{O} + \text{N} + \text{S} + \text{Si})\} \times 100$$

At the time of analysis, the background was removed by the shirley method. The surface Si element ratio was the average value of the measurement results at three or more places.

Measurement conditions

Excited X-rays: Monochrome Al K α rays

X-ray output: 12 kV, 6 mA

Photoelectron escape angle: 90°

Spot size: 400 mm f (approx.)

Path energy: 50 eV

Step: 0.1 eV

[0140]

<Example 1>

An adhesion imparting agent S1 (AD-032 manufactured by OSAKA SODA CO., LTD., a diallyl cyclohexane resin having a weight average molecular weight of 24,000, a polymer containing a structure represented by Formula C1) was

dissolved in toluene so that the solid concentration was 30% to prepare an adhesion imparting agent liquid A1. The adhesion imparting agent liquid A1 was added to a thermal addition-type silicone resin (DOWSIL LTC750A, solid concentration: 30% manufactured by Dow Toray Co., Ltd.) so that the solid ratio was 20% (that is, the solid ratio of adhesion imparting agent S1 to the thermal addition-type silicone resin) to prepare a coating liquid M1.

(Coating liquid M1)

Methyl ethyl ketone	46.62 parts
Toluene	46.62 parts
Thermal addition-type silicone resin (DOWSIL LTC750A, solid concentration: 30%	5.56 parts

manufactured by Dow Toray Co., Ltd.)

Adhesion imparting agent liquid A1	1.11 parts
Catalyst	0.10 part

(SRX212 (1,1,3,3-tetramethyl-1,3-divinyldisiloxane platinum complex, solid concentration: 5%) manufactured by Dow Toray Co., Ltd.)

The coating liquid M1 was applied on one surface (specifically the surface subjected to corona treatment) of a polyester film (Toyobo Ester Film E5100 manufactured by Toyobo Co., Ltd., thickness:50 μm , product having one surface subjected to corona treatment) by reverse gravure so that the coating thickness after drying was 50 nm.

Thereafter, a processing speed was adjusted so that the coated polyester film entered the first drying furnace after 0.5 second, and drying by heating and curing of the release layer were continuously performed at a first drying furnace temperature of 120°C and a second drying furnace temperature of 160°C to obtain a release film.

[0141]

<Example 2>

An adhesion imparting agent S2 (DAP-K manufactured by OSAKA SODA CO., LTD., a diallyl phthalate resin having a weight average molecular weight of 50,000, a polymer containing a structure represented by Formula C2) was dissolved in toluene so that the solid concentration was 30% to prepare an adhesion imparting agent liquid A2. The adhesion imparting agent liquid A2 was added to a thermal addition-type silicone resin (DOWSIL LTC750A, solid concentration: 30% manufactured by Dow Toray Co., Ltd.) so that the solid ratio was 20% to prepare a coating liquid M2. A release film was fabricated in the same manner as in Example 1, except that the coating liquid M2 was used instead of the coating liquid M1.

(Coating liquid M2)

Methyl ethyl ketone	46.62 parts
Toluene	46.62 parts
Thermal addition-type silicone resin	5.56 parts

(DOWSIL LTC750A, solid concentration: 30%
manufactured by Dow Toray Co., Ltd.)

Adhesion imparting agent liquid A2 1.11 parts

Catalyst 0.10 part

(SRX212 (1,1,3,3-tetramethyl-1,3-divinyldisiloxane
platinum complex, solid concentration: 5%) manufactured by
Dow Toray Co., Ltd.)

[0142]

<Example 3>

An adhesion imparting agent S3 (ISODAP manufactured
by OSAKA SODA CO., LTD., a diallyl phthalate resin having a
weight average molecular weight of 20,000, a polymer
containing a structure represented by Formula C3) was
dissolved in toluene so that the solid concentration was
30% to prepare an adhesion imparting agent liquid A3. The
adhesion imparting agent liquid A3 was added to a thermal
addition-type silicone resin (DOWSIL LTC750A, solid
concentration: 30% manufactured by Dow Toray Co., Ltd.) so
that the solid ratio was 20% to prepare a coating liquid
M3. A release film was fabricated in the same manner as in
Example 1, except that the coating liquid M3 was used
instead of the coating liquid M1.

(Coating liquid M3)

Methyl ethyl ketone 46.62 parts

Toluene 46.62 parts

Thermal addition-type silicone resin	5.56 parts
(DOWSIL LTC750A, solid concentration: 30%	
manufactured by Dow Toray Co., Ltd.)	
Adhesion imparting agent liquid A3	1.11 parts
Catalyst	0.10 part
(SRX212 (1,1,3,3-tetramethyl-1,3-divinyldisiloxane	
platinum complex, solid concentration: 5%) manufactured by	
Dow Toray Co., Ltd.)	

