

DESCRIPTION

TITLE OF THE INVENTION: RELEASE FILM FOR FORMING RESIN SHEET

TECHNICAL FIELD

[0001]

The present invention relates to a release film for forming a resin sheet, and more particularly to a release film used when forming an ultrathin resin sheet.

BACKGROUND ART

[0002]

Conventionally, a release film including a polyester film as a substrate and a release layer laminated thereon has been used as a process film for forming a resin sheet such as a pressure sensitive adhesive sheet, a cover film, a polymer film, or an optical lens.

[0003]

The release film is also used as a process film for forming a ceramic green sheet, which is required to have high smoothness, such as a laminated ceramic capacitor and a ceramic substrate. In recent years, the thickness of the ceramic green sheet has tended to also be reduced with reduction in the size of the laminated ceramic capacitor and an increase in the capacity thereof. The ceramic green

sheet is formed by applying a slurry containing a ceramic component such as barium titanate and a binder resin on a release film and drying the slurry. On the formed ceramic green sheet, an electrode is printed, and the ceramic green sheet is peeled off from the release film. Another ceramic green sheet is then laminated on the ceramic green sheet, followed by pressing, firing, and applying an external electrode, to produce a laminated ceramic capacitor.

[0004]

When a ceramic green sheet is formed on the surface of a release layer of a polyester film substrate, minute projections on the surface of the release layer affect the formed ceramic green sheet. These are disadvantageously apt to cause drawbacks such as cissing and pinholes. In recent years, the thickness of the ceramic green sheet has further been reduced, and a ceramic green sheet having a thickness of 1.0 μm or less, more specifically 0.2 μm to 1.0 μm has been required. Therefore, the demand for the smoothness of the surface of the release layer is further increased. Extremely minute protrusions and foreign matters on the release layer lead to deformation of the ceramic green sheet to be formed, which have a problem that pinholes, and sheet cracking during peeling, and the like are apt to occur.

[0005]

As the thickness of the ceramic green sheet is reduced, the peelability of the release film at the time of peeling the ceramic green sheet from the release film becomes more important. When the peeling force is large and nonuniform, damage is applied to the ceramic green sheet in the peeling step, and therefore sheet defects and thickness unevenness and the like occur, which have a problem that troubles such as pinholes and sheet cracking occur. Therefore, it is also required to peel the ceramic green sheet with a lower uniform force. That is, in order to produce an ultrathin resin sheet, particularly a ceramic green sheet, without defects, a release film having extremely high smoothness and excellent peelability is required.

[0006]

Examples of the release film excellent in smoothness and peelability include those disclosed in the following Patent Documents. For example, Patent Document 1 proposes a release film including a release layer containing a radically curable resin as a main component. Patent Document 2 proposes a release film having a configuration in which a smoothing layer and a release layer are laminated. Patent Document 3 proposes a release film including a release layer containing a cationically curable epoxy resin as a main component. Patent Document 4

proposes a release film including a release layer containing a cationically curable polydimethylsiloxane as a main component.

PRIOR ART DOCUMENTS

PATENT DOCUMENTS

[0007]

Patent Document 1: JP-B-5492352

Patent Document 2: JP-A-2015-164762

Patent Document 3: WO 2018/079337 A

Patent Document 4: JP-A-2016-079349

SUMMARY OF THE INVENTION

PROBLEMS TO BE SOLVED BY THE INVENTION

[0008]

However, in the release film of Patent Document 1, the release layer is provided on a substrate film having insufficient smoothness, and therefore the release film has a problem that the smoothness of the release layer is insufficient. Furthermore, as a result of intensive studies, the present inventors have found that the radically curable resin causes curing failure due to oxygen inhibition, and therefore the radically curable resin has a problem that the solvent resistance of the surface of the release layer is poor, the release layer is eroded by an

organic solvent used at the time of forming a ceramic green sheet or printing an internal electrode, and the peelability of the release layer is deteriorated.

In the invention of Patent Document 2, a thermosetting melamine resin is used for the smoothing applied layer and the applied release layer, and therefore high heat is required to accelerate the curing reaction of the melamine resin. Therefore, the flatness of the release film may be impaired by heat during processing. Since a plurality of processes of the applied smoothing layer and the applied release layer are required, not only foreign matters may be mixed into the release film, but also scratches may occur in the release layer. The foreign matters and the scratches may be transferred to a ceramic green sheet to be formed on the release layer, which may cause troubles.

[0009]

In each of Patent Documents 3 and 4, the release layer containing the cationically curable resin is proposed in order to improve curing failure caused by oxygen inhibition and planar failure caused by processing heat. However, in the release film of Patent Document 3, the smoothness of a substrate film is poor, and therefore the release film has a problem that the smoothness of the surface of the release layer is poor. A release agent

component disclosed in Patent Document 3 has poor reactivity, poor solvent resistance, and a problem in peelability.

Since the release film of Patent Document 4 includes the release layer containing the liquid cationically curable polydimethylsiloxane resin as a main component, the resin may aggregate on unevenness of the substrate film and protrusions such as oligomers present on the surface of the substrate film, resulting in a problem in flatness. The release layer has a low crosslinking density, and has a problem in peelability.

[0010]

The present invention has been devised in view of the problems of the conventional techniques. That is, it is an object of the present invention to provide a release film including a release layer particularly excellent in smoothness and peelability, and to provide a release film capable of forming an ultrathin resin sheet, particularly an ultrathin ceramic green sheet, without defects.

MEANS FOR SOLVING THE PROBLEMS

[0011]

As a result of intensive studies to solve the problems, the present inventors have found that the above object can be achieved by a release film having the

following configuration and have accomplished the present invention.

[0012]

That is, the present invention has the following configurations.

[1] A release film for forming a resin sheet, comprising a polyester film as a substrate and a release layer,

wherein the polyester film includes a surface layer A substantially containing no inorganic particles,

the release layer is provided on the surface layer A,

the release layer is a layer obtained by curing a release layer forming composition,

the release layer forming composition contains a cationically curable polydimethylsiloxane (a),

the release layer has an area surface roughness (S_a) of 2 nm or less, and

the number of protrusions having a height of 10 nm or more present on a surface of the release layer is 200 protrusions/mm² or less.

[2] In one embodiment, the release layer has a maximum protrusion height (S_p) of 20 nm or less, and a total of the number of protrusions having a height of 5 nm or more and less than 10 nm and the number of protrusions having a height of 10 nm or more present on the surface of

the release layer is 1500 protrusions/mm² or less.

[3] In one embodiment, the cationically curable polydimethylsiloxane (a) has at least one functional group selected from a vinyl ether group, an oxetanyl group, an epoxy group, and an alicyclic epoxy group.

[4] In one embodiment, a content of the cationically curable polydimethylsiloxane (a) contained in the release layer is 90 mg/m² or less.

[5] In one embodiment, the release layer forming composition further contains a cationically curable compound (b-1) having no silicone skeleton, the cationically curable compound (b-1) has two or more alicyclic epoxy groups in the molecule, and a content of the cationically curable compound (b-1) is 80% by mass or more based on a total of 100 parts by mass of the cationically curable polydimethylsiloxane (a) and the cationically curable compound (b-1).

[6] In one embodiment, the release layer forming composition further contains a cyclic siloxane compound (b-2) having an alicyclic epoxy group, the cyclic siloxane compound (b-2) has two or more alicyclic epoxy groups in the molecule, and a content of the cyclic siloxane compound (b-2) is 80% by mass or more based on a total of 100 parts by mass of the cationically curable polydimethylsiloxane (a) and the cyclic siloxane compound (b-2).

[7] In one embodiment, the release layer forming composition contains an organic solvent having an SP value (δ) of 14 or more and 17 or less, and the release layer forming composition contains the organic solvent having an SP value (δ) of 14 or more and 17 or less in an amount of 10% by mass or more based on 100 mass parts of a total weight of the release layer forming composition.

[8] In one embodiment, a release film for producing a resin sheet containing an inorganic compound is provided.

[9] In one embodiment, the resin sheet containing an inorganic compound is a ceramic green sheet.

[10] In one embodiment, a release film for forming a resin sheet having a thickness of 0.2 μm or more and 1.0 μm or less is provided.

EFFECT OF THE INVENTION

[0013]

The release film for forming a resin sheet of the present invention can enhance the smoothness and peelability of the release layer, and can suppress the occurrence of defects in the ultrathin resin sheet, particularly the ceramic green sheet.

MODE FOR CARRYING OUT THE INVENTION

[0014]

Hereinafter, the present invention will be described in detail.

The present invention relates to a release film for forming a resin sheet, including a polyester film as a substrate and a release layer. The polyester film includes a surface layer A substantially containing no inorganic particles. The release layer is provided on the surface layer A. The release layer is a layer obtained by curing a release layer forming composition. The release layer forming composition contains a cationically curable polydimethylsiloxane (a). The release layer has an area surface roughness (Sa) of 2 nm or less. The number of protrusions having a height of 10 nm or more present on a surface of the release layer is 200 protrusions/mm² or less.

[0015]

Since the release layer is excellent in smoothness and peelability in the present invention having such a configuration, for example, a uniform thickness can be provided without defects for a resin sheet having a thickness of 0.2 μm to 1.0 μm , and drawbacks such as pinholes can be suppressed.

The present invention can exhibit the following effects. In the present invention, the release layer is provided on the substrate film having sufficient

smoothness, and therefore the smoothness of the release layer can also be secured. Furthermore, in the present invention, in the release layer, curing failure due to oxygen inhibition can be suppressed, and high crosslinking of the release layer can be exhibited. The present invention exhibiting such an effect can improve, for example, the solvent resistance of the surface of the release layer. By improving the solvent resistance of the surface of the release layer, it is possible to suppress the release layer from being eroded by an organic solvent used at the time of forming a ceramic green sheet and at the time of printing an internal electrode, and therefore the release layer can have high peelability.

In the present invention, for example, as compared with a release layer containing a thermosetting melamine resin, high heat is not required for accelerating a curing reaction. Therefore, the flatness of the release film can be suppressed from being impaired by heat during processing. According to the production method of the present invention, it is possible to suppress the aggregation of the release layer forming composition through an applying step and a drying step according to the present invention, and to obtain a release film including a release layer having extremely high smoothness.

[0016]

More specifically, a release layer having extremely high smoothness can be obtained by applying and curing the release layer forming composition containing a predetermined amount of cationically curable polydimethylsiloxane (a) to the surface layer A of the substrate film substantially containing no inorganic particles.

Furthermore, by controlling the content of the cationically curable polydimethylsiloxane (a) in the release layer to a predetermined amount or less, it is possible to suppress the aggregation of the cationically curable polydimethylsiloxane (a) on extremely minute foreign matters and oligomer-derived minute protrusions present in the substrate film during the processing of the release layer. Although it should not be construed as being limited to a specific theory, it is possible to prevent the aggregation of the component (a) on fine protrusions caused by a substrate by increasing a first drying temperature (by strengthening drying).

By suppressing curing failure due to oxygen inhibition, improving the solvent resistance of the surface of the release layer, suppressing foreign matters from being mixed into the release layer, and suppressing the scratches of the release layer, the damage at the time of peeling, and the sheet deformation due to transfer of

scratches and foreign matters and the like, of a body to be released such as a ceramic green sheet can be prevented. As a result, it is possible to obtain a release layer excellent in smoothness, hardness, peelability, and antifouling property with respect to a layer to be released.

The cationically curable polydimethylsiloxane (a) is hardly aggregated during the drying of the organic solvent contained in the release layer forming composition, and therefore a release layer excellent in smoothness can be obtained. The details thereof will be described later.

[0017]

In another aspect, the present invention provides a method for producing a release film for forming a resin sheet, the method including the following steps:

an applying step of applying a release layer forming composition onto a surface layer A of a polyester film including the surface layer A,

the surface layer A being a layer substantially containing no inorganic particles,

the release layer forming composition containing a cationically curable polydimethylsiloxane (a);

a drying step of heating and drying the polyester film onto which the release layer forming composition is applied, the heating and drying including a first drying

step and a second drying step, and a drying temperature T1 in the first drying step being higher than a drying temperature T2 in the second drying step; and

a photocuring step of irradiating the release layer forming composition with active energy rays after the drying step to cure the release layer forming composition.

[0018]

In the production method according to the present invention, a release layer having high smoothness can be formed particularly by setting the production conditions when processing the release layer to predetermined conditions. For example, the applied amount of the release layer forming composition, the composition of an organic solvent, a drying time, and a drying temperature and the like are controlled. By producing the release film under the conditions of the present invention, the aggregation of the cationically curable polydimethylsiloxane (a) contained in the release layer forming composition can be suppressed, and therefore the release layer excellent in smoothness can be obtained. The details thereof will be described later.

