

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 coating 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 the ceramic green sheet is formed on the surface of the release layer of the polyester film substrate, peelability at the time of peeling off the ceramic green sheet from the release film is important. When the peeling force is large and nonuniform, damage is applied to the ceramic green sheet in a 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 off the ceramic green sheet with a lower uniform force.

[0005]

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 peelability required for the release films is further

increasing.

[0006]

Examples of the release film excellent in peelability include those described 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.

[0007]

However, the release film of Patent Document 1 uses the radically curable resin, and therefore when the release layer is processed in the atmosphere, there is a problem that the release layer is affected by oxygen inhibition, resulting in poor curing in the surface of the release layer. When poor curing occurs in the surface of the release layer, the release layer is eroded by an organic solvent during ceramic green sheet processing or internal electrode printing, so that an increase in a peeling force and uniformity of peeling are impaired, and therefore the ceramic green sheet may be damaged during peeling.

[0008]

In order to solve the above problems, Patent Document 2 proposes a release layer using a cationically curable resin as a main component. The cationically curable resin does not cause oxygen inhibition, and therefore poor curing does not occur even when the release layer is processed in

the atmosphere, and a release film excellent in peelability can be obtained.

PRIOR ART DOCUMENTS

PATENT DOCUMENTS

[0009]

Patent Document 1: WO 2013/145864 A

Patent Document 2: WO 2018/079337 A

SUMMARY OF THE INVENTION

PROBLEMS TO BE SOLVED BY THE INVENTION

[0010]

However, the cationically curable resin used in the release film of Patent Document 2 has a slower reaction rate than that of the radically curable resin, and therefore the reaction is not completed only by irradiation with active energy rays, and the polymerization reaction tends to proceed with time.

Therefore, when a release film using a cationically curable resin is produced, a release layer forming composition is applied to one surface of a substrate film, dried, and then irradiated with active energy rays to cure the release layer forming composition, and the cationic polymerization reaction is then completed in a state where the cured product is wound into a roll and stored, and

therefore a release layer excellent in peelability can be formed.

Furthermore, immediately after being wound into a roll and stored, the polymerization reaction may not be completed, which may affect the surface shape of the release layer. Therefore, it is desirable that defects in the surface shape of the release layer can be further reduced.

[0011]

The cationically curable resin tends to cause poor curing due to the influence of water. When the release film is processed, in order to wind and store the release film into a roll, the release film is stored in a state where the release layer and the anti-release surface of the substrate film are in contact with each other. Therefore, there is a problem that the temporal reaction of the cationically curable resin is inhibited due to the influence of moisture that is considered to be present in a trace amount on the anti-release surface side of the substrate film, and the curing of the release layer becomes insufficient.

[0012]

Such an influence of the poor curing of the release layer due to the influence of the anti-release surface side of the release film becomes more remarkable as the

thickness of the ceramic green sheet is reduced, and a release film more excellent in peelability is required.

[0013]

The present invention has been devised in view of the problems of the conventional techniques. That is, an object of the present invention is to provide a release film suppressing the occurrence of poor curing of a release layer containing a cationically curable resin as a main component and excellent in peelability.

[0014]

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.

MEANS FOR SOLVING THE PROBLEMS

[0015]

That is, the present invention has the following configurations.

[1] A release film for forming a resin sheet, the release film including:

a substrate film; and

a release layer provided on one surface of the substrate film,

wherein the release film includes a hydrophobic layer on a surface of the substrate film on a side opposite to the release layer,

the release layer is a layer formed of a cured product of a composition containing a cationically curable polydimethylsiloxane (a),

a water contact angle of the hydrophobic layer is 90° or more and 130° or less, and

a normal peeling force (I) and a post-heating peeling force (II) of the release layer measured in the release film obtained by winding the release film once into a roll and then unwinding the roll satisfy the following relationship: $(II)/(I) = 1.00$ or more and 1.50 or less.

[2] In one aspect, the normal peeling force (I) of the release layer in the unwound release film is $1500 \text{ mN}/50 \text{ mm}$ or less.

[3] In one aspect, an electric charge amount is less than $\pm 1 \text{ kV}$ when a release film roll obtained by winding the release film into a roll is unwound at 100 m/min .

[4] In one aspect, the hydrophobic layer is a layer formed of a cured product of a composition containing a cationically curable polydimethylsiloxane (a).

[5] In one aspect, the hydrophobic layer has a thickness of $0.001 \text{ }\mu\text{m}$ or more and $0.5 \text{ }\mu\text{m}$ or less.

[6] In one aspect, the release layer and the

hydrophobic layer are substantially free of particles having a particle size of 1.0 μm or more.

[7] In one aspect, the substrate film is a polyester film including a surface layer A substantially free of inorganic particles having a particle size of 1.0 μm or more and a surface layer B containing particles, the release layer is laminated on the surface layer A, and the hydrophobic layer is laminated on the surface layer B.

[8] In one aspect, the release film for forming a resin sheet contains an inorganic compound.

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

[10] In one aspect, the release film for forming a resin sheet has a thickness of 0.2 μm or more and 1.0 μm or less.

[11] In one aspect, a method for producing a ceramic green sheet, the method including forming the ceramic green sheet using the release film for producing the ceramic green sheet, wherein the formed ceramic green sheet has a thickness of 0.2 μm to 1.0 μm .

EFFECT OF THE INVENTION

[0016]

A release film for forming a resin sheet of the present invention includes a release layer on one surface

of a substrate film, and a hydrophobic layer is provided on a surface of the substrate film on a side opposite to the release layer (anti-release surface), and therefore it is possible to provide a release film capable of suppressing the occurrence of the curing inhibition of the release layer and capable of peeling off a thin resin sheet, particularly a ceramic green sheet, without defects.

MODE FOR CARRYING OUT THE INVENTION

[0017]

Hereinafter, the present invention will be described in detail.

[0018]

The present invention is a release film for forming a resin sheet, including: a substrate film; a release layer provided on one surface of the substrate film; and a hydrophobic layer on a surface (anti-release surface) of the substrate film on a side opposite to the release layer. By providing the hydrophobic layer on the anti-release surface of the substrate film, the release layer and the hydrophobic layer are in contact with each other when the release film is stored in a roll, and therefore there is no possibility that the poor curing of the release layer occurs, and a release film excellent in peelability can be obtained.

Furthermore, the occurrence of the poor curing of the release layer can be suppressed, and therefore it is possible to reduce deterioration in the smoothness of the release surface due to the influence of the unevenness of the anti-release surface in contact with the release surface, for example, when the release film is stored in a roll. Therefore, it is possible to further reduce defects in the surface shape of the release layer that may occur from the production to use of the release film.

[0019]

The release layer is preferably a cured product of a composition containing a cationically curable polydimethylsiloxane (a), which is less likely to cause poor curing due to oxygen inhibition. By using the cationically curable polydimethylsiloxane (a), when a release film is produced in the atmosphere, curing can stably proceed without causing curing inhibition, and a release film excellent in peelability can be obtained.

[0020]

The hydrophobic layer is preferably a cured product of a composition containing a cationically curable polydimethylsiloxane (a). In one aspect, the cationically curable polydimethylsiloxane (a) may have the same composition as or a different composition from that of the cationically curable polydimethylsiloxane (a) contained in

the release layer. The cationically curable polydimethylsiloxane (a) preferably has the same composition as that of the cationically curable polydimethylsiloxane (a) contained in the release layer. In the present specification, when the curable polydimethylsiloxane (a) having the same composition is contained, the molecular weight and the blending amount and the like of the curable polydimethylsiloxane (a) may be appropriately adjusted when the curable polydimethylsiloxane (a) is used in the hydrophobic layer.