[0143]

<Example 4>

The adhesion imparting agent liquid A1 was added to a thermal addition-type silicone resin (DOWSIL LTC750A, solid concentration: 30% manufactured by Dow Toray Co., Ltd.) so that the solid ratio was 10% to prepare a coating liquid M4. A release film was fabricated in the same manner as in Example 1, except that the coating liquid M4 was used instead of the coating liquid M1.

(Coating liquid M4)

Methyl ethyl ketone	46.89 parts
Toluene	46.89 parts
Thermal addition-type silicone resin	5.56 parts
(DOWSIL LTC750A, solid concentration: 30%	
manufactured by Dow Toray Co., Ltd.)	
Adhesion imparting agent liquid A1	0.56 part
Catalyst	0.10 part

(SRX212 (1,1,3,3-tetramethyl-1,3-divinyldisiloxane
platinum complex, solid concentration: 5%) manufactured by
Dow Toray Co., Ltd.)

[0144]

<Comparative Example 1>

A release film was fabricated in the same manner as
in Example 1, except that a coating liquid M5 having the
following composition was used instead of the coating
liquid M1.

(Coating liquid M5)

Methyl ethyl ketone	47.17 parts
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Toluene	47.17 parts
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Thermal addition-type silicone resin	5.56 parts
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(DOWSIL LTC750A, solid concentration: 30%

manufactured by Dow Toray Co., Ltd.)

Catalyst	0.10 part
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(SRX212 (1,1,3,3-tetramethyl-1,3-divinyldisiloxane
platinum complex, solid concentration: 5%) manufactured by
Dow Toray Co., Ltd.)

[0145]

<Comparative Example 2>

An adhesion imparting agent, specifically a reaction
product of vinyltriacetoxysilane and
glycidoxypropyltrimethoxysilane (SD7200, solid
concentration: 90% manufactured by Dow Toray Co., Ltd.) was

added to a thermal addition-type silicone resin (DOWSIL LTC750A, solid concentration: 30% manufactured by Dow Toray Co., Ltd.) so that the solid ratio was 10% to prepare a coating liquid M6. A release film was fabricated in the same manner as in Example 1, except that the coating liquid M6 was used instead of the coating liquid M1.

(Coating liquid M6)

Methyl ethyl ketone	47.08 parts
Toluene	47.08 parts
Thermal addition-type silicone resin	5.56 parts

(DOWSIL LTC750A, solid concentration: 30%

manufactured by Dow Toray Co., Ltd.)

Reaction product of vinyltriacetoxysilane and glycidoxypropyltrimethoxysilane

(SD7200, solid concentration: 90% manufactured by Dow Toray Co., Ltd.)

0.19 part

Catalyst	0.10 part
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(SRX212 (1,1,3,3-tetramethyl-1,3-divinyldisiloxane platinum complex, solid concentration: 5%) manufactured by Dow Toray Co., Ltd.)

[0146]

<Comparative Example 3>

A diallyl phthalate (DAP) monomer (diallyl phthalate manufactured by Tokyo Chemical Industry Co., Ltd.) as an

adhesion imparting agent was dissolved in toluene so that the solid concentration was 30% to prepare an adhesion imparting agent liquid A4. The adhesion imparting agent liquid A4 was added to a thermal addition-type silicone resin (DOWSIL LTC750A, solid concentration: 30% manufactured by Dow Toray Co., Ltd.) so that the solid ratio was 20% to prepare a coating liquid M7. A release film was fabricated in the same manner as in Example 1, except that the coating liquid M7 was used instead of the coating liquid M1.

(Coating liquid M7)

Methyl ethyl ketone	46.62 parts
Toluene	46.62 parts
Thermal addition-type silicone resin	5.56 parts
(DOWSIL LTC750A, solid concentration: 30%	

manufactured by Dow Toray Co., Ltd.)

Adhesion imparting agent liquid A4	1.11 parts
Catalyst	0.10 part

(SRX212 (1,1,3,3-tetramethyl-1,3-divinyldisiloxane platinum complex, solid concentration: 5%) manufactured by Dow Toray Co., Ltd.)

[0147]

<Comparative Example 4>

An adhesion imparting agent S4 (UVAD-091 manufactured by OSAKA SODA CO., LTD., a phthalate resin not having a

vinyl group, weight average molecular weight: 3000) was dissolved in toluene so that the solid concentration was 30% to prepare an adhesion imparting agent liquid A5. The adhesion imparting agent liquid A5 was added to a thermal addition-type silicone resin (DOWSIL LTC750A, solid concentration: 30% manufactured by Dow Toray Co., Ltd.) so that the solid ratio was 20% to prepare a coating liquid M8. A release film was fabricated in the same manner as in Example 1, except that the coating liquid M8 was used instead of the coating liquid M1.