[0019]

(Polyester film)

Polyester constituting the polyester film used as a substrate of the present invention is not particularly limited, and film-formed polyester which is generally used

as a substrate for a release film can be used. Preferably, crystalline linear saturated polyester composed of an aromatic dibasic acid component and a diol component is favorable. For example, a copolymer which contains polyethyleneterephthalate, polyethylene-2,6-naphthalate, polybutyleneterephthalate, polytrimethylene terephthalate or any of constituent components of these resins as a main component is more suitable. Among them, a polyester film formed of polyethylene terephthalate is particularly suitable. In the polyethylene terephthalate, the content of the repeating unit of ethylene terephthalate is preferably 90 mol% or more, and more preferably 95 mol% or more. Small amounts of other dicarboxylic acid component and diol component may be copolymerized with the polyethylene terephthalate. From the viewpoint of cost, the polyethylene terephthalate is preferably produced only from terephthalic acid and ethylene glycol. Known additives such as an antioxidant, a light stabilizer, an ultraviolet absorber, and a crystallization agent may be added as long as the effects of the film of the present invention are not impaired. The polyester film is preferably a biaxially oriented polyester film because of its elastic modulus in both directions, and the like.

[0020]

The intrinsic viscosity of the polyester film is

preferably 0.50 to 0.70 dl/g, and more preferably 0.52 to 0.62 dl/g. When the intrinsic viscosity is 0.50 dl/g or more, breakage does not often occur in a stretching process. which is preferable. Conversely, when the intrinsic viscosity is 0.70 dl/g or less, the cuttability of the polyester film at the time of being cut into a predetermined product width is good and dimensional failure does not occur. which is preferable. In addition, it is preferable that the raw material pellets are sufficiently vacuum-dried.

In the present specification, the term "polyester film" simply means a polyester film which includes the surface layer A (on which the surface layer A is laminated). In the present invention, the polyester film includes the surface layer A substantially containing no inorganic particles, and the release layer is provided on the surface layer A.

When referred to in the specification, the polyester film which further includes a surface layer B (on which the surface layer B is laminated) may be simply referred to as "polyester film".

[0021]

The method for producing the polyester film of the present invention 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 stretching the un-stretched film. The stretching is preferably biaxial stretching from the viewpoint of mechanical properties and the like. 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 an unstretched film is simultaneously stretched biaxially in the machine direction and the transverse direction.

[0022]

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

[0023]

The polyester film preferably has a thickness of 12 to 50 μm , more preferably 15 to 38 μm , and still more preferably 19 μm to 33 μm . When the thickness of the film is 12 μm or more, the film may not be deformed by heat

during the production of the film, the processing step of the release layer, and the formation of the ceramic green sheet and the like, which is preferable. 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.

[0024]

The polyester film may be composed of a single layer or multi layers of two layers or more, The polyester film includes a surface layer A containing substantially no inorganic particles. For example, the polyester film may have a single layer structure including the surface layer A or a multilayer structure including the surface layer A and another layer, for example, a surface layer B to be described later.

A laminated polyester film having a multilayer configuration including two or more layers preferably includes a surface layer B that can contain particles and the like on the surface opposite from the surface layer A substantially containing no inorganic particles. As the laminated configuration, the layer configuration in the thickness direction may be a laminated structure of release layer/A/B, release layer/A/C/B, or the like where a layer to which a release layer is applied is named a surface

layer A, a layer located opposite from the surface layer A is named a surface layer B, and a core layer other than these layers is named a layer C. As a matter of course, the layer C may have a configuration including a plurality of layers. The surface layer B may contain no particles. In that case, a coating layer containing particles and a binder is preferably provided on the surface layer B in order to impart slipperiness for winding the film into a roll.

[0025]

In the polyester film of the present invention, the surface layer A located on the surface to which the release layer is applied contains substantially no inorganic particles. In the present invention, the surface layer A substantially contains no inorganic particles, and therefore the surface layer A can exhibit the following average area surface roughness.

In the present invention, the average area surface roughness (S_a) of the surface layer A is the average area surface roughness (S_a) on the surface on which the release layer is disposed, and the average area surface roughness (S_a) on the surface on which the release layer is disposed is 7 nm or less. When S_a is 7 nm or less, the release layer laminated on the surface layer A can also exhibit high smoothness, and pinholes and the like hardly occur

during the formation of the ultrathin ceramic green sheet laminated on the release layer. Furthermore, when the release layer is formed, it is possible to suppress the aggregation of the release layer component on the protrusions on the surface layer A, and to prevent deterioration in the smoothness of the surface of the release layer.

[0026]

The average area surface roughness (S_a) of the surface layer A is preferably smaller, and may be 0.1 nm or more. In one aspect, the average area surface roughness (S_a) of the surface layer A is 0.1 nm or more and 7 nm or less, for example, 0.5 nm or more and 5 nm or less, or 0.5 nm or more and 4 nm or less. Within such a range, the smoothness of the release layer can be enhanced, and the occurrence of pinholes and the like can be suppressed during the formation of the ultrathin ceramic green sheets to be laminated. Furthermore, when the release layer is formed, it is possible to suppress the aggregation of the release layer component on the protrusions on the surface layer A, and to prevent deterioration in the smoothness of the surface of the release layer.

[0027]

In the present invention, "contain substantially no inorganic particles" means that the content of an inorganic

element quantified by fluorescent X-ray analysis is 50 ppm or less, preferably 10 ppm or less, and most preferably equal to or less than the detection limit. This is because, even if the inorganic particles are not positively added into the film, contamination components derived from foreign matters, and dirt attached to raw material resins, or lines or devices in film producing steps may be mixed into the film.

[0028]

In the polyester film substrate of the present invention, the surface layer B may be provided on the surface opposite to the surface on which the release layer is disposed. The surface layer B preferably contains particles. The surface layer B contains the particles, and therefore the film is excellent in slipperiness and air releasability, and can have excellent transportability and windability. In particular, the surface layer B preferably contains silica particles and/or calcium carbonate particles.

The amount of particles contained in the surface layer B is 1000 to 15000 ppm in total. At this time, the average area surface roughness (Sa) of the film of the surface layer B is, for example, 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. When the total content

of the silica particles and/or the calcium carbonate particles is 1000 ppm or more, and Sa is 1 mm or more, air can be uniformly released when the film is wound up into a roll shape, and the film can have good winding appearance and good flatness. Due to such characteristics, for example, in the case of producing an ultrathin resin sheet having a thickness of 0.2 μm or more and 1.0 μm or less, for example, a ceramic green sheet, it is possible to provide a release film which can prevent the wrinkles and positional displacement of the wound ceramic green sheet and is excellent in transportability, winding, and storability.

When the total content of the silica particles and/or calcium carbonate particles is 15000 ppm or less and the Sa is 40 nm or less, the aggregation of particles also functioning as a lubricant is less likely to occur, and coarse protrusions (for example, protrusions having a height of 1 μm or more) cannot be formed, and therefore the occurrence of pinholes due to, for example, winding can be suppressed during the production of an ultrathin resin sheet, for example, a ceramic green sheet, and a resin sheet having stable quality can be provided.

[0029]

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

calcium carbonate particles and/or heat-resistant organic particles can be used. It is more preferable to use silica particles and/or calcium carbonate particles from the viewpoints 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 the silica particles are used, porous colloidal silica is preferable. When the 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 particles from falling off.

[0030]

The average particle diameter of the 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. When the average particle diameter of the particles is 0.1 μm or more, the slipperiness of the release film is good, which is preferable. When the average particle diameter is 2.0 μm or less, the deformation of the surface layer A is suppressed, and the thickness unevenness of the ceramic green sheet and the occurrence of pinholes can be

suppressed.

[0031]

The surface layer B may contain two or more types of particles made of different materials. Also, the same type of particles having different average particle diameters may be contained. Two or more different particles may have different average particle diameters within the above range. The surface layer B contains two different types of particles, and therefore unevenness formed in the surface layer B can be highly controlled, and both slipperiness and smoothness can be achieved, which is preferable.

[0032]

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 provided, in order to prevent particles or impurities from being mixed.

[0033]

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 the substrate film. When the thickness ratio of the surface layer A is 20% or more, 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 can satisfy the above range, which is preferable. When the thickness ratio is 50% or less of the total thickness of the substrate film, the use ratio of the recycled raw material in the surface layer B and the above-mentioned intermediate layer C in coextrusion can be increased, to reduce the environmental load, which is preferable.

[0034]

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 recycled raw 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 surface layer B, and the average area surface roughness (S_a) of the surface layer B satisfy the above ranges.

[0035]

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

treatment or the like. It is preferable that, when the coat layer is provided on the surface layer A, the coat layer substantially contains no particles.

[0036]

(Release layer)

In the present invention, the release layer is laminated on the surface layer A. In the present invention, the release layer is a layer obtained by curing a release layer forming composition. The release layer and the release layer forming composition contain at least a cationically curable polydimethylsiloxane (a). The release layer has an area surface roughness (Sa) of 2 nm or less. The number of protrusions having a height of 10 nm or more present on the surface of the release layer is 200 protrusions /mm² or less.

When the release layer has such a characteristic, it is possible to suppress the occurrence of pinholes in an ultrathin film resin sheet required to have high smoothness, for example, a ceramic green sheet, and to form a resin sheet having a uniform film thickness.

More specifically, in the present invention, in the release layer, curing failure due to oxygen inhibition can be suppressed, and high crosslinking of the release layer can be exhibited. The present invention exhibiting such an effect can improve, for example, the solvent resistance of

the surface of the release layer. By improving the solvent resistance of the surface of the release layer, it is possible to suppress the release layer from being eroded by an organic solvent used at the time of forming a ceramic green sheet and at the time of printing an internal electrode, and therefore the release layer can have high peelability.

In the present invention, high heat of 130°C or higher is not required to accelerate the curing reaction. Therefore, the flatness of the release film can be suppressed from being impaired by heat during processing. It is possible to suppress foreign matters from being mixed into the release film for forming a resin sheet, and scratches from occurring in the release layer, and therefore the occurrence of the sheet damage due to transfer of foreign matters and scratches, of a body to be released such as a ceramic green sheet can be suppressed.

[0037]

The average area surface roughness (Sa) of the release layer is 2 nm or less. The number of protrusions having a height of 10 nm or more present on the surface of the release layer is 200 protrusions /mm² or less. The surface of the release layer of the release film has predetermined conditions of the average area surface roughness (Sa) and the number of protrusions of 10 nm or

more so as not to cause defects in the ceramic sheet to be applied and formed thereon.

When the area surface roughness (Sa) is 2 nm or less and the number of protrusions having a height of 10 nm or more is 200 protrusions/mm² or less, drawbacks such as pinholes do not occur in the ceramic sheet when the ceramic green sheet is formed, and the yield is good, which is preferable.

More preferably, the area surface roughness (Sa) is 1.7 nm or less, for example, 1.6 nm or less, and may be 1.5 nm or less. In one aspect, the area surface roughness (Sa) is 1.3 nm or less. The area surface roughness (Sa) may be 0.1 nm or more, or 0.2 nm or more.

Meanwhile, in one aspect, the number of protrusions having a height of 10 nm or more is 180 protrusions/mm² or less, for example, 170 protrusions/mm² or less, and may be 160 protrusions/mm² or less. In one aspect, the number of protrusions having a height of 10 nm or more may be 120 protrusions/mm² or less, or 100 protrusions/mm² or less. The number of protrusions having a height of 10 nm or more may be 1 protrusion/mm² or more, and may be, for example, 10 protrusion/mm² or more.

When the number of protrusions having a height of 10 nm or more is within the above range, drawbacks such as pinholes do not occur in the ceramic sheet, and excellent

releasability can also be achieved in a well-balanced manner.

More preferably, the area surface roughness (S_a) is 1.0 nm or less, and the number of protrusions having a height of 10 nm or more is 100 protrusions/mm² or less.

The release layer having the average area surface roughness (S_a) and the number of protrusions according to the present invention can exhibit extremely excellent smoothness.

[0038]

In one aspect, the maximum protrusion height (S_p) of the release layer is 20 nm or less. When the maximum protrusion height is in such a range, defects in the ceramic sheet can be further suppressed. More preferably, the maximum protrusion height (S_p) is 15 nm or less, and still more preferably 10 nm or less.