By using the cationically curable polydimethylsiloxane (a), an electric charge row becomes closer with that of the release layer in contact when stored in a roll state, and electric charge is suppressed, and therefore the ceramic green sheet can be peeled off without defects with a low force without peeling electric charge. The anti-release surface is hydrophobized, and therefore the influence of moisture on the anti-release surface can be suppressed when stored in a roll state, and the poor curing of the release layer can also be prevented.

The curable polydimethylsiloxane (a) will be described in detail later.

[0021]

(Polyester film)

Polyester constituting a polyester film to be used as

the substrate film (hereinafter, sometimes referred to as a substrate) in the present invention is not particularly limited, and it is possible to use a film formed product of polyester generally used as a substrate for a release film. The polyester is preferably crystalline linear saturated polyester composed of an aromatic dibasic acid component and a diol component, and for example, polyethylene terephthalate, polyethylene-2,6-naphthalate, polybutylene terephthalate, polytrimethylene terephthalate, or a copolymer containing constituent components of these resins as main components is more suitable. In particular, polyester films formed from polyethylene terephthalate are particularly suitable. In polyethylene terephthalate, the content of repeating units of ethylene terephthalate is preferably 90 mol% or more, more preferably 95 mol% or more, and other dicarboxylic acid components and diol components may be copolymerized in small amounts. For example, from the viewpoint of cost, a polymer produced from only terephthalic acid and ethylene glycol is preferable. Known additives such as an antioxidant, a light stabilizer, an ultraviolet absorber, and a crystallization agent may be added as long as the effect of the release film of the present invention is not impaired. The polyester film is preferably a biaxially oriented polyester film because of its elastic modulus in both directions, and the like.

[0022]

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 step, 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 described means a polyester film including a surface layer A and a surface layer B (in which the surface layer A and the surface layer B are laminated).

[0023]

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 biaxially stretching the un-stretched film. A biaxially stretched

film can be obtained by a method in which a film uniaxially stretched in a machine direction or a transverse direction is sequentially stretched biaxially in the transverse direction or the machine direction, or a method in which an un-stretched film is simultaneously stretched biaxially in the machine direction and the transverse direction.

[0024]

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.

[0025]

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, there is no risk of deformation due to heat during film production, processing steps, and molding, 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.

[0026]

The polyester film substrate may have a single layer

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

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

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

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

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

[0027]

Here, in the present invention, the phrase "substantially free of inorganic particles" means, for example, in the case of inorganic particles of less than 1.0 μm , a content that is 50 ppm or less, preferably 10 ppm or less, and most preferably equal to or less than the detection limit when an inorganic element is quantified by fluorescent X-ray analysis. This is because, even if the particles are not positively added into the film, contamination components derived from foreign matters, and dirt attached to raw material resins, or lines or devices in film producing steps may be peeled off and mixed into the film. The phrase "substantially free of particles having a particle size of 1.0 μm or more" means that particles having a particle size of 1.0 μm or more are not actively contained.

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

As the laminated configuration, when the layer on the side to which the release layer is applied is a layer A, the layer on the opposite surface thereof is a layer B, and the core layer other than these is a layer C, the layer configuration in the thickness direction may be a laminated structure such as release layer/A/B or release layer/A/C/B. As a matter of course, the layer C may have a plurality of layer configurations. The surface layer B may contain no inorganic particles. In that case, a coating layer containing at least inorganic particles and a binder is preferably provided on the surface layer B in order to impart slipperiness for winding the film into a roll.

[0028]

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

At this time, the average area surface roughness (S_a) of the film of the surface layer B is preferably within a

range of 1 to 40 nm. More preferably, it is within a range of 5 to 35 nm. When the total content of the silica particles and/or the calcium carbonate particles is 5000 ppm or more, and the Sa is 1 nm or more, air can be uniformly released when the film is wound into a roll, and the film has a good winding appearance and good flatness, so that the film is suitable for the production of an ultrathin ceramic green sheet. In addition, when the total content of the silica particles and/or the calcium carbonate particles is 15000 ppm or less and the Sa is 40 nm or less, the aggregation of the lubricant is less likely to occur, and coarse protrusions are not formed, so that the quality is stable during the production of the ultrathin ceramic green sheet, which is preferable.

[0029]

As the particles contained in the layer B, inert inorganic particles other than silica and/or calcium carbonate particles and/or heat-resistant organic particles can be used, but silica particles and/or calcium carbonate particles are more preferably used from the viewpoint of transparency and cost. Other examples of the inorganic particles that can be used include alumina-silica composite oxide particles and hydroxyapatite particles. Examples of the heat-resistant organic particles include crosslinked polyacrylic particles, crosslinked polystyrene particles,

and benzoguanamine-based particles. When silica particles are used, porous colloidal silica is preferable, whereas when calcium carbonate particles are used, light calcium carbonate surface-treated with a polyacrylic acid-based polymeric compound is preferable from the viewpoint of preventing the lubricant from falling off.

[0030]

The average particle diameter of the inorganic particles to be added to the surface layer B is preferably 0.1 μm or more and 2.0 μm or less, and particularly preferably 0.5 μm or more and 1.0 μm or less. When the average particle diameter of the inorganic particles is 0.1 μm or more, the slipperiness of the release film is good, which is preferable. When the average particle diameter is 2.0 μm or less, there is no possibility of adversely affecting the smoothness of the surface of the release layer, and therefore there is no possibility of generating pinholes in the ceramic green sheet, which is preferable.

[0031]

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

[0032]

The thickness ratio of the surface layer A, which is a layer on which the release layer is provided, is preferably 20% or more and 50% or less of the total thickness of all the layers of the substrate film. 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 easily satisfies the above range, which is preferable. When the thickness ratio of the surface layer A is 50% or less of the total thickness of all the layers of the substrate film, the use ratio of a recycled raw material in the surface layer B can be increased, so that the environmental load is reduced, which is preferable.

[0033]

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

[0034]

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

[0035]

(Release layer)

In the present invention, the release layer is formed on one surface of the substrate film. It is preferable that when the substrate film including the surface layer A substantially free of inorganic particles is used, the release layer is formed on the surface layer A. By providing the release layer on the surface layer A substantially free of inorganic particles, a release layer surface excellent in smoothness can be realized, and the deformation and defects of the resin sheet provided on the release layer can be suppressed, which is preferable.

[0036]

The release layer is a release layer that is a cured product of a composition containing a cationically curable polydimethylsiloxane (a). When the release layer has such characteristics, poor curing 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.

The cationically curable polydimethylsiloxane is cured by active energy rays, and therefore does not require high heat of 130°C or higher for the curing reaction. Therefore, the flatness of the release film can be suppressed from being impaired by heat during processing. As a result, 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 normal peeling force (I) and the post-heating peeling force (II) of the release layer in the release film of the present invention satisfy the following

relationship: $(II)/(I) = 1.00$ or more and 1.50 or less.

When the ratio between the normal peeling force (I) and the post-heating peeling force (II) of the release layer according to the present invention has a predetermined condition, for example, the degree of curing of the release layer can be evaluated.

The release film may be heated when a resin sheet represented by a ceramic green sheet is formed on the release film or peeled off.