(Coating liquid M8)

Methyl ethyl ketone	46.62 parts
Toluene	46.62 parts
Thermal addition-type silicone resin (DOWSIL LTC750A, solid concentration: 30%	5.56 parts

manufactured by Dow Toray Co., Ltd.)

Adhesion imparting agent liquid A5	1.11 parts
Catalyst	0.10 part

(SRX212 (1,1,3,3-tetramethyl-1,3-divinyldisiloxane platinum complex, solid concentration: 5%) manufactured by Dow Toray Co., Ltd.)

[0148]

[Table 1]

	Coating liquid for release layer formation				Polyester film	Evaluation item				
	Kind	Adhesion imparting agent				Tape peeling force mN/50mm	Rub off after heat-moisture treatment	Water adhesion energy mJ/m ²	Si ratio at%	
		Kind	Weight average molecular weight	Solid ratio %						
Example 1	M1	AD-032	24000	20.0	E5100	84	Favorable	2	8	25.3
Example 2	M2	DAP-K	50000	20.0	E5100	85	Favorable	1.9	8.5	25.5
Example 3	M3	ISODAP	20000	20.0	E5100	90	Favorable	1.8	8.8	25.4
Example 4	M4	AD-032	24000	10.0	E5100	82	Favorable	2.4	7.8	25.3
Comparative Example 1	M5	—	—	—	E5100	83	Poor	17	5	25.7
Comparative Example 2	M6	SD7200	206	10.0	E5100	88	Acceptable	6.5	5.2	25.7
Comparative Example 3	M7	DAP monomer		20.0	E5100	120	Poor	12	7	21.1
Comparative Example 4	M8	UVAD-091	3000	20.0	E5100	110	Poor	15	7.9	25.5

In Table 1, the solid ratio is the ratio of the solid mass of the adhesion imparting agent to the solid mass of the thermal addition-type silicone resin. In Table 1, the diagonal lines indicate that the weight average molecular weight has not been measured. In other words, the weight average molecular weight of SD7200 was not measured.

[0149]

The release films obtained using the adhesion imparting agent S1 (AD-032), the adhesion imparting agent S2 (DAP-K), and the adhesion imparting agent S3 (ISODAP) had higher water adhesion energy than the release film obtained without using any adhesion imparting agent (see Examples 1 to 4 and Comparative Example 1). Therefore, the release films obtained using these adhesion imparting agents (specifically, adhesion imparting agents S1, S2, and S3) can reduce the degree of cissing that may occur when a liquid fluid such as a ceramic slurry is applied to the release layer of the release films or suppress the occurrence of cissing.

[0150]

The release films obtained using the adhesion imparting agent S1 (AD-032), the adhesion imparting agent S2 (DAP-K), and the adhesion imparting agent S3 (ISODAP) had a rate of change in rub off after heat-moisture treatment (that is, peeling force of rubbed portion/peeling

force of unrubbed portion) close to 1.0 as compared to the release film obtained without using any adhesion imparting agent (see Examples 1 to 4 and Comparative Example 1). The increase in rate of change in rub off after heat-moisture treatment is also caused by the falling off of the release layer (specifically, falling off of the release layer from the polyester film), and thus the release films obtained using these adhesion imparting agents (specifically, adhesion imparting agents S1, S2, and S3) can be evaluated in that the release layer was less likely to fall off from the polyester film as compared to the release film obtained without using any adhesion imparting agent. In other words, it can be evaluated that the adhesion between the release layer and the polyester film is improved by these adhesion imparting agents (specifically, adhesion imparting agents S1, S2, and S3).

[0151]

The tape peeling force of the release films obtained using the adhesion imparting agent S1 (AD-032), the adhesion imparting agent S2 (DAP-K), and the adhesion imparting agent S3 (ISODAP) was not significantly different from the tape peeling force of the release film obtained without using any adhesion imparting agent (see Examples 1 to 4 and Comparative Example 1).

[0152]

Meanwhile, the water adhesion energy of the release film obtained using SD7200 (reaction product of vinyltriacetoxysilane and glycidoxypyrpyltrimethoxysilane) as the adhesion imparting agent was comparable to the water adhesion energy of the release film obtained without using any adhesion imparting agent (see Comparative Examples 1 and 2). With regard to the rate of change in rub off after heat-moisture treatment as an index of adhesion, although the rate of change was close to 1.0, that is, the adhesion was improved by SD7200 (see Comparative Examples 1 and 2), the improvement in adhesion by SD7200 was smaller than the improvement in adhesion by adhesion imparting agents S1, S2, and S3 (see Comparative Examples 1 and 2 and Examples 1 to 4).