In one aspect, the total of the number of protrusions having a height of 5 nm or more and less than 10 nm and the number of protrusions having a height of 10 nm or more present on the surface of the release layer is 1500 protrusions/mm² or less. When the total of the number of protrusions having a height of 5 nm or more and less than 10 nm and the number of protrusions having a height of 10 nm or more present on the release layer is 1500 protrusions/mm² or less, defects in the ceramic sheet can be further

suppressed, and a release layer having high smoothness can be obtained, which is preferable.

More preferably, the total of the number of protrusions having a height of 5 nm or more and less than 10 nm and the number of protrusions having a height of 10 nm or more is 1000 protrusions/mm² or less, and for example, and still more preferably 500 protrusions mm² or less.

[0039]

The release layer of the release film for forming a resin sheet according to the present invention is a layer obtained by curing a release layer forming composition, and the release layer forming composition contains at least a cationically curable polydimethylsiloxane (a). Since the cationically curable polydimethylsiloxane (a) undergoes a crosslinking reaction by a cationic curing reaction, curing failure due to oxygen inhibition does not occur, and a release layer excellent in solvent resistance is formed. Therefore, there is no possibility that the release layer is eroded by the organic solvent used when the ceramic green sheet is formed, or when the internal electrode is printed, and a release layer excellent in peelability can be obtained.

[0040]

Furthermore, the present inventors have found that in

the release layer containing the cationically curable polydimethylsiloxane (a), the amount of the cationically curable polydimethylsiloxane (a) is important for realizing a release layer having high smoothness.

The content of the cationically curable polydimethylsiloxane (a) contained in the release layer is preferably 90 mg/m² or less, for example, 60 mg/m² or less or 50 mg/m² or less, more preferably 40 mg/m² or less, and still more preferably 30 mg/m² or less. For example, the content of the cationically curable polydimethylsiloxane (a) may be 20 mg/m² or less.

When the content of the cationically curable polydimethylsiloxane (a) in the release layer is 50 mg/m² or less, the aggregation of the polydimethylsiloxane (a) can be suppressed during a step of forming the release layer, for example, a drying step, and there is no possibility that a large number of protrusions falling outside the scope of the present invention occur, and therefore the effect of the present invention can be exhibited.

In one aspect, a component other than the cationically curable polydimethylsiloxane (a) may be contained in the release layer and the release layer forming composition. Even in this case, it should not be determined based on a specific theory, but in the present

invention, the polydimethylsiloxane (a) can segregate on the surface of the release layer during the processing of the release layer, and when the content of the polydimethylsiloxane (a) is 50 mg/m² or less, the polydimethylsiloxane (a) is less likely to aggregate, and a release layer having high smoothness can be formed.

When the content of the polydimethylsiloxane (a) according to the present invention is less, the polydimethylsiloxane (a) is less likely to aggregate, but when the content of the polydimethylsiloxane (a) in the release layer is 0.1 mg/m² or more, the leveling property of the release layer is maintained, and a release layer having excellent coating appearance and high smoothness can be obtained. When the content of the polydimethylsiloxane (a) is 0.1 mg/m² or more, the release layer is also excellent in peelability, which is preferable. For example, the content of the polydimethylsiloxane (a) may be 0.5 mg/m² or more.

In the present invention, the release layer forming composition contains the cationically curable polydimethylsiloxane (a). In the release layer obtained by curing the release layer forming composition, a compound (cured product) derived from the cationically curable polydimethylsiloxane (a) is present. In the present specification, the compound derived from the component (a)

present in the release layer may also be simply described as the cationically curable polydimethylsiloxane (a).

[0041]

In the present invention, the cationically curable polydimethylsiloxane (a) refers to a polydimethylsiloxane having a cationically curable functional group. The cationically curable functional group is a reactive functional group exhibiting cationically curability, and specific examples thereof include a vinyl ether group, an oxetanyl group, an epoxy group, and an alicyclic epoxy group. Among them, from the viewpoint of reactivity, it is preferable to have at least one functional group selected from an oxetanyl group, an epoxy group, and an alicyclic epoxy group, and it is most preferable to have an alicyclic epoxy group. By having such a functional group, a crosslinked structure is formed by a cationic curing reaction, and a release layer having excellent solvent resistance and excellent peelability is obtained, which is preferable.

[0042]

The number of cationically curable functional groups of the cationically curable polydimethylsiloxane (a) may be 1 or more. For example, by having two or more cationically curable functional groups, the cationic curing reaction is more likely to proceed, and a release layer having a high

crosslinking density is obtained, which is preferable. The introduction position of the cationically curable functional group is not particularly limited, and those having the cationically curable functional group at the side chain or terminal of polydimethylsiloxane are common. The structure of the polydimethylsiloxane may be a linear structure or a branched structure, and even if the polydimethylsiloxane has a functional group other than the cationically curable functional group, the polydimethylsiloxane can be used without any problem.

[0043]

As the cationically curable polydimethylsiloxane (a), commercially available products can be suitably used. Examples thereof include Silcoleases (registered trademark) UV POLY200, UV POLY201, UV POLY215, UV RCA200, and UV RCA251 manufactured by Arakawa Chemical Industries, Ltd., X-62-7622, X-62-7629, X-62-7660, KF-101, KF-105, X-22-343, X-22-169AS, X-22-169B, X-22-163, X-22-173BX, X-22-173DX, and X-22-9002 manufactured by Shin-Etsu Chemical Co., Ltd., and UV 9440 E and UV 9430 manufactured by Momentive Performance Materials.

[0044]

The weight average molecular weight of the cationically curable polydimethylsiloxane (a) is preferably 1000 to 500000, and more preferably 5000 to 100000. When

the weight average molecular weight is 1000 or more, the cationic curing reaction easily proceeds and the peelability is excellent, which is preferable. When the weight average molecular weight is 500,000 or less, the viscosity does not become too high, and a release layer having excellent coatability and high flatness is obtained, which is preferable.

[0045]

The release layer forming composition of the present invention may contain another resin in addition to the cationically curable polydimethylsiloxane (a). In this case, the film thickness of the release layer can be reduced. In the present invention, the release layer is provided on the surface layer A of the substrate film substantially containing no inorganic particles, and therefore the release layer having extremely high smoothness can be obtained even if the film thickness of the release layer is small. Since the film thickness of the release layer is small, the curing reaction of the release layer easily proceeds, and the release layer can be processed at a higher speed, and therefore the release layer can be economically obtained.

[0046]

When the film thickness of the release layer is smaller, there is no possibility that extremely minute

foreign matters and the like present in the substrate film, the release processing step and the like are taken into the release layer. Therefore, there is no possibility that protrusions caused by the foreign matters occur on the surface of the release layer, and the release layer having a smooth surface as described above can be obtained.

[0047]

In the case of a release layer obtained by curing a composition containing a cationically curable polydimethylsiloxane (a) as a main component, the film thickness of the release layer is preferably 0.001 μm or more and less than 0.050 μm . When the film thickness of the release layer is 0.001 μm or more, the release layer is excellent in releasability, which is preferable. When the film thickness of the release layer is less than 0.050 μm , the aggregation of the release layer forming composition can be prevented, and therefore a smooth release layer is obtained, which is preferable.

In the present invention, when the cationically curable polydimethylsiloxane (a) is contained as a main component, the composition contains the cationically curable polydimethylsiloxane (a) in an amount of 50 parts by mass or more, for example, more than 50 parts by mass, preferably 70 parts by mass or more, for example, 80 parts by mass or more, based on 100 parts by mass of the resin

solid content of the release layer, and in one aspect, 90 parts by mass or more. An aspect may be employed, in which substantially the entire resin solid content of the release layer contains the cationically curable polydimethylsiloxane (a).

[0048]

The release layer forming composition of the present invention may contain a cationically curable resin (b) in addition to the cationically curable polydimethylsiloxane (a). At this time, the component (b) is a resin different from the component (a), and the resin (b) does not have a polydimethylsiloxane structure. Specifically, the resin (b) is roughly classified into two types of a cationically curable compound (b-1) having no silicone skeleton and a cyclic siloxane compound (b-2) having an alicyclic epoxy group.

[0049]

In one aspect, the release layer forming composition further contains the cationically curable compound (b-1) having no silicone skeleton in addition to the cationically curable polydimethylsiloxane (a). Examples of the cationically curable compound (b-1) having no silicone skeleton include polymers and monomers having two or more cationically curable functional groups in the molecule and having no silicone skeleton. Among them, a resin having

two or more epoxy groups or alicyclic epoxy groups is preferable, and a resin having two or more alicyclic epoxy groups is more preferable. For example, the number of the alicyclic epoxy groups may be 6 or less.

By having two or more alicyclic epoxy groups, a crosslinking reaction proceeds by a cationic curing reaction, and a release layer excellent in solvent resistance is obtained. At the same time, the crosslinking reaction also proceeds with the polydimethylsiloxane (a) contained in the release layer, and therefore the release layer is excellent in peelability, and the migration of the polydimethylsiloxane (a) to the ceramic green sheet is also suppressed, which is preferable.

[0050]

In one aspect, the release layer forming composition contains both the cationically curable resin (b-1) having no silicone skeleton and the polydimethylsiloxane (a), and therefore a release layer having high smoothness can be realized. By forming the release layer containing the compound (b-1), it is possible to fill fine unevenness, extremely minute foreign matters, oligomer-derived protrusions, and the like present in the substrate film, and therefore an ultrasmooth release layer is obtained. Since ultraviolet rays cause the curing reaction to proceed, a release layer having high smoothness is

obtained. Although it should not be construed as being limited to a specific theory, it can be presumed that in the drying step in the release layer forming composition during the processing of the release layer, the component (b-1) and the component (a) are uniformly leveled, and curing proceeds after flatness is enhanced, and a release layer having high smoothness can be obtained. In the present invention, the polydimethylsiloxane (a) contained at the same time segregates on the surface of the release layer in the drying step, and therefore a release layer excellent in peelability can be obtained.

[0051]

The cationically curable compound (b-1) having no silicone skeleton is preferably a low-molecular-weight monomer. Specifically, the number average molecular weight is preferably 200 or more and less than 5000, more preferably 200 or more and less than 2500, and still more preferably 200 or more and less than 1000. When the number average molecular weight is 200 or more, the boiling point does not decrease, and there is no possibility that the cationically curable compound (b-1) volatilizes in the step of drying the release layer forming composition during the processing of the release layer, which is preferable. When the number average molecular weight is less than 5000, the release layer has an increased crosslinking density and

excellent solvent resistance, which is preferable. Since the release layer forming composition can be present in a liquid state with fluidity during the drying step, an ultrasmooth release layer excellent in leveling property is obtained, which is preferable.

[0052]

As the cationically curable compound (b-1) having no silicone skeleton, commercially available products can be suitably used. Examples of the compound having an alicyclic epoxy group include CELLOXIDE 2021P, CELLOXIDE 2081, EPOLEAD GT401, and EHPE3150 manufactured by Daicel Corporation, HiREM-1 manufactured by Shikoku Chemicals Corporation, and THI-DE, DE-102, and DE-103 manufactured by ENEOS Corporation. Examples of the resin having an epoxy group include EPICLON (registered trademark) 830, 840, 850, 1051-75M, N-665, N-670, N-690, N-673-80M, and N-690-75M manufactured by DIC Corporation, Denacol (registered trademark) EX-611, EX-313, and EX-321 manufactured by Nagase Chemtex Corporation.

[0053]

The content of the cationically curable compound (b-1) having no silicone skeleton is preferably 80% by mass or more, more preferably 85% by mass or more, and still more preferably 90% by mass or more, based on a total of 100 parts by mass of the cationically curable

polydimethylsiloxane (a) and the cationically curable compound (b-1) in the release layer.

When the content of the cationically curable compound (b-1) is 80% by mass or more and the cationically curable compound (b-1) is contained as a main component in the release layer, a release layer having a high crosslinking density and excellent peelability is obtained, which is preferable. The content of the cationically curable polydimethylsiloxane (a) contained in the release layer can be reduced, the aggregation of the composition derived from the polydimethylsiloxane (a) on the surface of the release layer in the drying step can be suppressed, and therefore there is no possibility that the flatness of the release layer deteriorates, which is preferable. As the content of the cationically curable compound (b-1) is larger, a release layer having more excellent smoothness is obtained. However, in order to ensure the peelability of the release layer when containing the cationically curable polydimethylsiloxane (a), the content of the cationically curable compound (b-1) is preferably 99.9% by mass or less.