When the normal peeling force (I) and the post-heating peeling force (II) in the present invention are within predetermined ranges, it is possible to exhibit stable retention and peelability of the ceramic green sheet before and after heating.

For example, although it should not be construed as being limited to a specific theory, stable peelability can be exhibited as long as there is no difference between the normal peeling force (I) and the post-heating peeling force (II), or the difference is within the scope of the present invention. The ratio between the normal peeling force (I) and the post-heating peeling force (II), $(II)/(I)$, is 1.00 or more and 1.50 or less, and more preferably 1.00 or more and 1.45 or less. For example, the ratio may be 1.00 or more and 1.40 or less. For example, the ratio may be 1.05 or more or 1.10 or more.

When the ratio (II)/(I) between the normal peeling force (I) and the post-heating peeling force (II) is 1.50 or less, it means that the curing of the release layer sufficiently proceeds and the amount of unreacted substances is small, and the release layer is excellent in peelability to a resin sheet such as a ceramic green sheet, which is preferable. In general, the post-heating peeling force is higher than the normal peeling force, and therefore the ratio is preferably 1.00 or more. The evaluation method will be described in detail later.

In the present invention, the proceeding degree of the polymerization reaction of the release layer that proceeds with time can be indirectly evaluated by measuring the normal peeling force (I) and the post-heating peeling force (II) of the release layer measured in the release film obtained by winding the release film for forming a resin sheet once into a roll and then unwinding the roll. It is possible to evaluate the peeling force in consideration of the influence of the flatness of the release layer caused by storage in a roll state.

By providing the hydrophobic layer and then storing the release film in a roll, the reaction of the release layer can further proceed, the release layer can be obtained in a state where the release force is stabilized and an excellent surface shape is retained, and a release

film excellent in the release force after heating is obtained.

[0038]

When the ratio (II)/(I) between the normal peeling force (I) and the post-heating peeling force (II) is 1.50 or less and 1.00 or more, it is possible to more favorably reduce the influence on the surface shape of the release layer than the conventional release film and retain high smoothness when the release film is wound into a roll and stored. It means that the curing of the release layer sufficiently proceeds, and therefore blocking hardly occurs in the roll state, and the unwinding electric charge amount can also be suppressed.

[0039]

For example, the release layer is substantially free of particles having a particle size of 1.0 μm or more. In this aspect, particles having a particle size of less than 1.0 μm and 1 nm or more may be present in the release layer. The release layer is substantially free of inorganic particles having a particle size of 1.0 μm or more, and therefore the occurrence of pinholes in an ultrathin resin sheet required to have high smoothness, for example, a ceramic green sheet can be suppressed, and a resin sheet having a uniform film thickness can be formed.

In one aspect, the release layer preferably has high

smoothness, and therefore it is preferable to provide the release layer according to the present invention on a substrate film including a surface layer A substantially free of inorganic particles, specifically, substantially free of particles having a particle size of less than 1.0 μm , and preferably substantially free of particles.

For example, in a preferable aspect, the release layer substantially free of particles having a particle size of less than 1.0 μm is substantially free of particles having a particle size of 1.0 μm or more.

When the release layer is provided on the surface layer A substantially free of inorganic particles, the area surface roughness S_a of the release layer is 7 nm or less, and the maximum protrusion height thereof is 50 nm or less.

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

[0040]

It is preferable that the average area surface roughness (S_a) of the release layer is 7 nm or less and the maximum protrusion height (S_p) is 50 nm or less. The surface of the film on which the release layer is formed has the average area surface roughness and the maximum

protrusion height so as not to cause defects in the ceramic green sheet applied and formed thereon. When the area surface roughness is 7 nm or less and the maximum protrusion height is 50 nm or less, defects such as pinholes do not occur during the formation of the ceramic green sheet, and the yield is good, which is preferable.

Furthermore, the release film of the present invention includes the release layer according to the present invention and the hydrophobic layer, and therefore the release film is excellent in peelability with respect to the resin sheet. Furthermore, it is possible to suppress the occurrence of pinholes, wrinkles, and deviation when winding and storing the resin sheet. In addition, the present invention makes it possible to suppress an increase in unwinding electric charge. As described above, in the release film of the present invention, not only the resin sheet can be favorably produced due to high smoothness and excellent peelability, but also handling properties at the time of winding and conveying the film can be improved, and the contamination of foreign matters can be reduced by suppressing unwinding electric charge.

[0041]

In one aspect, the release layer has an average area surface roughness (Sa) of 5 nm or less and a maximum

protrusion height (S_p) of 30 nm or less. The maximum protrusion height is preferably lower. The average area surface roughness (S_a) is preferably as small as possible, and may be 0.1 nm or more or 0.3 nm or more. The average area surface roughness (S_a) may be 3 nm or less, and may be, for example, less than 2 nm.

The maximum protrusion height (S_p) is also preferably as small as possible, and may be 1 nm or more or 3 nm or more. The maximum protrusion height (S_p) may be 25 nm or less or 20 nm or less.

[0042]

The release layer is preferably a cured product of a composition containing at least a cationically curable polydimethylsiloxane (a). 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 cationic 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 excellent in solvent resistance and excellent in peelability is obtained, which is preferable.

[0043]

The viscosity of the cationically curable polydimethylsiloxane (a) is preferably 100 mPa·s or more and 10,000 mPa·s or less, more preferably 100 mPa·s or more and 5000 mPa·s or less, and still more preferably 100 mPa·s or more and 1000 mPa·s or less. When the viscosity is 100 mPa·s or more, the amount of unreacted components after storage in a roll state is reduced, and therefore a sufficiently cured release layer is obtained, which is preferable. When the viscosity is 10,000 mPa·s or less, the cationically curable polydimethylsiloxane (a) exhibits solubility in an organic solvent contained in a release layer forming composition and can be uniformly applied, which is preferable. The viscosity in the present invention is a value measured in an atmosphere at 25°C.

[0044]

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.

[0045]

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 9440E and UV 9430 manufactured by Momentive Performance Materials.

[0046]

The release layer forming composition of the present invention may contain another resin in addition to the cationically curable polydimethylsiloxane (a). When the

release layer is provided on the surface layer A of the substrate film substantially free of inorganic particles, the release layer is preferably a release layer obtained by curing the cationically curable polydimethylsiloxane (a) as a main component. In this case, even if the film thickness of the release layer is small, a release layer having extremely high smoothness can be obtained, which is preferable. 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.

[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 peelability, 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 at least 50 parts by mass, for example, more than 50 parts by mass, preferably 70 parts by mass or more, for example, 80 parts by mass or more, with respect to 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) having no silicone skeleton 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.

[0049]

In one aspect, the release layer forming composition further contains the cationically curable resin (b) having no silicone skeleton in addition to the cationically curable polydimethylsiloxane (a). Examples of the cationically curable compound (b) 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) 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 resin (b), 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 active energy 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) 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 in 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) 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) 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 is excellent in 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 resin (b) 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]

In an aspect in which the release layer contains the cationically curable resin (b) having no silicone skeleton,

the content of the cationically curable resin (b) having no silicone skeleton may be more than 50 parts by mass, and is preferably 80% by mass or more, more preferably 85% by mass or more, and still more preferably 90% by mass or more, with respect to 100 parts by mass of the total of the cationically curable polydimethylsiloxane (a) and the cationically curable resin (b) in the release layer.