[0153]

Although the water adhesion energy of the release film obtained using a DAP monomer as an adhesion imparting agent was higher than the water adhesion energy of the release film obtained without using any adhesion imparting agent (see Comparative Examples 1 and 3), the improvement in water adhesion energy by a DAP monomer was smaller than the improvement in water adhesion energy by adhesion imparting agents S1, S2, and S3 (See Comparative Examples 1 and 3 and Examples 1 to 4). With regard to the rate of change in rub off after heat-moisture treatment as an index

of adhesion, the rate of change was small, that is, the adhesion was improved by a DAP monomer (see Comparative Examples 1 and 3), but the improvement in adhesion by a DAP monomer was smaller than the improvement in adhesion by adhesion imparting agents S1, S2, and S3 (see Comparative Examples 1 and 3 and Examples 1 to 4). With regard to peeling properties, the tape peeling force of the release film obtained using a DAP monomer was significantly higher than the tape peeling force of the release film obtained without using any adhesion imparting agent (see Comparative Examples 1 and 3). From the fact that the Si element ratio in the release film obtained using a DAP monomer was significantly smaller than the Si element ratio in the release film obtained without using any adhesion imparting agent, it is considered that the migration of DAP monomer to the release layer surface causes heavy peeling in the release film obtained using a DAP monomer (see Comparative Examples 1 and 3).

[0154]

Although the rate of change (specifically, the rate of change in rub off after heat-moisture treatment as an index of adhesion) of the release film obtained using UVAD-091 (a phthalate resin not having a vinyl group) as an adhesion imparting agent was smaller than the rate of change of the release film obtained without using any

adhesion imparting agent (see Comparative Examples 1 and 4), the improvement in adhesion by UVAD-091 was smaller than the improvement in adhesion by adhesion imparting agents S1, S2, and S3 (see Comparative Examples 1 and 4 and Examples 1 to 4). With regard to peeling properties, the tape peeling force of the release film obtained using UVAD-091 was significantly higher than the tape peeling force of the release film obtained without using any adhesion imparting agent (see Comparative Examples 1 and 4). With regard to water adhesion energy, the water adhesion energy of the release film obtained using UVAD-091 was higher than the water adhesion energy of the release film obtained without using any adhesion imparting agent (see Comparative Examples 1 and 4), and was comparable to the water adhesion energy of the release films obtained using adhesion imparting agents S1, S2, and S3 (See Comparative Example 4 and Examples 1 to 4).

INDUSTRIAL APPLICABILITY

[0155]

The present invention relates to a release film, and therefore the present invention has industrial applicability.

CLAIMS

[Claim 1] A release film comprising:
a polyester film; and
a release layer, wherein
the release layer is a layer formed by curing a
silicone composition containing an addition curable
silicone,
the silicone composition contains a resin that does
not contain a silicon atom or a nitrogen atom in a molecule
but contains a plurality of alkenyl groups and a plurality
of rings in the molecule, and
the rings are each independently at least one
selected from the group consisting of a monovalent aromatic
ring, a divalent aromatic ring, a monovalent aliphatic
ring, and a divalent aliphatic ring.

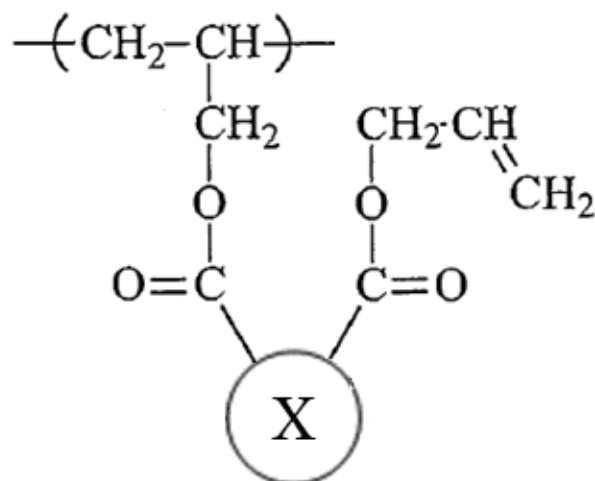
[Claim 2] The release film according to claim 1,
wherein the alkenyl group is an allyl group.

[Claim 3] The release film according to claim 1,
wherein the rings are each independently at least one
selected from the group consisting of a phenylene group, a
naphthylene group, a cyclopentylene group, and a
cyclohexylene group.

[Claim 4] The release film according to claim 1, wherein the resin contains a plurality of ester bonds in the molecule.

[Claim 5] The release film according to claim 1, wherein the resin contains a plurality of structural units represented by the following formula in the molecule:

[Formula 1]



(a plurality of X's are each independently at least one selected from the group consisting of a phenylene group, a naphthylene group, a cyclopentylene group, and a cyclohexylene group).

[Claim 6] The release film according to claim 1, wherein a weight average molecular weight of the resin is 4,000 or more.

[Claim 7] The release film according to any one of claims 1 to 6, which is used to manufacture a ceramic green sheet.