In the present invention, in the release layer obtained by curing the release layer forming composition, a compound (cured product) derived from the cationically curable compound (b-1) having no silicone skeleton is present. In the present specification, the compound

derived from the component (b-1) present in the release layer may also be simply described as the cationically curable compound (b-1) having no silicone skeleton.

[0054]

When the release layer forming composition contains the cationically curable polydimethylsiloxane (a) and the cationically curable compound (b-1), the release layer has a high crosslinking density, excellent solvent resistance, and an excellent peeling force, which is preferable. When the release layer forming composition contains the cationically curable compound (b-1), the film thickness of the release layer can be increased while the content of the cationically curable polydimethylsiloxane (a) is set within a predetermined range, which is preferable. By increasing the film thickness of the release layer, scratches and extremely minute unevenness present in the substrate film can be filled, and a smooth release layer is obtained as described above, which is preferable.

[0055]

When the release layer forming composition contains the cationically curable polydimethylsiloxane (a) and the cationically curable compound (b-1), the film thickness of the release layer is preferably 0.05 μm or more and 1.0 μm or less, and more preferably 0.1 μm or more and 0.5 μm or less. When the film thickness is 0.05 μm or more, a smooth

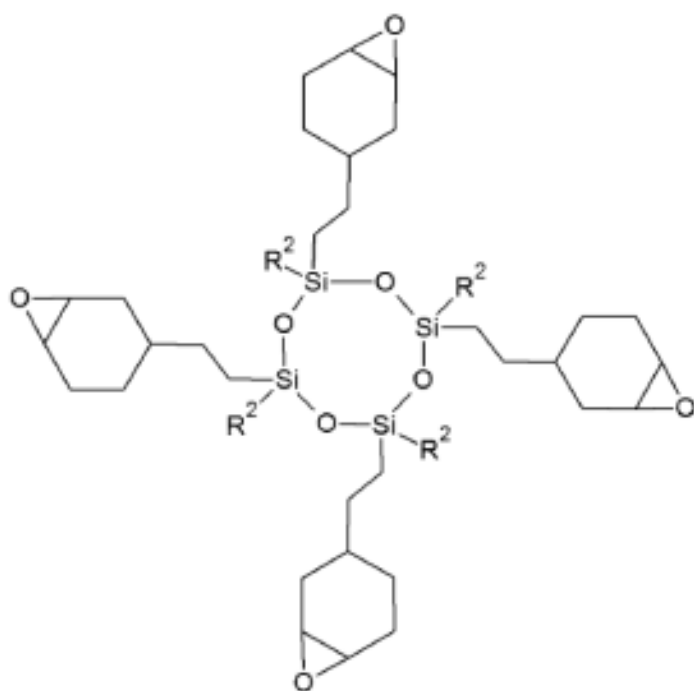
release layer is obtained, which is preferable. When the film thickness is 1.0 μm or less, curling does not occur and a release film excellent in flatness is obtained, which is preferable.

[0056]

In one aspect, the release layer forming composition may further contain a cyclic siloxane compound (b-2) having an alicyclic epoxy group. Examples of the cyclic siloxane compound (b-2) having an alicyclic epoxy group include those represented by the following structural formula (Formula 1) (in Formula 1, R^2 represents an alkyl group having 1 to 4 carbon atoms). The cationically curable compound (b-2) having a cyclic siloxane skeleton preferably has at least two or more alicyclic epoxy groups. When the number of the alicyclic epoxy groups is 2 or more, a cationic curing reaction proceeds to obtain a release layer having a high crosslinking density, which is preferable.

[0057]

[Formula 1]



[0058]

By use of the cyclic siloxane compound (b-2) having an alicyclic epoxy group, an ultrasmooth release layer is obtained for the same reason as that when the cationically curable compound (b-1) is used, which is preferable. That is, it is possible to fill fine unevenness, extremely minute foreign matters, oligomer-derived protrusions, and the like present in the substrate film. Since ultraviolet rays cause the curing reaction to proceed, the compound (b-2) and the polydimethylsiloxane (a) are uniformly leveled in the step of drying the release layer forming composition during the processing of the release layer, and the curing proceeds after the flatness is enhanced, and therefore an ultrasmooth release layer can be obtained. Furthermore, in

the present invention, the polydimethylsiloxane (a) contained at the same time segregates on the surface of the release layer in the drying step, and therefore a release layer excellent in peelability can be obtained.

[0059]

Since the cyclic siloxane compound (b-2) having an alicyclic epoxy group has good compatibility with the cationically curable polydimethylsiloxane (a), the cyclic siloxane compound (b-2) and the cationically curable polydimethylsiloxane (a) are appropriately mixed in the release layer, to cause a crosslinking reaction to proceed with each other. Therefore, the release layer is excellent in solvent resistance and exhibits excellent peelability, which is preferable. The cyclic siloxane compound (b-2) has a cyclic siloxane structure to have a rigid molecular skeleton, and film hardness when cured is increased, which is preferable. When the film hardness is increased, the release layer is less likely to be deformed when the resin sheet, for example, the ceramic green sheet, is peeled off, and therefore good peelability can be exhibited. Furthermore, scratches hardly occur in the release layer, and there is no possibility that the scratches of the release layer are transferred to the resin sheet, for example, the ceramic green sheet, resulting in troubles, which is preferable.

[0060]

When the release layer forming composition contains the cyclic siloxane compound (b-2), the adhesion of the release layer to the substrate film is improved, which is preferable. When the adhesion of the release layer is improved, the occurrence of scratches in a transportation step can be suppressed, and there is no possibility that the release layer is transferred when the resin sheet is peeled off, which is preferable.

[0061]

In one aspect, the cyclic siloxane compound (b-2) has two or more alicyclic epoxy groups in the molecule. The cyclic siloxane compound (b-2) has two or more alicyclic epoxy groups in the molecule, and therefore a cationic curing reaction causes a crosslinking reaction to proceed, and a release layer excellent in solvent resistance is obtained. At the same time, the crosslinking reaction also proceeds with the polydimethylsiloxane (a) contained in the release layer, and therefore the release layer is excellent in peelability, and the migration of the polydimethylsiloxane (a) to the ceramic green sheet is also suppressed, which is preferable.

For example, the cyclic siloxane compound (b-2) has 6 or less alicyclic epoxy groups in the molecule.

[0062]

As the cyclic siloxane compound (b-2) having an alicyclic epoxy group, commercially available products can be used. Examples thereof include X-40-2670 and X-40-2678 manufactured by Shin-Etsu Chemical Co., Ltd.

[0063]

The content of the cyclic siloxane compound (b-2) is preferably 80% by mass or more, more preferably 85% by mass or more, and still more preferably 90% by mass or more, based on a total of 100 mass parts of the cationically curable polydimethylsiloxane (a) and the cyclic siloxane compound (b-2) in the release layer. When the content of the cyclic siloxane compound (b-2) is 80% by mass or more and the cyclic siloxane compound (b-2) is contained as a main component in the release layer, a release layer having a high crosslinking density and excellent peelability is obtained, which is preferable. The content of the cationically curable polydimethylsiloxane (a) contained in the release layer can be reduced. In the present invention, in the drying step, the aggregation of the cationically curable polydimethylsiloxane (a) on the surface of the release layer can be suppressed, and there is no possibility that the flatness of the release layer deteriorates, which is preferable. As the content of the cyclic siloxane compound (b-2) is larger, a release layer having more excellent smoothness is obtained. For example,

in order to ensure the peelability of the release layer when containing the cationically curable polydimethylsiloxane (a), the content of the cyclic siloxane compound (b-2) is preferably 99.9% by mass or less.

In the present invention, in the release layer obtained by curing the release layer forming composition, a compound (cured product) derived from the cyclic siloxane compound (b-2) is present. In the present specification, the compound derived from the cyclic siloxane compound (b-2) present in the release layer may also be simply described as the cyclic siloxane compound (b-2).

[0064]

When the release layer forming composition contains the cationically curable polydimethylsiloxane (a) and the cyclic siloxane compound (b-2), the film thickness of the release layer is preferably 0.05 μm or more and 1.0 μm or less, and more preferably 0.1 μm or more and 0.5 μm or less. When the film thickness is 0.05 μm or more, a smooth release layer is obtained, which is preferable. When the film thickness is 1.0 μm or less, curling does not occur and a release film excellent in flatness is obtained, which is preferable.

[0065]

In one aspect, the release layer may contain both the

cationically curable resin (b-1) and the cyclic siloxane compound (b-2), and the total amount of the cationically curable resin (b-1) and the cyclic siloxane compound (b-2) may be 80% by mass or more and 99.9% by mass or less based on a total of 100 parts by mass of the cationically curable polydimethylsiloxane (a), the cationically curable compound (b-1), and the cyclic siloxane compound (b-2) in the release layer.

[0066]

In the present invention, it is necessary to cause the cationic curing reaction to proceed in order to form the release layer. Therefore, the release layer forming composition preferably contains an acid generating agent (c). A compound derived from the acid generating agent (c) may be present in the release layer. Here, the compound derived from the acid generating agent (c) present in the release layer may also be simply described as the acid generating agent (c).

The acid generating agent is not particularly limited, and general acid generating agents are used. The use of a photo acid generating agent which generates an acid under irradiation with ultraviolet light makes it possible to suppress an amount of heat during processing, and a release layer excellent in flatness is obtained, which is preferable.

[0067]

As the photo acid generating agent, salts composed of onium ions and non-nucleophilic anions are suitably used from the viewpoint of reactivity. An organometallic complex represented by an iron arene complex or a carbocation salt represented by tropylium may be used, or an anthracene derivative or a phenol substituted with an electron-withdrawing group, for example, pentafluorophenol may be used.

[0068]

When the salts composed of onium ions and non-nucleophilic anions are used as the photo acid generating agent, for example, iodonium, sulfonium, and ammonium can be used as the onium ions. As the organic group of the onium ions, triaryl, diaryl (monoalkyl), monoaryl (dialkyl), and trialkyl may be used. Benzophenone or 9-fluorene may be introduced, or other organic groups may be used. As the non-nucleophilic anions, it is suitable to use hexafluorophosphate, hexafluoroantimonate, hexafluoroborate, or tetra(pentafluorophenyl)borate. Tetra(pentafluorophenyl)gallium ions or anions obtained by replacing some of fluorine anions with perfluoroalkyl groups or organic groups may be used, and other anion components may be used.

[0069]

The added amount of the acid generating agent is 0.1 to 10% by mass, and more preferably 0.5 to 8% by mass, based on a total of 100 parts by mass of the cationically curable polydimethylsiloxane (a) and the cationically curable compound (b-1) and/or the cyclic siloxane compound (b-2) in the release layer. The added amount is still more preferably 1 to 5% by mass. When the added amount is 0.1% by mass or more, the amount of an acid to be generated is insufficient. This is free from the possibility of insufficient curing, which is preferable. When the added amount is 10% by mass or less, the amount of an acid to be generated is appropriate. This can suppress the amount of transition of the acid to the ceramic green sheet to be formed, which is preferable.

[0070]

In the present specification, a total of 100 parts by mass of the cationically curable polydimethylsiloxane (a) and the cationically curable compound (b-1) and/or the cyclic siloxane compound (b-2) in the release layer means the total value of the solid content of the cationically curable polydimethylsiloxane (a) and the solid content of the cationically curable resin (b). In an aspect in which the release layer does not contain the cationically curable resin (b), the weight of the cationically curable polydimethylsiloxane (a) corresponds to 100 parts by mass

of the resin solid content in the release layer.

[0071]

In one aspect, the release layer forming composition contains an organic solvent having an SP value (δ) of 14 or more and 17 or less, and the release layer forming composition contains the organic solvent having an SP value (δ) of 14 or more and 17 or less in an amount of 10% by mass or more based on 100 mass parts of the total weight of the release layer forming composition.

The organic solvent having an SP value (δ) of 14 to 17 exhibits excellent solubility in the cationically curable polydimethylsiloxane (a). Therefore, even if the organic solvent is dried in the drying step after the applying step to increase the concentration of the component (a) in the release layer forming composition, it is possible to maintain a uniformly dissolved state of the component (a), and it is possible to obtain a smooth release layer by leveling without aggregation.

When the content of the organic solvent is 10% by mass or more, the cationically curable polydimethylsiloxane (a) can be kept dissolved for a long time during drying, and therefore there is no possibility that the cationically curable polydimethylsiloxane (a) is aggregated during drying to deteriorate smoothness, which is preferable.

The organic solvent having an SP value (δ) of 14 or

more and 17 or less will be described in detail later.