When the content of the cationically curable resin (b) is more than 50 parts by mass, for example, 80% by mass or more, and the cationically curable resin (b) is contained as a main component in the release layer, a release layer having a high crosslinking density and is excellent in peelability is obtained, which is preferable. The content of the cationically curable polydimethylsiloxane (a) contained in the release layer can be reduced, and 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 resin (b) is larger, a release layer more excellent in 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 resin (b) 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 resin (b) having no silicone skeleton is present. In the present specification, the compound derived from the component (b) present in the release layer may also be simply described as the cationically curable resin (b) having no silicone skeleton.

[0054]

When the release layer forming composition contains the cationically curable polydimethylsiloxane (a) and the cationically curable resin (b), the release layer has a high crosslinking density, is excellent in solvent resistance, and is excellent in a peeling force, which is preferable. When the release layer forming composition contains the cationically curable resin (b), 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), the film thickness of the release layer is preferably 0.01 μm or more and 1.0 μm or less, and more preferably 0.05 μm or more and 0.5 μm or less. When the film thickness is 0.01 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 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.

[0057]

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.

[0058]

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.

[0059]

The added amount of the photo acid generating agent is 0.1 to 10% by mass, and more preferably 0.5 to 8% by mass, with respect to 100 parts by mass of the total of the cationically curable polydimethylsiloxane (a) and the cationically curable resin (b) 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.

[0060]

In the present specification, a total of 100 parts by mass of the cationically curable polydimethylsiloxane (a) and the cationically curable resin (b) 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.

[0061]

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, but it is preferable that the release layer does not contain particles. Since the release layer does not contain particles, it is possible to suppress deterioration in the smoothness of the surface of the release layer and the mixing of the particles into the resin sheet due to the falling of the particles. In order to improve the adhesion to the substrate, the surface of the polyester film can also be subjected to a pretreatment such as anchor coating, a corona treatment, a plasma treatment, or an atmospheric pressure plasma treatment before providing the release coating layer.

[0062]

(Hydrophobic layer)

The hydrophobic layer is formed on the surface of the substrate film on a side opposite to the surface provided with the release layer. When the release layer is provided on the surface layer A that is substantially free of inorganic particles or may have an extremely small amount

of particles, the hydrophobic layer is formed on the surface layer B on the other surface of the substrate film.

For example, the hydrophobic layer is substantially free of particles having a particle size of 1.0 μm or more. In this aspect, particles having a particle size of less than 1.0 μm and 1 nm or more may be present in the hydrophobic layer. The release layer is substantially free of inorganic particles having a particle size of 1.0 μm or more, and therefore there is no possibility of causing deformation (defect) to the resin sheet due to the influence of the particles present in the anti-release surface (hydrophobic layer) when the release film is wound into a roll, which is preferable.

The hydrophobic layer is preferably substantially free of particles having a particle size of less than 1.0 μm , and preferably contains no particles. The hydrophobic layer is substantially free of particles having a particle size of less than 1.0 μm , and therefore there is no possibility that the resin sheet is deformed due to the transfer of the particle shape in the hydrophobic layer when the release film is stored in a roll after the resin sheet is formed on the release film, which is preferable. There is no possibility that the particles in the hydrophobic layer fall off and are mixed into the resin sheet, which is preferable. In particular, the hydrophobic

layer is substantially free of particles, and therefore the above effect can be more favorably exhibited.

For example, in a preferable aspect, the surface layer A substantially free of particles having a particle size of less than 1.0 μm is substantially free of particles having a particle size of 1.0 μm or more. Such an aspect is the same as an aspect being substantially free of particles.

[0063]

The hydrophobic layer is preferably a cured product of a composition containing a cationically curable polydimethylsiloxane (a). When the hydrophobic layer has such a characteristic, the release layer and the hydrophobic layer are in contact with each other when the release film is wound into a roll and stored, and therefore the reaction proceeds without the release layer being affected by curing inhibition due to moisture, which is preferable. The release layer also contains the cationically curable polydimethylsiloxane (a), and therefore an electric charge row becomes closer with the release layer in contact when stored in a roll state, and electric charge is suppressed, which is preferable. Electric charge is suppressed, and therefore a resin sheet such as a ceramic green sheet can be peeled off without defects with a low force without peeling electric charge.

In addition, it is possible to suppress the adhesion of extremely minute environmental foreign matters during the step, and film debris generated during slitting, and the like due to static electricity. As a result, it is possible to prevent foreign matters from being mixed into the resin sheet and from contaminating the resin sheet. For example, the release film of the present invention can suppress electric charge even in a roll unwinding step performed before the formation of the resin sheet, and can prevent the contamination of the release layer. Furthermore, unwinding electric charge can be suppressed even in a state where the resin sheet is formed on the release layer, and therefore various effects described in the present specification can be exhibited.

[0064]

The water contact angle of the hydrophobic layer of the present invention is 90° or more and 130° or less. By setting the water contact angle within this range, it is possible to reduce moisture that is considered to be adsorbed to the anti-release surface of the substrate film, and there is no possibility of causing the curing inhibition of the release layer in contact in a roll state, which is preferable.

In one aspect, the water contact angle of the hydrophobic layer may be 95° or more and 130° or less, for

example, 98° or more and 130° or less.

In the present invention, in particular, the water contact angle of the hydrophobic layer is within the above range, and the hydrophobic layer contains the cationically curable polydimethylsiloxane (a) contained in the release layer, and therefore it is possible to reduce moisture that is considered to be adsorbed to the anti-release surface of the substrate film, and it is possible to more remarkably solve the problem of causing the curing inhibition of the release layer in contact in a roll state. When the roll-shaped film is unwound, the adhesion of foreign matters to the release layer can be suppressed, and therefore high smoothness of the release layer can be maintained. Furthermore, the film is less likely to adsorb moisture during storage or transportation in a roll state, and deterioration in roll appearance quality such as moisture absorption wrinkles and winding deviation can also be prevented, which is preferable.

[0065]

The hydrophobic layer in the present invention may be a cured product of a composition containing a cationically curable resin (b) having no silicone skeleton in addition to the cationically curable polydimethylsiloxane (a). By using the cationically curable resin (b), the elastic modulus of the hydrophobic layer can be improved. The

hydrophobic layer having a high elastic modulus improves the handleability of the release film and suppresses unwinding electric charge, which is preferable. When the elastic modulus of the hydrophobic layer is increased, slipperiness between the release layer and the hydrophobic layer in contact with each other during roll storage is improved (the release layer and the hydrophobic layer become slippery). Although it should not be construed as being limited to a specific theory, when the hydrophobic layer becomes slippery, stress applied in a direction perpendicular to the release film surface easily escapes in a horizontal direction, and therefore an adhesive force between the release layer and the resin sheet or the hydrophobic layer when the release film is stored in a roll can be reduced, and electric charge can be suppressed, which is preferable.

[0066]

As examples of the cationically curable polydimethylsiloxane (a) and the cationically curable resin (b) that form the hydrophobic layer, the same as the examples that can be used in the release layer described above can be used. The release layer and the hydrophobic layer do not need to have exactly the same configuration, and when both the release layer and the hydrophobic layer contain the cationically curable polydimethylsiloxane (a),

a release film having the effect of the present invention can be obtained.

[0067]

In the case of a hydrophobic layer obtained by curing a composition containing a cationically curable polydimethylsiloxane (a) as a main component, the film thickness of the hydrophobic layer is preferably 0.001 μm or more and 0.050 μm or less. When the film thickness is 0.001 μm or more, an effect of suppressing the curing inhibition of the release layer in contact with the hydrophobic layer is sufficient, which is preferable. When the film thickness is 0.050 μm or less, the elastic modulus of the hydrophobic layer decreases, and therefore an increase in unwinding electric charge and occurrence of blocking in a roll state can be prevented, which is preferable.