[0072]

Additives such as an adhesion improver and an anti-static agent may be added to the release layer in the present invention as long as the effect of the present invention is not impaired. In order to improve the adhesion to the substrate, it is also preferable that the surface of the polyester film is subjected to a pretreatment such as anchor coating, a corona treatment, a plasma treatment, or an atmospheric pressure plasma treatment before providing the release layer.

[0073]

The release film obtained by the present invention preferably has a peeling force of 0.01 mN/mm or more and 2.0 mN/mm or less when the ceramic green sheet is peeled off. More preferably, the peeling force is 0.05 mN/mm or more and 1.0 mN/mm or less. When the peeling force is 0.01 mN/mm or more, there is no possibility that the ceramic green sheet floats during transportation, which is preferable. When the peeling force is 2.0 mN/mm or less, there is no possibility that the ceramic green sheet is damaged during peeling, which is preferable.

[0074]

Since the release film obtained by the present invention uses a highly flattened substrate film, the

release layer can have a smooth surface even if the thickness of the release layer is 1.0 μm or less, further 0.5 μm or less, and further 0.3 μm or less. Therefore, the amount of a solvent and the amount of a resin to be used can be reduced, and therefore an environmentally-friendly release film for forming an ultrathin ceramic green sheet can be produced at low cost.

[0075]

(Method for producing release film)

In another aspect, the present invention provides a method for producing a release film for forming a resin sheet, the method including the following steps:

an applying step of applying a release layer forming composition onto a surface layer A of a polyester film including the surface layer A,

the surface layer A being a layer substantially containing no inorganic particles,

the release layer forming composition containing a cationically curable polydimethylsiloxane (a);

a drying step of heating and drying the polyester film onto which the release layer forming composition is applied, the heating and drying including a first drying step and a second drying step, and a drying temperature T1 in the first drying step being higher than a drying temperature T2 in the second drying step; and

a photocuring step of irradiating the release layer forming composition with active energy rays after the drying step to cure the release layer forming composition.

[0076]

According to the production method of the present invention, by strengthening a first drying condition (by strengthening drying), the aggregation of the resin constituting the release layer can be prevented, and a release layer having high smoothness can be obtained.

Furthermore, by setting the SP value of the solvent in the release layer forming composition to a predetermined value, the aggregation of the resin constituting the release layer can be prevented, and a release layer having high smoothness can be obtained.

As described above, in the present invention, the first drying step has a predetermined condition, and in one aspect, a release layer having high smoothness can be obtained by using a specific solvent.

[0077]

The method for producing a release film of the present invention includes, in order, an applying step of applying a release layer forming composition containing at least a cationically curable polydimethylsiloxane (a) onto a surface layer A of a polyester film substantially containing no inorganic particles, a drying step of heating

and drying the film after applying using, for example, a drying furnace, and a photocuring step of curing the release layer forming composition after heating and drying using active energy rays. In particular, it is preferable to adopt a method in which the applying step, the drying step, and the photocuring step are performed in this order. [0078]

According to the production method of the present invention, it has been found that a release layer having high smoothness can be realized by devising production conditions in the applying step. Specifically, the release layer forming composition contains the organic solvent having an SP value (δ) of 14 to 17, and therefore the aggregation of the cationically curable polydimethylsiloxane (a) can be suppressed, and an excellent release layer can be obtained. The SP value (δ) can be used to predict the solubility of a substance, and the organic solvent having an SP value (δ) of 14 to 17 exhibits excellent solubility in the cationically curable polydimethylsiloxane (a). Therefore, even if the organic solvent is dried in the drying step after the applying step to increase the concentration of the component (a) in the release layer forming composition, it is possible to maintain a uniformly dissolved state of the component (a), and it is possible to obtain a smooth release layer by

leveling without aggregation.

[0079]

The content of the organic solvent having an SP value (δ) of 14 to 17 and contained in the release layer forming composition is preferably 10% by mass or more, and preferably 15% by mass or more, based on 100 parts by mass of the release layer forming composition. When the content of the organic solvent is 10% by mass or more, the cationically curable polydimethylsiloxane (a) can be kept dissolved for a long time during drying, and therefore there is no possibility that the cationically curable polydimethylsiloxane (a) is aggregated during drying to deteriorate smoothness, which is preferable. For example, the content of the organic solvent having an SP value (δ) of 14 to 17 is 80% by mass or less, for example, 65% by mass or less, and may be less than 50% by mass, based on 100 mass parts of the release layer forming composition.

[0080]

As the SP value (δ) in the present specification, a Hildebrand solubility parameter is adopted. The Hildebrand solubility parameter can be experimentally calculated from Hansen solubility parameters (HSP value) as in Formula 1.

$$\text{SP value } (\delta) = ((\delta_d)^2 + (\delta_p)^2 + (\delta_h)^2)^{1/2} \dots (\text{Formula 1})$$

Here, (δ_D) is a dispersing power term, (δ_P) is a polarity term, and (δ_H) is a hydrogen bonding power term.

A concept in which the Hildebrand solubility parameter is decomposed into three components is the Hansen solubility parameter.

The SP value can also be calculated using computer software such as Hansen Solubility Parameters in Practice (HSPiP), and as the value described in the present specification, a value calculated according to Formula 1 using an HSP value described in database in HSPiP ver 4.0 is adopted.

[0081]

Examples of the organic solvent having an SP value (δ) of 14 to 17 include normal hexane (δ : 14.9), normal heptane (δ : 15.3), normal octane (δ : 15.5), isopropyl ether (δ : 15.8), 1,1-diethoxyethane (δ : 15.9), methylcyclohexane (δ : 16.0), cyclopentane (δ : 16.5), and cyclohexane (δ : 16.8).

[0082]

The applied amount of the release layer forming composition is preferably 10 g/m² or less, and more preferably 8 g/m² or less. When the applied amount is 10 g/m² or less, liquid disturbance is less likely to occur at a kiss portion between the film and a gravure roll, for example, when application is performed by a gravure coating method, and a release layer excellent in smoothness is obtained, which is preferable.

[0083]

In the present invention, the number of kinds of solvents contained in the release layer forming composition is preferably 2 or more. At least one of the solvents is the solvent having an SP value (δ) of 14 to 17 as described above, and preferably has a boiling point of 100°C or higher. The addition of the solvent having a boiling point of 100°C or higher makes it possible to prevent bumping during drying, to level the coating film, and to improve the smoothness of the surface of the coating film after drying.

The addition amount thereof is preferably about 10 to 70% by mass based on the entire release layer forming composition. Examples of the solvent having a boiling point of 100°C or higher include toluene, xylene, normal octane, cyclohexanone, methyl isobutyl ketone, propylene glycol monomethyl ether, propylene glycol monopropyl ether, isobutyl acetate, and normal butanol.

[0084]

In the present invention, the coating liquid of the release layer forming composition is preferably filtered before the application. A filtration method is not particularly limited, and known methods can be used, but surface-type, depth-type and adsorption-type cartridge filters are preferably used. The use of a cartridge-type

filter is preferable, because such a filter can be used while sending the coating liquid continuously from a tank to a coating unit, and thus can filtrate the coating liquid efficiently with high productivity. As the filtration accuracy of the filter, a filter which can remove 99% or more of substances having a size of 1 μm is preferably used, and a filter which can filtrate 99% or more of substances having a size of 0.5 μm is more preferably used. By using the filter having the above-described filtration accuracy, foreign matters mixed in the coating liquid for forming the release layer can be removed, foreign matters adhering to the release film of the present invention can be reduced, and a release layer excellent in smoothness is obtained, which is preferable.

[0085]

As the applying method of the coating solution, 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.

[0086]

Examples of the method for applying the release layer forming composition onto the substrate film and drying the

composition include known hot air drying and an infrared heater, and hot air drying with a high drying speed is preferable. Drying in a drying furnace is preferable, and known drying furnaces can be used without particular limitation. The method of the drying furnace may be either a roll support method or a floating method, but the roll support method has a wider range in which an air volume during drying can be adjusted, and therefore the air volume and the like can be adjusted according to the type of the release layer, which is preferable.

[0087]

The drying step can be divided into two drying steps of a constant rate drying step (hereinafter, referred to as first drying step) at the initial stage of drying and a reduced rate drying step (hereinafter, referred to as second drying step). The two steps are preferably continuous in the order of the first drying step and the second drying step, and can be distinguished by being divided into zones in a drying furnace. The first (initial) drying step can be performed using a first drying furnace, and the second (late) drying step can be performed using a second drying furnace.

[0088]

The present inventors have found that in order to enhance the smoothness of the release layer, it is

important that a drying temperature T1 in the first drying step is higher than a drying temperature T2 in the second drying step. A first drying furnace temperature and a second drying furnace temperature are preferably in ranges described later. By production under such conditions, a constant rate drying time in the first drying step can be shortened, a reduced rate drying time in the second drying step can be lengthened, and a release layer excellent in flatness is obtained, which is preferable.

[0089]

Furthermore, the present inventors have found that it is important to increase the temperature in the first drying furnace to shorten the constant rate drying time.

More specifically, the drying temperature T1 is preferably 90°C or higher and 180°C or lower, and more preferably 100°C or higher and 150°C or lower. By increasing the temperature in the first drying furnace to shorten the constant rate drying time, the aggregation of the cationically curable polydimethylsiloxane (a) contained in the release layer forming composition can be prevented, which is preferable. As the temperature in the first drying furnace is higher, the constant rate drying time is shorter, which is preferable, but when the temperature is too high, the flatness of the film is deteriorated due to heat, and therefore the temperature is preferably 180°C or

lower. When the temperature is 90°C or higher, the drying ability is sufficient, which is preferable.

[0090]

The temperature in the second drying furnace is preferably 60°C or higher and 140°C or lower, and more preferably 80°C or higher and 120°C or lower. In the second drying step, the surface of the release layer before photocuring can be dried without being roughened by delaying the drying time, and the smoothness of the release layer is enhanced, which is preferable.

[0091]

For example, the constant rate drying time in the first drying step is preferably shorter than the reduced rate drying time in the second drying step. This makes it possible to prevent deterioration in the flatness of the film, and to dry the film without roughening the surface of the release layer before photocuring, and therefore the smoothness of the release layer can be enhanced.

[0092]

A time from the application to the entrance into the first drying furnace is preferably 0.1 seconds or more and 2.5 seconds or less, and preferably 0.1 seconds or more and 2.0 seconds or less, and the time is preferably shorter. By shortening the time to enter the first drying furnace, the drying time in the first drying step can be shortened,

and the aggregation of the cationically curable polydimethylsiloxane (a) is suppressed, and therefore a release layer excellent in smoothness is obtained, which is preferable. The time to enter the drying furnace can be calculated from a processing speed and the structure of a processing machine table.

[0093]

The production method of the present invention includes, after the drying step, a photocuring step of irradiating the release layer forming composition with active energy rays to cure the release layer forming composition.

In the photocuring step, irradiation with active energy rays cause the cationic curing reaction of the release layer forming composition after drying to proceed. As the active energy rays to be used, known techniques such as ultraviolet rays and electron beams can be used, and ultraviolet rays are preferably used. An integrated light amount when the ultraviolet rays are used can be expressed by a product of illuminance and an irradiation time. For example, the integrated light amount is preferably 10 to 500 mJ/cm². When the integrated light amount is equal to or greater than the lower limit, the release layer can be sufficiently cured, which is preferable. When the integrated light amount is equal to or less than the upper

limit, thermal damage to the film due to heat during irradiation can be suppressed and the smoothness of the surface of the release layer can be maintained, which is preferable.

[0094]

When the film is irradiated with active energy rays, the back surface of the film is preferably held by a backup roll. By providing the backup roll, the distance to an active energy ray source can be kept constant, and therefore the irradiation can be uniformly performed, which is preferable. The film is preferably irradiated with active energy rays while the surface of the backup roll is cooled to cool the film. By cooling, the film is less likely to be damaged by heat and the smoothness of the surface of the release layer can be maintained even when the film is irradiated with active energy rays, which is preferable.

[0095]

In one aspect, the production method of the present invention provides a method for producing a release film for producing a resin sheet containing an inorganic compound.

[0096]

(Resin sheet)

The resin sheet of the present invention is not

particularly limited as long as the resin sheet is a sheet containing a resin. In one aspect, the release film of the present invention is a release film for forming a resin sheet containing an inorganic compound. Examples of the inorganic compound include metal particles, metal oxides, and minerals, and specific examples thereof include calcium carbonate, silica particles, aluminum particles, and barium titanate particles. Since the present invention includes the release layer having high smoothness, it is possible to suppress drawbacks that may be caused by the inorganic compounds, for example, problems such as breakage of the resin sheet and difficulty in peeling the resin sheet from the release layer even in an aspect in which these inorganic compounds are contained in the resin sheet.

Resin components forming the resin sheet can be appropriately selected according to the application. In one aspect, the resin sheet containing an inorganic compound is a ceramic green sheet. For example, the ceramic green sheet can contain barium titanate as the inorganic compound. As the resin components, for example, a polyvinyl butyral-based resin can be contained.

In one aspect, the resin sheet has a thickness of 0.2 μm or more and 1.0 μm or less.

For example, the present invention can provide a method for producing a release film for producing a resin

sheet containing such an inorganic compound. The method for producing a release film for forming a resin sheet of the present invention may include a step of forming a resin sheet having a thickness of 0.2 μm or more and 1.0 μm or less.

[0097]

(Ceramic green sheet and ceramic capacitor)

In general, a laminated ceramic capacitor has 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.

[0098]

In one aspect, the release film of the present invention is a release film for producing a ceramic green sheet, and is used for producing such a laminated ceramic

capacitor.

For example, the method for producing a ceramic green sheet in which the release film for producing the ceramic green sheet according to the present invention is used to form the ceramic green sheet can form the ceramic green sheet having a thickness of 0.2 μm or more and 1.0 μm or less.

More specifically, for example, the ceramic green sheet is produced as follows. First, the release film of the present invention 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 to 1.0 μm 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 green 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

[0099]

Hereinafter, the present invention will be described in more detail with reference to Examples, but the present invention is not limited to the following Examples. Characteristic values used in the present invention were evaluated using the following methods.

[0100]

(Thickness of release layer)

A cut release film was embedded in a resin, and ultrathinly sectioned using an ultramicrotome. Thereafter, the cross section of the release film was observed using a JEM 2100 transmission electron microscope manufactured by JEOL Ltd., and the film thickness of the release layer was measured from the observed TEM image. When the thickness of the release layer was too small, and could not be accurately evaluated by the observation of the cross-section, the film thickness of the release layer was measured using a reflection spectrophotometer (FE-3000 manufactured by Otsuka Electronics Co., Ltd.).

[0101]

(Weight of release layer)

In the present specification, the value of a weight calculated with a weight per 1 μm of the thickness of the

release layer as 1 g/m² was adopted. For example, when the thickness of the release layer measured by the above-described method is 0.2 μm, the total weight of the release layer is 0.2 g/m². As the weights of a cationically curable polydimethylsiloxane (a), a cationically curable resin (b), and an acid generating agent (c) contained in the release layer, values calculated from the blending ratios of the components contained in a release layer forming composition and the total weight of the release layer were adopted. For example, when the thickness of the release layer is 0.2 μm and the weight ratio of the cationically curable polydimethylsiloxane (a) in the release layer is 5 parts by mass, the weight of the component (a) contained in the release layer is 0.01 g/m². The weight ratio (% by mass) in the release layer was calculated with the total of the component (a) and the component (b) as 100 parts by mass.

[0102]

(Applied amount of release layer forming composition)

A value calculated from the liquid consumption weight and the processing area of the release layer forming composition used in the applying step was adopted.

[0103]

(Time from application to first drying furnace)

A value calculated from a film travel distance from

an applying unit to a first drying furnace, and a processing speed was adopted.

[0104]

(Area surface roughness S_a , maximum protrusion height S_p)

The area surface roughness and the maximum protrusion height were measured under the following conditions using a noncontact surface profilometer system (VertScan R550H-M100). For the average area surface roughness (S_a), the average value of five measurements was employed. For the maximum protrusion height (S_p), seven measurements were performed, and the maximum value of five measurements excluding the maximum and minimum values was employed.

(Measurement conditions)

- Measurement mode: WAVE mode
- Objective lens: 50 times
- 0.5 × Tube lens
- Measurement area 187 μm × 139 μm

(Analysis conditions)

- Surface correction: 4th order correction
- Interpolation processing: complete interpolation

[0105]

(Number of protrusions having height of 10 nm or more, number of protrusions having height of 5 nm or more)

Particle analysis was performed using measurement data indicating a center value among a total of the seven

measurements in which the maximum protrusion height was measured. The particle analysis was obtained under the following conditions using analysis software of Vertscan R550H-M100. Particle analysis was performed with the area surface roughness and the same measurement area as that of the measurement of the maximum protrusion height, and the number of protrusions having a maximum degree of 10 nm or more or the number of protrusions having a maximum degree of 5 nm or more was calculated. As the number of protrusions, a value converted per 1 mm² was adopted.

(Particle analysis conditions)

- Surface correction: 4th order correction
- Interpolation processing: Complete interpolation
- Convex analysis
- Reference height: zero surface

[0106]

(Peeling force of ceramic sheet)

A slurry composition I composed of materials shown below was stirred and mixed for 10 minutes, and dispersed for 10 minutes with zirconia beads having a diameter of 0.5 mm using a bead mill to obtain a primary dispersion.

Thereafter, a slurry composition II composed of materials shown below was added to the primary dispersion at a ratio of (slurry composition I):(slurry composition II)=3.4:1.0, followed by secondarily dispersing for 10 minutes with

zirconia beads having a diameter of 0.5 mm using a bead mill to obtain a ceramic slurry.

(Slurry Composition I)

Toluene	22.3 parts by mass
Ethanol	18.3 parts by mass
Barium titanate (average particle diameter: 100 nm)	57.5 parts by mass
HOMOGENOL L-18 (manufactured by Kao Corporation)	1.9 parts by mass

(Slurry Composition II)

Toluene	39.6 parts by mass
Ethanol	39.6 parts by mass
Dioctyl phthalate	3.3 parts by mass
Polyvinyl butyral (S-LEC BM-S manufactured by SEKISUI CHEMICAL CO., LTD.)	16.3 parts by mass
1-Ethyl-3-methylimidazolium ethyl sulfate	0.5 parts by mass

Then, the slurry was coated on the release surface of the obtained release film sample using an applicator such that the thickness after drying was 1.0 μm , and dried at 60°C for 1 minute, to obtain a release film including a ceramic green sheet. The obtained release film including the ceramic green sheet was statically eliminated using a static eliminator (SJ-F020 manufactured by Keyence Corporation), and then peeled off at a peeling angle of 90

degrees, a peeling temperature of 25°C, and a peeling speed of 10 m/min using a peeling tester (VPA-3 manufactured by Kyowa Interface Science Co., Ltd., load of load cell: 0.1 N). As a direction of peeling, a double-sided adhesive tape (No. 535A manufactured by Nitto Denko Corporation) was attached on a SUS plate attached to the peeling tester, and the release film was fixed thereon by bonding the ceramic green sheet side to a double-sided tape. The release film was peeled off by pulling the release film side. Among the obtained measured values, the average value of peeling forces at a peel distance of 20 mm to 70 mm was calculated, and the value was taken as the peeling force. The measurement was performed five times in total, and the average value of the peeling forces was adopted and evaluated. Determination was made according to the following criteria based on the obtained numerical values of the peeling forces.

○: 0.1 mN/mm or more and less than 1.0 mN/mm

×: 1.0 mN/mm or more

[0107]

(Evaluation of pinholes of ceramic green sheet)

A ceramic green sheet having a thickness of 1 μm was formed on the release surface of the release film in the same manner as in the evaluation of the peelability of the ceramic slurry. Subsequently, the release film was peeled

off from the formed release film including the ceramic green sheet to obtain the ceramic green sheet. In a range of 25 cm² in the central region of the obtained ceramic green sheet in the film transverse direction, light was applied to a surface opposite from a surface to which a ceramic slurry was applied, and the occurrence status of pinholes viewed from the transmission of light was observed. The pinholes were visually determined according to the following criteria.

○: No occurrence of pinholes

×: Occurrence of one or more pinholes

[0108]

(Preparation of polyethylene terephthalate pellets (PET (I)))

As an esterification reactor, a continuous esterification reactor including a three-stage complete mixing tank including a stirrer, a partial condenser, a raw material charging port, and a product outlet was used. The amount of TPA (terephthalic acid) was set to 2 tons/hour, and the amount of EG (ethylene glycol) was set to 2 mol per 1 mol of TPA. The amount of antimony trioxide was set such that the amount of Sb atoms with respect to produced PET was set to 160 ppm. These slurries were continuously supplied to a first reaction can of the esterification reactor, and reacted at normal pressure at 255°C for an

average residence time of 4 hours. Next, the reaction product in the first esterification reaction can was continuously taken out of the system, and supplied to a second esterification reaction can. 8% by mass of EG distilled off from the first esterification reaction can with respect to produced PET was supplied into the second esterification reaction can. Furthermore, an EG solution containing magnesium acetate tetrahydrate set such that the amount of Mg atoms with respect to the produced PET was set to 65 ppm and an EG solution containing TMPA (trimethyl phosphate) set such that the amount of P atoms with respect to the produced PET was set to 40 ppm were added, and reacted at 260°C at normal pressure for an average residence time of 1 hour. Subsequently, the reaction product of the second esterification reaction can was continuously taken out of the system, and fed to a third esterification reaction can. 0.2% by mass of porous colloidal silica having an average particle diameter of 0.9 μm and subjected to a dispersion treatment with the average number of treatments of 5 passes under pressure of 39 MPa (400 kg/cm²) using a high pressure disperser (manufactured by Nippon Seiki Co., Ltd.), and 0.4% by mass of synthetic calcium carbonate having an average particle diameter of 0.6 μm and obtained by attaching 1% by mass of a polyacrylic acid ammonium salt per calcium carbonate were

added in the forms of 10% EG slurries, and reacted at 260°C at normal pressure for an average residence time of 0.5 hours. The esterification reaction product produced in the third esterification reaction can was continuously fed to a three-stage continuous polycondensation reaction apparatus to perform polycondensation, and the polycondensation product was filtered with a filter prepared by sintering stainless steel fibers having a 95% cut diameter of 20 μm, and then subjected to ultrafiltration. Then, the filtered product was extruded into water, cooled, and then cut into a chip shape to obtain PET chips having an intrinsic viscosity of 0.60 dl/g (hereinafter abbreviated as PET (I)). The content of the lubricant in the PET chip was 0.6% by mass.

[0109]

(Preparation of polyethylene terephthalate pellets (PET (II)))

Meanwhile, in the production of the PET (I) chip, a PET chip having an intrinsic viscosity of 0.62 dl/g and containing no particles made of calcium carbonate and silica and the like was obtained (hereinafter abbreviated as PET (II)).

[0110]

(Production of laminated film X1)

These PET chips were dried, then melted at 285°C,

melted at 290°C by a separate melt extruder, subjected to two-stage filtration of a filter obtained by sintering stainless steel fibers having a 95% cut diameter of 15 μm and a filter obtained by sintering stainless steel particles having a 95% cut diameter of 15 μm, and merged in a feed block. The PET (I) and the PET (II) were laminated such that the PET (I) was a surface layer B (opposite side layer to release surface) and the PET (II) was a surface layer A (release surface side layer), extruded (cast) into a sheet shape at a speed of 45 m/min, and electrostatically adhered and cooled on a casting drum at 30°C by an electrostatic adhesion method, to obtain an un-stretched polyethylene terephthalate sheet having an intrinsic viscosity of 0.59 dl/g. The layer ratio was adjusted such that PET (I)/PET (II)=60% by mass/40% by mass was set in the calculation of the discharge amount of each extruder. Then, this un-stretched sheet was heated with an infrared heater, and then stretched by 3.5 times in a machine direction at a roll temperature of 80°C according to the speed difference between rolls. Thereafter, the sheet was guided to a tenter, and stretched by 4.2 times in a transverse direction at 140°C. Then, a heat treatment was performed at 210°C in a heat fixation zone. Thereafter, a 2.3% relaxation treatment was performed at 170°C in a transverse direction to obtain a biaxially stretched

polyethylene terephthalate film X1 having a thickness of 31 μm . In the obtained film X1, Sa of the surface layer A was 1 nm, and Sa of the surface layer B was 28 nm.

[0111]

(Production of laminated film X2)

As a laminated film X2, E5101 (Toyobo Ester (registered trademark) film manufactured by Toyobo Co., Ltd.) having a thickness of 25 μm was used. In E5101, particles are contained in a surface layer A and a surface layer B. Sa of the surface layer A of the laminated film X2 was 24 nm, and Sa of the surface layer B was 24 nm.