[0068]

When the hydrophobic layer is formed from a cured product of a composition containing a cationically curable polydimethylsiloxane (a) and a cationically curable resin (b) having no silicone skeleton, the content of the cationically curable resin (b) 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, with respect to 100 parts by mass in total. When the

content of the cationically curable compound (b) is 80% by mass or more and the cationically curable compound (b) is contained as a main component in the release layer, a hydrophobic layer having a high crosslinking density and a high elastic modulus is obtained, which is preferable. The film thickness of the hydrophobic layer at this time is preferably 0.001 μm to 0.5 μm , and more preferably 0.001 μm to 0.3 μm . When the film thickness of the hydrophobic layer is 0.001 μm , an effect of suppressing the curing inhibition of the release layer and an effect of suppressing electric charge are sufficient, which is preferable. When the film thickness is 0.5 μm or less, unevenness on the anti-release surface side is not completely filled, conveyance property is excellent, and blocking does not occur when the film is wound, which is preferable.

[0069]

The surface of the hydrophobic layer is preferably rougher than the surface of the release layer. The surface of the hydrophobic layer is rougher than that of the release layer, and therefore the conveyance property and windability of the roll are improved, and it is possible to prevent scratches, foreign matters, and an increase in unwinding electric charge, which is preferable.

[0070]

If the surface roughness Sa of the hydrophobic layer is larger than the surface roughness of the release layer, a desired effect can be obtained, but the Sa is preferably in a range of 1 to 40 nm, more preferably in a range of 2 to 30 nm, and still more preferably in a range of 3 to 20 nm. When the Sa is 1 nm or more, deterioration in the conveyance property and windability of the roll can be prevented, which is preferable. When the film thickness is 40 nm or less, there is no possibility that the surface shape of the hydrophobic layer is transferred to the resin sheet to cause defects, which is preferable.

[0071]

In the present invention, it is necessary to cause the cationic curing reaction to proceed in order to form the hydrophobic layer. Therefore, the hydrophobic layer forming composition preferably contains an acid generating agent (c). The amount and type of the acid generating agent to be used are the same as those of the release layer described above.

Here, the hydrophobic layer can contain the acid generating agent (c) within a range in which the water contact angle does not deviate from the scope of the present invention.

The amounts of the solvent contained in the composition for forming the release layer and the

composition for forming the hydrophobic layer may be different from each other even in an aspect containing the same kind of resin. For this reason, it is not easy to identify the structure of the obtained polymer and to specify the claims based on the structure, and there are unrealistic circumstances.

[0072]

(Method for producing release film)

In the present invention, the application of the release layer forming composition for forming the release layer is preferably an in-line method performed in the process of producing the polyester film or an off-line method performed after the production of the polyester film.

In the case of application by the in-line method, a method is preferable, in which a coating liquid obtained by dissolving or dispersing a releasable resin is applied to a film stretched in a film machine direction (machine direction) and uniaxially oriented, the film is then stretched in a transverse direction (direction orthogonal to the film machine direction) and biaxially oriented, and at the same time, a release layer is formed.

In the case of application by the off-line method, a method is used, in which a coating liquid obtained by dissolving or dispersing a releasable resin is applied to one surface of a biaxially oriented polyester film, a

solvent or the like is removed by drying, and heat drying, heat curing, or ultraviolet curing is then performed.

[0073]

It is preferable to use an aqueous coating liquid as the coating liquid at the time of the application by the in-line method. The type of the aqueous coating liquid is not particularly limited, but it is preferable to add a water-soluble organic solvent, for example, alcohols.

The coating liquid at the time of the application by the off-line method is not particularly limited, but a coating liquid using an organic solvent is preferable, and a solvent having a boiling point of 90°C or higher is preferably added. The addition of the solvent having a boiling point of 90°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.

[0074]

The method for forming the hydrophobic layer is not particularly limited, but the hydrophobic layer can be processed by a method in which both surfaces are processed simultaneously with the release layer, or a method in which one surface is processed and the opposite surface is then processed. In the latter case, it is preferable to process the hydrophobic layer after processing the release layer.

This is because the release layer needs to be smoother than the hydrophobic layer because the resin sheet is directly laminated. Therefore, when the hydrophobic layer is first processed, the slipperiness of the back surface is good, wrinkles and the like are less likely to occur during release layer processing to allow more uniform coating, which is preferable.

[0075]

The hydrophobic layer is preferably processed not by the in-line method in which the hydrophobic layer is coated during the formation of the polyester film but by the off-line method in which the hydrophobic layer is processed after the formation of the polyester film. In the off-line method, tension at the time of coating, and tension at the time of winding, and the like can be highly controlled, and therefore handling at the time of processing is excellent.

[0076]

As the applying method of the release layer forming composition and the hydrophobic layer forming composition, any known applying method can be applied, and for example, conventionally known methods such as roll coating methods (such as a gravure coating method and 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.

[0077]

In the release film of the present invention, the substrate film is conveyed by roll-to-roll during the processing of the release layer and the processing of the hydrophobic layer. Therefore, after the processing the release layer and the hydrophobic layer, the release film is wound into a roll and stored. The forming of the resin sheet and the peeling of the resin sheet are also performed by roll-to-roll.

[0078]

Tension when the release film is wound into a roll is preferably 10 N/m to 300 N/m. When the winding tension is 10 N/m or more, there is no winding deviation, which is preferable. There is no occurrence of rewinding at the time of storage in a roll, and there is no possibility of the contamination of the release layer with scratches or an increase in the unwinding electric charge amount, which is preferable. When the winding tension is 300 N/m or less, the deformation of the release film due to winding tightening and blocking do not occur, which is preferable.

[0079]

When the release film is wound into a roll, it is preferable to wind the release film using a touch roll. The touch pressure of the touch roll is preferably 100 to 3000 N/m. When the touch pressure is 100 N/m or more,

accompanying air mixed at the time of winding can be reduced, and the occurrence of winding deviation can be suppressed, which is preferable. If the touch pressure is 3000 N/m or less, the deformation of the release film due to the touch roll pressure is suppressed, and a release film excellent in flatness is obtained, which is preferable.

[0080]

(Other characteristics)

In the present invention, the unwinding electric charge amount when the release film stored in a roll state is unwound can be suppressed to be low. The electric charge amount is preferably less than ± 1.0 kV when the release film wound into a roll is unwound at 100 m/min. If the electric charge amount is less than ± 1.0 , there is no possibility that extremely small foreign matters during the step adheres to the release film, which is preferable. Peeling electric charge at the time of peeling off the resin sheet is also suppressed to be low, and peeling can be performed with a lower uniform force, which is preferable.

[0081]

The storage environment in the roll state is not particularly limited as long as the storage environment is in an indoor cold dark place that avoids direct sunlight and high temperature. The storage environment may be a

humidity control environment or in a temperature-controlled storage place. When the humidity is in a range of 20 RH% to 90 RH% and the temperature is in a range of -5°C to 50°C, the effect of the present invention is obtained.