[0112]

(Cationically curable polydimethylsiloxane (a))

(a)-1: UV Poly215 (manufactured by Arakawa Chemical Industries, solid content: 100%)

[0113]

(Cationally curable resin (b))

(b)-1: CELLOXIDE 2021P (manufactured by Daicel Corporation, solid content: 100%)

(b)-2: X-40-2670 (manufactured by Shin-Etsu Chemical Co., Ltd., solid content: 100%)

[0114]

(Acid generating agent (c))

(c)-1: CPI-101A (manufactured by San-Apro Ltd., solid content: 50%)

[0115]

(Example 1)

A release layer forming composition 1 having the following composition was passed through a filter capable of removing 99% or more of foreign matters of 0.5 μm or more, and then coated on a surface layer A of a laminated film X1 using reverse gravure so that the applied amount was 5.0 g/m². Thereafter, a processing speed was adjusted so that the laminated film X1 entered a first drying furnace after 0.5 seconds, and the laminated film X1 was continuously dried by heating at a first drying furnace temperature of 120°C and a second drying furnace temperature of 90°C. After the drying step, the laminated film X1 was irradiated with ultraviolet rays with an integrated light amount of 100 mJ/cm² on a cooling roll using an ultraviolet irradiator (manufactured by Heraeus, H valve) to cure a release layer, thereby obtaining a release film for forming a resin sheet. As a result of evaluating the smoothness, peelability, and pinholes of the obtained release film, good results were obtained as shown in Table 1.

As described above, the obtained release film for forming a resin sheet was, for example, a release film capable of producing a resin sheet having a thickness of 0.2 μm or more and 1.0 μm or less.

The weight (mg/m^2) of each of the components (a), (b), and (c) described in Table indicates a content ratio per solid content (the weight of each of the components with respect to the total weight of the release layer).

(Release layer forming composition 1)

Methyl ethyl ketone	24.000 parts by mass
---------------------	----------------------

(SP value (δ): 19.1, (δ_D): 16.0, (δ_P): 9.0, (δ_H): 5.1)

Toluene	24.000 parts by mass
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(SP value (δ): 18.2, (δ_D): 18.0, (δ_P): 1.4, (δ_H): 2.0)

Normal heptane	48.000 parts by mass
----------------	----------------------

(SP value (δ): 15.3, (δ_D): 15.3, (δ_P): 0.0, (δ_H): 0.0)

(a)-1	0.039 parts by mass
(b)-1	3.883 parts by mass
(c)-1	0.078 parts by mass

[0116]

(Examples 2 to 4)

Release films for forming a resin sheet were obtained in the same manner as in Example 1 except that the compositions and production methods of the release layers were changed to those shown in Table 1.

[0117]

(Example 5)

A release film for forming a resin sheet was obtained

in the same manner as in Example 1 except that a release layer forming composition 2 having the following composition was used.

(Release layer forming composition 2)

Methyl ethyl ketone	38.400 parts by mass
---------------------	----------------------

(SP value (δ): 19.1, (δ_D): 16.0, (δ_P): 9.0, (δ_H):

5.1)

Toluene	38.400 parts by mass
---------	----------------------

(SP value (δ): 18.2, (δ_D): 18.0, (δ_P): 1.4, (δ_H):

2.0)

Normal heptane	19.200 parts by mass
----------------	----------------------

(SP value (δ): 15.3, (δ_D): 15.3, (δ_P): 0.0, (δ_H):

0.0)

(a)-1	0.196 parts by mass
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(b)-1	3.726 parts by mass
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(c)-1	0.078 parts by mass
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[0118]

(Example 6)

A release film for forming a resin sheet was obtained in the same manner as in Example 2 except that normal heptane in a release layer forming composition was changed to cyclohexane (SP value (δ): 16.8, (δ_D): 16.8, (δ_P): 0.0, (δ_H): 0.2).

[0119]

(Examples 7 and 8)

Release films for forming a resin sheet were obtained in the same manner as in Example 2 except that the coating amounts and the solid content ratios were changed to those described in Table 1. At this time, an organic solvent ratio was adjusted so as to be the same as that of the release layer forming composition 1.

[0120]

(Example 9)

A release film for forming a resin sheet was obtained in the same manner as in Example 1 except that the release layer forming composition was changed to a release layer forming composition 3 having the following composition.

(Release layer forming composition 3)

Methyl ethyl ketone	24.000 parts by mass
(SP value (δ): 19.1, (δ_D): 16.0, (δ_P): 9.0, (δ_H):	
5.1)	
Toluene	24.000 parts by mass
(SP value (δ): 18.2, (δ_D): 18.0, (δ_P): 1.4, (δ_H):	
2.0)	
Normal heptane	48.000 parts by mass
(SP value (δ): 15.3, (δ_D): 15.3, (δ_P): 0.0, (δ_H):	
0.0)	
(a)-1	0.039 parts by mass
(b)-2	3.883 parts by mass
(c)-1	0.078 parts by mass

[0121]

(Examples 10 to 12)

Release films for forming a resin sheet were obtained in the same manner as in Example 1 except that the compositions and production methods of the release layers were changed to those shown in Table 1.

[0122]

(Example 13)

A release film for forming a resin sheet was obtained in the same manner as in Example 1 except that a release layer forming composition 4 having the following composition was used.

(Release layer forming composition 4)

Methyl ethyl ketone	38.400 parts by mass
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(SP value (δ): 19.1, (δ_D): 16.0, (δ_P): 9.0, (δ_H):

5.1)

Toluene	38.400 parts by mass
---------	----------------------

(SP value (δ): 18.2, (δ_D): 18.0, (δ_P): 1.4, (δ_H):

2.0)

Normal heptane	19.200 parts by mass
----------------	----------------------

(SP value (δ): 15.3, (δ_D): 15.3, (δ_P): 0.0, (δ_H):

0.0)

(a)-1	0.196 parts by mass
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(b)-2	3.726 parts by mass
-------	---------------------

(c)-1	0.078 parts by mass
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[0123]

(Example 14)

A release film for forming a resin sheet was obtained in the same manner as in Example 2 except that normal heptane in a release layer forming composition was changed to cyclohexane (SP value (δ): 16.8, (δ_D): 16.8, (δ_P): 0.0, (δ_H): 0.2).

[0124]

(Examples 15 and 16)

Release films for forming a resin sheet were obtained in the same manner as in Example 2 except that the coating amounts and the solid content ratios were changed to those described in Table 1. At this time, an organic solvent ratio was adjusted so as to be the same as that of the release layer forming composition 3.

[0125]

(Example 17)

A release film for forming an ultrathin resin sheet was obtained in the same manner as in Example 1 except that a release layer forming composition 5 having the following composition was used.

(Release layer forming composition 5)

Methyl ethyl ketone	24.950 parts by mass
---------------------	----------------------

(SP value (δ): 19.1, (δ_D): 16.0, (δ_P): 9.0, (δ_H):

5.1)

Toluene	24.950 parts by mass
(SP value δ): 18.2, (δ_D): 18.0, (δ_P): 1.4, (δ_H):	
2.0)	
Normal heptane	49.900 parts by mass
(SP value δ): 15.3, (δ_D): 15.3, (δ_P): 0.0, (δ_H):	
0.0)	
(a)-1	0.196 parts by mass
(c)-1	0.004 parts by mass

[0126]

(Example 18)

A release film for forming a resin sheet was obtained in the same manner as in Example 1 except that the solid content concentration was changed to that shown in Table 1, and the organic solvent ratio was adjusted so as to be the same as that of the release layer forming composition 5.

[0127]

(Example 19)

A release film for forming a resin sheet was obtained in the same manner as in Example 17 except that the production method was changed to that shown in Table 1.

[0128]

(Example 20)

A release film for forming an ultrathin resin sheet was obtained in the same manner as in Example 1 except that the release layer forming composition was changed to a

release layer forming composition 6.

(Release layer forming composition 6)

Methyl ethyl ketone 39.920 parts by mass

(SP value (δ): 19.1, (δ_D): 16.0, (δ_P): 9.0, (δ_H):

5.1)

Toluene 39.920 parts by mass

(SP value (δ): 19.1, (δ_D): 16.0, (δ_P): 9.0, (δ_H):

5.1)

Normal heptane 19.960 parts by mass

(SP value (δ): 15.3, (δ_D): 15.3, (δ_P): 0.0, (δ_H):

0.0)

(a)-1 0.196 parts by mass

(c)-1 0.004 parts by mass

[0129]

(Example 21)

A release film for forming a resin sheet was obtained in the same manner as in Example 1 except that normal heptane in a release layer forming composition 5 was changed to cyclohexane (SP value (δ): 16.8, (δ_D): 16.8, (δ_P): 0.0, (δ_H): 0.2).

[0130]

(Examples 22 and 23)

Release films for forming a resin sheet were obtained in the same manner as in Example 17 except that the coating amounts and the solid content ratios were changed to those

described in Table 1. At this time, organic solvent ratios were adjusted so as to be the same as that of the release layer forming composition 5.

[0131]

(Comparative Example 1)

A release film for forming an ultrathin resin sheet was obtained in the same manner as in Example 1 except that the release layer forming composition was changed to a release layer forming composition 7 having the following composition.

(Release layer forming composition 7)

Methyl ethyl ketone	24.000 parts by mass
---------------------	----------------------

(SP value (δ): 19.1, (δ_D): 16.0, (δ_P): 9.0, (δ_H):

5.1)

Toluene	24.000 parts by mass
---------	----------------------

(SP value (δ): 18.2, (δ_D): 18.0, (δ_P): 1.4, (δ_H):

2.0)

Normal heptane	48.000 parts by mass
----------------	----------------------

(SP value (δ): 15.3, (δ_D): 15.3, (δ_P): 0.0, (δ_H):

0.0)

(b)-1	3.922 parts by mass
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(c)-1	0.078 parts by mass
-------	---------------------

[0132]

(Comparative Example 2)

A release film for forming an ultrathin resin sheet

was obtained in the same manner as in Example 1 except that the release layer forming composition was changed to a release layer forming composition 8 having the following composition.

(Release layer forming composition 8)

Methyl ethyl ketone	24.000 parts by mass
---------------------	----------------------

(SP value (δ) : 19.1, (δ_D) : 16.0, (δ_P) : 9.0, (δ_H) :

5.1)

Toluene	24.000 parts by mass
---------	----------------------

(SP value (δ) : 18.2, (δ_D) : 18.0, (δ_P) : 1.4, (δ_H) :

2.0)

Normal heptane	48.000 parts by mass
----------------	----------------------

(SP value (δ) : 15.3, (δ_D) : 15.3, (δ_P) : 0.0, (δ_H) :

0.0)

(a)-1	2.941 parts by mass
-------	---------------------

(b)-2	0.981 parts by mass
-------	---------------------

(c)-1	0.078 parts by mass
-------	---------------------

[0133]

(Comparative Example 3)

A release film for forming a resin sheet was obtained in the same manner as in Example 1 except that the release layer forming composition was changed to a release layer forming composition 9 having the following composition.

(Release layer forming composition 9)

Methyl ethyl ketone	24.000 parts by mass
---------------------	----------------------

(SP value δ): 19.1, (δ_D): 16.0, (δ_P): 9.0, (δ_H):

5.1)

Toluene 24.000 parts by mass

(SP value δ): 18.2, (δ_D): 18.0, (δ_P): 1.4, (δ_H):

2.0)

Normal heptane 48.000 parts by mass

(SP value δ): 15.3, (δ_D): 15.3, (δ_P): 0.0, (δ_H):

0.0)

(a)-1 3.922 parts by mass

(c)-1 0.078 parts by mass

[0134]

(Comparative Example 4)

A release film for forming an ultrathin resin sheet was obtained in the same manner as in Example 10 except that the release layer forming composition was applied onto the laminated film X2.