[0082]

The peeling force in the present invention is a value measured using a release film obtained by storing a release film provided with a release layer and a hydrophobic layer in a roll state under an environment of 40 to 50 RH% and 20 to 25°C for 3 days, and then unwinding and collecting the release film roll. When the hydrophobic layer is provided and then stored in a roll, the reaction of the release layer is completed, and a release film having an excellent peeling force is obtained. The peeling force in the present invention is a value measured by bonding an adhesive tape ("31B" manufactured by Nitto Denko Corporation) to the surface of the release film and subjecting the release film to T-type peeling at a tensile speed of 300 m/min. The evaluation method will be described in detail later.

[0083]

The normal peeling force (I) of the release layer is preferably 100 mN/50 mm or more and 1500 mN/50 mm or less, more preferably 100 mN/50 mm or more and 1300 mN/50 mm or less, and still more preferably 100 mN/50 mm or more and

1000 mN/50 mm or less. When the normal peeling force (I) is 100 N/50 mm or more, there is no possibility that partial lifting or peeling of the resin sheet during conveyance occurs, and the release layer is excellent in retentivity of the resin sheet, which is preferable. If the normal peeling force (I) is 1500 mN/50 mm or less, the resin sheet can be peeled off without being damaged, which is preferable.

[0084]

The post-heating peeling force (II) of the release layer is preferably 150 mN/50 mm or more and 2250 mN/50 mm or less, more preferably 150 mN/50 mm or more and 1950 mN/50 mm or less, and still more preferably 150 mN/50 mm or more and 1500 mN/50 mm or less. Heat is applied to the release film when the resin sheet is formed on the release film or peeled off, and therefore the peelability of the release film can be evaluated in more detail by the post-heating peeling force. When the post-heating peeling force (II) is 150 mN/50 mm or more, the retentivity of the ceramic green sheet is excellent, which is preferable. When the post-heating peeling force (II) is 2250 mN/50 mm or less, the amount of unreacted substances contained in the release layer is small, and the resin sheet is excellent in peeling off, which is preferable.

Although it should not be construed as being limited

to a specific theory, in the present invention, the release layer contains the cationically curable polydimethylsiloxane (a), and the water contact angle of the hydrophobic layer is 90° or more and 130° or less, and therefore the inhibition of the temporal reaction of the cationically curable resin due to the influence of moisture that is considered to be present in a trace amount on the anti-release surface side of the substrate film can be suppressed, and the problem that the curing of the release layer becomes insufficient can be solved. As a result, the post-heating peeling force (II) can be guided to the above range, and for example, when processing is performed under the condition of 30°C or higher and 120°C or lower in the step of forming the resin sheet, the resin sheet forming composition can be favorably retained, and the obtained resin sheet can be easily peeled off.

Therefore, in the present invention, the retention of the resin sheet forming composition and the peeling of the resin sheet after heating can be performed in a well-balanced manner. For example, even in an aspect in which the ceramic green sheet has an extremely small thickness of $1.0\text{ }\mu\text{m}$ or less, these effects can be exhibited.

[0085]

The ratio between the normal peeling force (I) and the post-heating peeling force (II): $(\text{II})/(\text{I})$ is preferably

1.00 or more and 1.50 or less. The fact that the ratio between the normal peeling force (I) and the post-heating peeling force (II): $(II)/(I)$ is large suggests that unreacted substances remain in the release layer, and means that the curing of the release layer does not completely proceed. If $(II)/(I)$ is 1.50 or less, the release layer is in contact with the hydrophobic layer during storage in a roll state, and therefore poor curing due to moisture does not occur, and the curing of the release layer completely proceeds, which is preferable. The post-heating peeling force (II) generally has a larger value than that of the normal peeling force (I), and therefore $(I)/(II)$ is preferably 1.0 or more.

[0086]

(Resin sheet)

In one aspect, the release film of the present invention is not particularly limited as long as the release film is a resin sheet, and may be applied to the production of a pressure-sensitive adhesive and an optical film. In one aspect, the release film for forming a resin sheet contains 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.

Examples of the resin include a polyvinyl acetal resin and a poly (meth)acrylic acid ester resin.

Since the present invention includes the release layer having high smoothness and a back layer excellent in smoothness, handleability, and antistatic properties, even in an aspect in which these inorganic compounds are contained in the resin sheet, it is possible to suppress drawbacks that can be caused by the inorganic compounds, for example, problems such as breakage of the resin sheet and difficulty in peeling off the resin sheet from the release layer.

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

[0087]

(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.

[0088]

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 raw ceramic body is fired to obtain a ceramic body. Thereafter, the laminated ceramic capacitor can be completed by forming first and second external electrodes.

EXAMPLES

[0089]

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.

[0090]

(Thickness measurement)

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.).

[0091]

(Area surface roughness Sa, maximum protrusion height Sp)

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 (Sa), the average value of five measurements was employed. For the maximum protrusion height (Sp), 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

[0092]

(Normal peeling force (I))

A release film for producing a resin sheet obtained in each of Examples and Comparative Examples was wound into a roll having a width of 400 mm and a length of 6000 m to obtain a release film roll. At this time, winding tension was 150 N/mm, and touch roll pressure was 700 N/m. The obtained film roll was stored in an environment of 20 to 25°C and a humidity of 40 to 50 RH% for 3 days and then unwound to obtain a release film for measurement. An adhesive tape ("31B" manufactured by Nitto Denko Corporation) was bonded to the surface of a release layer of the release film for measurement, and the release film with the adhesive tape was cut into a strip having a width of 25 mm and a length of 150 mm. The cut release film with the adhesive tape was pressure-bonded with a pressure-bonding roller of 5 kg, and then allowed to stand for 20 hours under conditions of a temperature of 22°C and a humidity of 60%. Thereafter, one end of the adhesive tape was fixed, one end of the release film was held, the release film side was pulled at a speed of 300 mm/min, and measurement was performed by T-type peeling. For the measurement, a tensile tester ("AUTOGRAPHAG-X" manufactured by Shimadzu Corporation) was used.

[0093]

(Post-heating peeling force (II))

A release film for evaluation was obtained in the same manner as in the normal peeling force (I), an adhesive tape (trade name "31B" manufactured by Nitto Denko Corporation) was bonded to the surface of a release layer, and the release film with the adhesive tape was cut into a strip having a width of 25 mm and a length of 150 mm. The cut release film with the adhesive tape was pressure-bonded with a pressure-bonding roller of 5 kg, and then heated in an oven at a temperature of 70°C for 20 hours. Thereafter, one end of the adhesive tape was fixed, one end of the release film was held, the release film side was pulled at a speed of 300 mm/min for peeling, and measurement was performed by T-type peeling. For the measurement, a tensile tester ("AUTOGRAPHAG-X" manufactured by Shimadzu Corporation) was used.

[0094]

(Unwinding electric charge amount)

A release film for producing a resin sheet obtained in each of Examples and Comparative Examples was wound into a roll having a width of 400 mm and a length of 6000 m to obtain a release film roll. At this time, winding tension was 150 mN/mm, and touch roll pressure was 700 N/m. The release film roll was stored in an environment of 20 to

25°C and a humidity of 40 to 50 RH% or less for 30 days, and an electric charge amount at the time of unwinding the film at 100 m/min was then measured using "KSD-0103" manufactured by Kasuga Electric Works Ltd. The electric charge amount was measured for each unwinding length of 500 M at a position of 100 mm immediately after unwinding, and the average value thereof was calculated.

○: less than ± 1.0 kV

×: ± 1.0 kV or more

[0095]

(Water contact angle)

Using an automatic contact angle meter (DM-701 manufactured by Kyowa Interface Science Co., Ltd.), the contact angle of water in contact with the release surface was measured under the conditions of 22°C and 60% RH. The dropping amount of water was 1.8 μ L, and the value of the contact angle after 60 seconds had elapsed after the dropping was adopted.

[0096]

(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 size 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 size 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.

[0097]

(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)).

[0098]

(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.

[0099]

(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.

[0100]

(Release layer forming composition Y1)

Methyl ethyl ketone	49.833 parts by mass
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Toluene	49.833 parts by mass
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Cationically curable polydimethylsiloxane (a):

Alicyclic epoxy group-containing polydimethylsiloxane	0.316 parts by mass
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(Product name: Silcolease UV POLY215, manufactured by Arakawa Chemical Industries, Ltd., solid content concentration: 100%)

Acid generating agent (c) 0.018 parts by mass

(Product name: UV CATA211, manufactured by Arakawa Chemical Industries, Ltd., solid content concentration: 18%)

[0101]

(Release layer forming composition Y2)

Methyl ethyl ketone 47.361 parts by mass

Toluene 47.361 parts by mass

Cationically curable polydimethylsiloxane (a)

0.250 parts by mass

(Product name: Silcolease UV POLY215, manufactured by Arakawa Chemical Industries, Ltd., solid content concentration: 100%)

Cationically curable resin (b) having no silicone skeleton:

Bifunctional cycloaliphatic epoxy monomer

4.750 parts by mass

(Product name: CELLOXIDE 2021P, manufactured by Daicel Corporation, solid content: 100%)

Acid generating agent (c)

0.278 parts by mass

(Product name: UV CATA211, manufactured by Arakawa

Chemical Industries, Ltd., solid content concentration:
18%)

[0102]

(Release layer forming composition Y3)

Methyl ethyl ketone 44.900 parts by mass

Toluene 44.900 parts by mass

Dipentaerythritol hexaacrylate

9.500 parts by mass

(Product name: A-DPH, manufactured by Shin-Nakamura
Chemical Co., Ltd., solid content concentration: 100%)

Acryloyl group-containing polydimethylsiloxane

0.500 parts by mass

(Product name: BYK UV3500, manufactured by BYK Japan
KK, solid content concentration: 100%)

Initiator 0.200 parts by mass

(Product name: Omnirad907, manufactured by IGM Resins,
solid content concentration: 100%)

[0103]

(Release layer forming composition Y4)

Methyl ethyl ketone 47.361 parts by mass

Toluene 47.361 parts by mass

Cationically curable polydimethylsiloxane (a):

Side chain epoxy group-modified polydimethylsiloxane

0.250 parts by mass

(Product name: KF-101, manufactured by Shin-Etsu

Chemical Co., Ltd., solid content concentration: 100%)

Cationically curable resin (b) having no silicone skeleton:

Trifunctional epoxy resin 4.750 parts by mass

(Product name: Denacol EX-421, manufactured by Nagase ChemteX Corporation, solid content concentration: 100%)

Acid generating agent (c) 0.278 parts by mass

(Product name: UV CATA211, manufactured by Arakawa Chemical Industries, Ltd., solid content concentration: 18%)

[0104]

(Hydrophobic layer forming composition Z1)

Methyl ethyl ketone 69.766 parts by mass

Toluene 29.900 parts by mass

Cationically curable polydimethylsiloxane (a):

Alicyclic epoxy group-containing polydimethylsiloxane

0.316 parts by mass

(Product name: Silcolease UV POLY200, manufactured by Arakawa Chemical Industries, Ltd., solid content concentration: 100%)

Acid generating agent (c) 0.018 parts by mass

(Product name: UV CATA211, manufactured by Arakawa Chemical Industries, Ltd., solid content concentration: 18%)

[0105]

(Hydrophobic layer forming composition Z2)

Methyl ethyl ketone 71.041 parts by mass

Toluene 23.681 parts by mass

Cationically curable polydimethylsiloxane (a)

0.250 parts by mass

(Product name: Silcolease UV POLY200, manufactured by Arakawa Chemical Industries, Ltd., solid content concentration: 100%)

Cationically curable resin (b) having no silicone skeleton:

Bifunctional cycloaliphatic epoxy monomer

4.750 parts by mass

(Product name: CELLOXIDE 2021P, manufactured by Daicel Corporation, solid content: 100%)

Acid generating agent (c) 0.278 parts by mass

(Product name: UV CATA211, manufactured by Arakawa Chemical Industries, Ltd., solid content concentration: 18%)

[0106]

(Hydrophobic layer forming composition Z3)

Methyl ethyl ketone 47.361 parts by mass

Toluene 47.361 parts by mass

Cationically curable resin (b) having no silicone

skeleton:

Bifunctional cycloaliphatic epoxy monomer

5.000 parts by mass

(Product name: CELLOXIDE 2021P, manufactured by
Daicel Corporation, solid content: 100%)

Acid generating agent (c) 0.278 parts by mass

[0107]

(Method for forming release layer)

The release layer forming compositions Y1 to Y4 were applied onto the surface layer A of the laminated film X1 or one surface of the laminated film X2 with a reverse gravure coater so that the film thickness after drying was a predetermined thickness. Next, after drying with hot air at 90°C for 20 seconds, ultraviolet irradiation (100 mJ/cm²) was immediately performed with an electrodeless lamp (H bulb manufactured by Heraeus Co., Ltd.) to form a release layer. The release layer was formed by roll-to-roll. That is, a roll-shaped laminated film was unwound, followed by applying, drying, and irradiating with ultraviolet rays sequentially and continuously. The laminated film was wound into a roll to obtain a release film roll provided with the release layer.

[0108]

(Method for forming hydrophobic layer)

The hydrophobic layer forming compositions Z1 to Z3 were applied to the surface of the substrate film on which the release layer was not provided with a reverse gravure

coater so that the film thickness after drying was a predetermined thickness. Next, after drying with hot air at 90°C for 20 seconds, ultraviolet irradiation (100 mJ/cm²) was immediately performed with an electrodeless lamp (H bulb manufactured by Heraeus) to form a hydrophobic layer. The hydrophobic layer was formed by roll-to-roll. That is, a release film roll provided with a release layer was unwound, followed by applying, drying, and irradiating with ultraviolet rays sequentially and continuously. The release film was wound into a roll to obtain a release film roll provided with the release layer and the hydrophobic layer.

[0109]

(Example 1)

A release layer forming composition Y1 was applied onto a surface layer A of a laminated film X1 to form a release layer, and a hydrophobic layer forming composition Z1 was then applied onto a surface layer B to form a hydrophobic layer, thereby obtaining a release film roll for forming a resin sheet. The release layer and the hydrophobic layer were formed so as to have thicknesses shown in Table 1. A release film sample was unwound from the obtained release film roll and collected for each evaluation. The film configuration and various physical property values are shown in Table 1A.

[0110]

(Examples 2 to 11)

A release film roll for forming a resin sheet was obtained in the same manner as in Example 1 so as to have a combination of a substrate film, a release layer, and a hydrophobic layer shown in Table 1. A release film sample was unwound from the obtained release film roll and collected for each evaluation. The film configurations and various physical property values are shown in Table 1A or Table 1B.