[0135]

[Table 1A]

	Release film								
	Substrate film	Release layer						Thickness (μm)	Total weight of release layer (mg/m ²)
		(a) Cationically curable polydimethylsiloxane		(b) Cationically curable resin		(c) Acid generating agent			
		Type	Weight contained in release layer (mg/m ²)	Type	Weight contained in release layer (mg/m ²)	Type	Weight contained in release layer (mg/m ²)		
Example 1	X1	(a)-1	2.0	(b)-1	194	(c)-1	3.9	0.2	200
Example 2	X1	(a)-1	10	(b)-1	186	(c)-1	3.9	0.2	200
Example 3	X1	(a)-1	39	(b)-1	157	(c)-1	3.9	0.2	200
Example 4	X1	(a)-1	10	(b)-1	186	(c)-1	3.9	0.2	200
Example 5	X1	(a)-1	10	(b)-1	186	(c)-1	3.9	0.2	200
Example 6	X1	(a)-1	10	(b)-1	186	(c)-1	3.9	0.2	200
Example 7	X1	(a)-1	10	(b)-1	186	(c)-1	3.9	0.2	200
Example 8	X1	(a)-1	10	(b)-1	186	(c)-1	3.9	0.2	200
Example 9	X1	(a)-1	2.0	(b)-2	194	(c)-1	3.9	0.2	200
Example 10	X1	(a)-1	10	(b)-2	186	(c)-1	3.9	0.2	200

[0136]

[Table 1B]

	Release film								
	Substrate film	Release layer							Total weight of release layer (mg/m ²)
		(a) Cationically curable polydimethylsiloxane		(b) Cationically curable resin		(c) Acid generating agent		Thickness (μm)	
Type	Weight contained in release layer (mg/m ²)	Type	Weight contained in release layer (mg/m ²)	Type	Weight contained in release layer (mg/m ²)				
Example 11	X1	(a)-1	39	(b)-2	157	(c)-1	3.9	0.2	200
Example 12	X1	(a)-1	10	(b)-2	186	(c)-1	3.9	0.2	200
Example 13	X1	(a)-1	10	(b)-2	186	(c)-1	3.9	0.2	200
Example 14	X1	(a)-1	10	(b)-2	186	(c)-1	3.9	0.2	200
Example 15	X1	(a)-1	10	(b)-2	186	(c)-1	3.9	0.2	200
Example 16	X1	(a)-1	10	(b)-2	186	(c)-1	3.9	0.2	200
Example 17	X1	(a)-1	10	-	-	(c)-1	0.2	0.01	10
Example 18	X1	(a)-1	49	-	-	(c)-1	1.0	0.05	50
Example 19	X1	(a)-1	10	-	-	(c)-1	0.2	0.01	10
Example 20	X1	(a)-1	10	-	-	(c)-1	0.2	0.01	10

[0137]

[Table 1C]

	Release film								
	Substrate film	Release layer							Total weight of release layer (mg/m ²)
		(a) Cationically curable polydimethylsiloxane		(b) Cationically curable resin		(c) Acid generating agent		Thickness (μm)	
Type	Weight contained in release layer (mg/m ²)	Type	Weight contained in release layer (mg/m ²)	Type	Weight contained in release layer (mg/m ²)				
Example 21	X1	(a)-1	10	-	-	(c)-1	0.2	0.01	10
Example 22	X1	(a)-1	10	-	-	(c)-1	0.2	0.01	10
Example 23	X1	(a)-1	10	-	-	(c)-1	0.2	0.01	10
Comparative Example 1	X1	-	-	(b)-2	196	(c)-1	3.9	0.2	200
Comparative Example 2	X1	(a)-1	147	(b)-2	49	(c)-1	3.9	0.2	200
Comparative Example 3	X1	(a)-1	196	-	-	(c)-1	3.9	0.2	200
Comparative Example 4	X2	(a)-1	10	(b)-2	186	(c)-1	3.9	0.2	200

[0138]

[Table 2A]

	Production method							
	Coating						Drying	
	Release layer forming composition		Organic solvent having SP value (δ) of 14 to 17				First drying step	Second drying step
	Applied amount (g/m ²)	Solid content (% by mass)	Type	Solvent ratio	SP value (δ)	Content ratio in release layer forming composition %	T1 (°C)	T2 (°C)
Example 1	5	4.0	Heptane	50	15.3	48	120	90
Example 2	5	4.0	Heptane	50	15.3	48	120	90
Example 3	5	4.0	Heptane	50	15.3	48	120	90
Example 4	5	4.0	Heptane	50	15.3	48	100	90
Example 5	5	4.0	Heptane	20	15.3	19	120	90
Example 6	5	4.0	Cyclohexane	50	16.8	48	120	90
Example 7	8	2.5	Heptane	50	15.3	49	120	90
Example 8	3	6.7	Heptane	50	15.3	47	120	90
Example 9	5	4.0	Heptane	50	15.3	48	120	90
Example 10	5	4.0	Heptane	50	15.3	48	120	90

	Release film						
	Smoothness				Peelability		Pinhole
	Sa (nm)	Sp (nm)	Number of protrusions having height of 10 nm or more /1 mm ²	Total value of number of protrusions having height of 5 nm or more and less than 10 nm and number of protrusions having height of 10 nm or more /1 mm ²	Peeling force of ceramic sheet (mN/mm)	Evaluation	
Example 1	0.7	10	38	308	0.7	○	○
Example 2	0.7	14	38	769	0.4	○	○
Example 3	1.4	19	77	1154	0.4	○	○
Example 4	0.9	14	115	885	0.4	○	○
Example 5	0.9	17	77	769	0.4	○	○
Example 6	1	14	115	769	0.4	○	○
Example 7	1.2	15	77	1154	0.4	○	○
Example 8	0.7	10	38	385	0.4	○	○
Example 9	0.7	10	38	308	0.7	○	○
Example 10	0.7	14	38	769	0.4	○	○

[0139]

[Table 2B]

	Production method							
	Coating						Drying	
	Release layer forming composition		Organic solvent having SP value (δ) of 14 to 17				First drying step	Second drying step
	Applied amount (g/m ²)	Solid content (% by mass)	Type	Solvent ratio	SP value (δ)	Content ratio in release layer forming composition %	T1 (°C)	T2 (°C)
Example 11	5	4.0	Heptane	50	15.3	48	120	90
Example 12	5	4.0	Heptane	50	15.3	48	100	90
Example 13	5	4.0	Heptane	20	15.3	19	120	90
Example 14	5	4.0	Cyclohexane	50	16.8	48	120	90
Example 15	8	2.5	Heptane	50	15.3	49	120	90
Example 16	3	6.7	Heptane	50	15.3	47	120	90
Example 17	5	0.2	Heptane	50	15.3	50	120	90
Example 18	5	1.0	Heptane	50	15.3	50	120	90
Example 19	5	0.2	Heptane	50	15.3	50	100	90
Example 20	5	0.2	Heptane	20	15.3	20	120	90

	Release film						
	Smoothness				Peelability		Pinhole
	Sa (nm)	Sp (nm)	Number of protrusions having height of 10 nm or more /1 mm ²	Total value of number of protrusions having height of 5 nm or more and less than 10 nm and number of protrusions having height of 10 nm or more /1 mm ²	Peeling force of ceramic sheet (mN/mm)	Evaluation	
Example 11	1.4	19	77	1154	0.4	○	○
Example 12	0.9	14	115	885	0.4	○	○
Example 13	0.8	14	77	769	0.4	○	○
Example 14	1	14	77	769	0.4	○	○
Example 15	1.2	15	77	1154	0.4	○	○
Example 16	0.7	10	77	385	0.4	○	○
Example 17	1.1	16	77	962	0.4	○	○
Example 18	1.4	19	192	1269	0.4	○	○
Example 19	1.1	16	154	1154	0.4	○	○
Example 20	1.2	16	115	981	0.4	○	○

[0140]

[Table 2C]

	Production method							
	Coating						Drying	
	Release layer forming composition		Organic solvent having SP value (δ) of 14 to 17				First drying step	Second drying step
	Applied amount (g/m ²)	Solid content (% by mass)	Type	Solvent ratio	SP value (δ)	Content ratio in release layer forming composition %	T1 (°C)	T2 (°C)
Example 21	5	0.2	Cyclohexane	50	16.8	50	120	90
Example 22	8	0.1	Heptane	50	15.3	50	120	90
Example 23	3	0.3	Heptane	50	15.3	50	120	90
Comparative Example 1	5	4.0	Heptane	50	15.3	48	120	90
Comparative Example 2	5	4.0	Heptane	50	15.3	48	120	90
Comparative Example 3	5	4.0	Heptane	50	15.3	48	120	90
Comparative Example 4	5	4.0	Heptane	50	15.3	48	120	90

	Release film						
	Smoothness				Peelability		Pinhole
	Sa (nm)	Sp (nm)	Number of protrusions having height of 10 nm or more /1 mm ²	Total value of number of protrusions having height of 5 nm or more and less than 10 nm and number of protrusions having height of 10 nm or more /1 mm ²	Peeling force of ceramic sheet (mN/mm)	Evaluation	
Example 21	1.1	16	77	962	0.4	○	○
Example 22	1.3	15	115	1154	0.4	○	○
Example 23	1.1	10	77	385	0.4	○	○
Comparative Example 1	0.8	10	38	308	Unpeelable	×	×
Comparative Example 2	4	80	3846	9615	2.1	×	×
Comparative Example 3	3	45	962	3077	0.4	○	×
Comparative Example 4	16	860	20000	38462	0.4	○	×

[0141]

Comparative Example 1 did not contain the cationically curable polydimethylsiloxane (a), and therefore the peeling force of the ceramic sheet was large, and peeling was impossible. In Comparative Examples 2 to 4, the number of protrusions having a height of 10 nm or

more was more than 200 protrusions/mm², and pinholes occurred in the green sheet which was an object to be released. Furthermore, in Comparative Example 4, the inorganic particles were present in the entire substrate, the smoothness of the release film was significantly poor, and the breakage and pinholes and the like of the green sheet occurred.

INDUSTRIAL APPLICABILITY

[0142]

According to the present invention, the smoothness and peelability of the release layer are enhanced, and therefore the resin sheet can be produced without possibility of causing failures by providing the release film capable of forming the resin sheet having few defects even in an ultrathin layer article having a thickness of 1 μm or less.

CLAIMS

1. A release film for forming a resin sheet,
comprising a polyester film as a substrate and a release
layer,

wherein the polyester film includes a surface layer A
substantially containing no inorganic particles,

the release layer is provided on the surface layer A,

the release layer is a layer obtained by curing a
release layer forming composition,

the release layer forming composition contains a
cationically curable polydimethylsiloxane (a),

the release layer has an area surface roughness (Sa)
of 2 nm or less, and

the number of protrusions having a height of 10 nm or
more present on a surface of the release layer is 200
protrusions/mm² or less.

2. The release film for forming a resin sheet
according to claim 1, wherein the release layer has a
maximum protrusion height (Sp) of 20 nm or less, and a
total of the number of protrusions having a height of 5 nm
or more and less than 10 nm and the number of protrusions
having a height of 10 nm or more present on the surface of
the release layer is 1500 protrusions/mm² or less.

3. The release film for forming a resin sheet according to claim 1 or 2, wherein the cationically curable polydimethylsiloxane (a) has at least one functional group selected from a vinyl ether group, an oxetanyl group, an epoxy group, and an alicyclic epoxy group.

4. The release film for forming a resin sheet according to any one of claims 1 to 3, wherein a content of the cationically curable polydimethylsiloxane (a) contained in the release layer is 90 mg/m² or less.

5. The release film for forming a resin sheet according to any one of claims 1 to 4, wherein

the release layer forming composition further contains a cationically curable compound (b-1) having no silicone skeleton,

the cationically curable compound (b-1) has two or more alicyclic epoxy groups in the molecule, and

a content of the cationically curable compound (b-1) is 80% by mass or more based on a total of 100 parts by mass of the cationically curable polydimethylsiloxane (a) and the cationically curable compound (b-1).

6. The release film for forming a resin sheet

according to any one of claims 1 to 5, wherein

the release layer forming composition further contains a cyclic siloxane compound (b-2) having an alicyclic epoxy group,

the cyclic siloxane compound (b-2) has two or more alicyclic epoxy groups in the molecule, and

a content of the cyclic siloxane compound (b-2) is 80% by mass or more based on a total of 100 parts by mass of the cationically curable polydimethylsiloxane (a) and the cyclic siloxane compound (b-2).

7. The release film for forming a resin sheet according to any one of claims 1 to 6, wherein

the release layer forming composition contains an organic solvent having an SP value (δ) of 14 or more and 17 or less, and

the release layer forming composition contains the organic solvent having an SP value (δ) of 14 or more and 17 or less in an amount of 10% by mass or more based on 100 parts by mass of a total weight of the release layer forming composition.

8. The release film for forming a resin sheet according to any one of claims 1 to 7, wherein the release film is a release film for producing a resin sheet

containing an inorganic compound.

9. The release film for forming a resin sheet according to claim 8, wherein the resin sheet containing an inorganic compound is a ceramic green sheet.

10. The release film for forming a resin sheet according to any one of claims 1 to 9, wherein the release film is a release film for forming a resin sheet having a thickness of 0.2 μm or more and 1.0 μm or less.