[0111]

In the present invention, the hydrophobic layer is provided on the surface of the substrate film on a side opposite to the release layer, and therefore the release layer and the hydrophobic layer are in contact with each other when the release film is stored in a roll state, so that there is no possibility of the poor curing of the release layer due to moisture, and excellent peelability is obtained. Both the surfaces of the release layer and the hydrophobic layer contain the cationically curable polydimethylsiloxane, and therefore it is possible to suppress electric charge when unwound from a roll state. Therefore, in the present invention, for example, it is possible to suppress the adhesion of extremely minute environmental foreign matters during the step, and film

debris generated during slitting, and the like due to static electricity, and it is possible to suppress the contamination of the resin sheet. For example, a resin sheet having a thickness of 0.2 μm or more and 1.0 μm or less can be peeled off with a low peeling force by suppressing peeling electric charge.

[0112]

(Comparative Examples 1 to 5)

A release film for forming a resin sheet was obtained in the same manner as in Example 1 so as to have a combination of a substrate film, a release layer, and a hydrophobic layer shown in Table 1. In Comparative Examples 1 to 4, a release film roll provided with a release layer without providing a hydrophobic layer was used for each evaluation. The film configurations and various physical property values are shown in Table 1B.

[0113]

In Comparative Example 1, the release layer did not contain the cationically curable polydimethylsiloxane (a) but contained a radically curable resin, and therefore poor curing due to oxygen inhibition occurred, the ratio between the post-heating peeling force (II) and the normal peeling force (I), (II)/(I) was large, and deterioration in peelability was observed. The unwinding electric charge was also high. Comparative Examples 2 to 4 did not have

the hydrophobic layer (the hydrophobic layer having a water contact angle of 90° or more and 130° or less), and therefore the temporal reaction of the release layer was inhibited under the influence of moisture when the release film was stored in a roll state, resulting in poor curing, and deterioration in peelability was observed. The unwinding electric charge was also high. In Comparative Example 5, the water contact angle of the hydrophobic layer was 90° or less, and therefore the effect of suppressing the curing inhibition of the release layer when the release film was stored in a roll state was insufficient, and deterioration in peelability and unwinding electric charge was observed.

[0114]

[Table 1A]

	Film configuration				
	Substrate	Release layer		Hydrophobic layer	
	Type	Release layer forming composition	Thickness (μm)	Hydrophobic layer forming composition	Thickness (μm)
Example 1	X1	Y1	0.05	Z1	0.01
Example 2	X1	Y1	0.01	Z1	0.01
Example 3	X1	Y1	0.05	Z2	0.15
Example 4	X1	Y2	0.2	Z1	0.01
Example 5	X1	Y2	0.5	Z1	0.01
Example 6	X1	Y2	0.2	Z2	0.15
Example 7	X2	Y1	0.05	Z1	0.01
Example 8	X2	Y1	0.01	Z1	0.01

	Physical property							
	Release layer		Hydrophobic layer		Peelability			Unwinding charge amount (kV)
	Sa (nm)	Sp (nm)	Sa (nm)	Water contact angle (°)	Normal peeling force (I)	Pre-heating peeling force (II)	(II)/(I)	
					mN/50 mm	mN/50 mm		
Example 1					2	50		
Example 2	1	30	28	99	400	531	1.33	0.1
Example 3	2	50	20	98	450	615	1.37	0.5
Example 4	1	15	28	99	1250	1475	1.18	0.1
Example 5	1	10	28	99	1200	1429	1.19	0.1
Example 6	1	15	20	98	1250	1475	1.18	0.5
Example 7	24	800	24	99	450	615	1.37	0.1
Example 8	24	800	24	99	400	531	1.33	0.1

[0115]

[Table 1B]

	Film configuration				
	Substrate	Release layer		Hydrophobic layer	
	Type	Release layer forming composition	Thickness (μm)	Hydrophobic layer forming composition	Thickness (μm)
Example 9	X2	Y1	0.05	Z2	0.15
Example 10	X2	Y2	1	Z1	0.01
Example 11	X2	Y2	1	Z2	0.15
Comparative Example 1	X1	Y3	0.2	-	-
Comparative Example 2	X1	Y1	0.05	-	-
Comparative Example 3	X1	Y2	0.2	-	-
Comparative Example 4	X1	Y4	0.2	-	-
Comparative Example 5	X1	Y1	0.05	Z3	0.15

	Physical property								
	Substrate	Release layer		Hydrophobic layer		Peelability			Unwinding charge amount (kV)
	Type	Sa (nm)	Sp (nm)	Sa (nm)	Water contact angle (°)	Normal peeling force (I)	Pre-heating peeling force (II)	(II)/(I)	
						mN/50 mm	mN/50 mm		
Example 9	X2	24	800	18	98	450	615	1.37	0.1
Example 10	X2	5	100	24	99	1200	1429	1.19	0.1
Example 11	X2	5	100	18	98	1200	1429	1.19	0.5
Comparative Example 1	X1	1	10	28	67	4000	12000	3.00	3.0
Comparative Example 2	X1	2	50	28	67	450	1250	2.78	1.5
Comparative Example 3	X1	1	15	28	67	1250	2250	1.80	2.0
Comparative Example 4	X1	1	20	28	67	3000	8500	2.83	5.0
Comparative Example 5	X1	2	50	20	82	450	900	2.00	5.0

INDUSTRIAL APPLICABILITY

[0116]

According to the present invention, by having a release layer on one surface of a substrate film and providing a hydrophobic layer on the anti-release surface of the substrate film, a release film excellent in peelability and low unwinding electric charge can be provided, and an ultrathin resin sheet having a thickness of 1 μm or less can be produced without a risk of causing defects.

CLAIMS

1. A release film for forming a resin sheet, the release film comprising:

a substrate film; and

a release layer provided on one surface of the substrate film,

wherein the release film includes a hydrophobic layer on a surface of the substrate film on a side opposite to the release layer,

the release layer is a layer formed of a cured product of a composition containing a cationically curable polydimethylsiloxane (a),

a water contact angle of the hydrophobic layer is 90° or more and 130° or less, and

a normal peeling force (I) and a post-heating peeling force (II) of the release layer measured in the release film obtained by winding the release film once into a roll and then unwinding the roll satisfy a following relationship: $(II)/(I) = 1.00$ or more and 1.50 or less.

2. The release film for forming a resin sheet according to claim 1, wherein the normal peeling force (I) of the release layer measured in the unwound release film is $1500 \text{ mN}/50 \text{ mm}$ or less.

3. The release film for forming a resin sheet according to claim 1 or 2, wherein an electric charge amount is less than ± 1 kV when a release film roll obtained by winding the release film into a roll is unwound at 100 m/min.

4. The release film for forming a resin sheet according to any one of claims 1 to 3, wherein the hydrophobic layer is formed of a cured product of a composition containing a cationically curable polydimethylsiloxane (a).

5. The release film for forming a resin sheet according to any one of claims 1 to 4, wherein the hydrophobic layer has a thickness of 0.001 μm or more and 0.5 μm or less.

6. The release film for forming a resin sheet according to any one of claims 1 to 5, wherein the release layer and the hydrophobic layer are substantially free of particles having a particle size of 1.0 μm or more.

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

the substrate film is a polyester film including a surface layer A substantially free of particles having a particle size of 1.0 μm or more and a surface layer B containing particles,

the release layer is laminated on the surface layer A, and

the hydrophobic layer is laminated on the surface layer B.

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

11. A method for producing a ceramic green sheet, the method comprising forming the ceramic green sheet using the release film for forming a resin sheet according to

claim 9,

wherein the formed ceramic green sheet has a
thickness of 0.2 μm to 1.0 μm .