

[DESCRIPTION]

[TITLE OF INVENTION]

RELEASE SHEET

5 [Technical Field]

[0001]

The present invention relates to a release sheet including at least a base material, an intermediate layer, and a release agent layer in this order, and after the release sheet is used, the base material can be separated from the release sheet.

10 [Background Art]

[0002]

In general, a release sheet has a laminated structure, in which a release agent layer to implement a function is provided on a base material, and paper base materials or various plastic base materials are used as the base material.

15 From the viewpoints of global resource protection, environmental protection, and the like, active efforts in an attempt to establish a sustainable society has been increasing in various fields through reduction, reuse, recycling, and the like of waste.

The same is true in the field of release sheets, and, for example, various methods for reusing release sheets have been studied, in which a base material having a high
20 content of a resin or the like is separated from a used release sheet to collect the resin.

For example, Patent Document 1 discloses a method of collecting a release film, in which a release layer is formed on at least one face of a base material film by interposing an easily soluble resin layer between the base material film and the release layer, and the method includes collecting only the base material film by immersing the
25 release film after use in a solvent capable of dissolving the easily soluble resin to dissolve

the easily soluble resin in the solvent, and separating and removing the release layer on the film surface.

Furthermore, Patent Document 2 discloses a method of recycling a laminated film, the laminated film including an easily soluble resin layer and a surface functional layer that are laminated in this order on at least one face of a base material film, the method including washing the laminated film after use by using a solvent capable of dissolving the resin constituting the easily soluble resin layer and that does not dissolve the resin constituting the base material film, separating and collecting the base material film or a ground product thereof from the laminated film, redissolving this separated and collected material, and regenerate the resin composition constituting the base material film.

Furthermore, Patent Document 3 discloses a method for producing a ceramic green sheet by using a carrier sheet, the method using a release film, in which a release layer is formed on at least one face of a base material film by interposing a easily soluble resin layer formed from a water-soluble resin between the base material film and the release layer, as the carrier sheet, the method including a step of forming a ceramic green sheet layer on a release film by applying a ceramic slurry on a release layer face of the release film, a step of releasing the ceramic green sheet layer from the release film to form a ceramic green sheet, and a step of separating and removing components attached to a base material film surface by washing the release film with a solvent that can dissolve the easily soluble resin after the ceramic green sheet layer is released.

[Citation List]

[Patent Literature]

[0003]

Patent Document 1: JP 2002-265665 A

Patent Document 2: JP 2004-169005 A

Patent Document 3: JP 4284936 B

[Summary of Invention]

[Technical Problem]

5 [0004]

In all the methods described above, a method of dissolving an easily soluble resin in a solvent is employed to separate the base material, and because of this, a laminate having a layer formed from an easily soluble resin is required.

10 However, the easily soluble resin is dissolved in the solvent used to separate the base material, and the dissolved resin content may reattach to the separated base material.

Furthermore, from the viewpoint of environmental protection, for example, even in a case where water is used as the solvent, the water becomes a solution in which the easily soluble resin is dissolved, various liquid-waste treatments are required because a value for the chemical oxygen demand (COD) needs to be reduced and the like.

15 Furthermore, also the liquid-waste treatment step leads to increase of CO₂ emission amount and the like depending on the degree of a load of the liquid-waste treatment.

Thus, a release sheet that is effective to further reduce environmental impact has been demanded.

[0005]

20 The present invention was completed in light of the circumstances described above, and an object of the present invention is to provide a novel release sheet that can easily separate a base material from a release sheet by using water and can suppress contamination of the water used for the separation of the base material.

[Solution to Problem]

25 [0006]

The inventor of the present invention found that the issues described above can be solved by forming a release sheet including a base material, and an intermediate layer that is hydrophilic and water-insoluble and a release agent layer in this order on at least one surface side of the base material and thus completed the present invention.

5 That is, the present invention provides the following [1] to [10]:

[1] A release sheet including a base material and an intermediate layer and a release agent layer in this order on at least one surface side of the base material, the intermediate layer being hydrophilic and water-insoluble.

[2] The release sheet according to [1] above, where a contact angle of water on
10 the base material side surface of the intermediate layer is 55 degrees or less.

[3] The release sheet according to [1] or [2] above, where a difference between a contact angle of water on the release agent layer surface and a contact angle of water on the base material side surface of the intermediate layer is 30 degrees or greater.

[4] The release sheet according to any one of [1] to [3] above, where the
15 intermediate layer is directly laminated on the base material.

[5] The release sheet according to any one of [1] to [4] above, where the intermediate layer is a layer having a siloxane bond.

[6] The release sheet according to [5] above, where the layer having a siloxane bond is a layer formed from a silane-based compound exhibiting polycondensation
20 property by hydrolysis.

[7] The release sheet according to [6] above, where the silane-based compound contains, as a main component, at least one selected from the group consisting of a tetrafunctional silane-based compound represented by the following General Formula (a) and an oligomer thereof:

25 $\text{Si(OR)}_p(\text{X})_{4-p}$ (a)

where in General Formula (a), R represents an alkyl group, and X represents a halogen atom, in a case where a plurality of R and X exists, the plurality of R and X may each be the same or different from each other, and p represents an integer from 0 to 4.

[8] The release sheet according to [7] above, where the tetrafunctional silane-based compound is a tetraalkoxysilane represented by the following General Formula (a1):



where in General Formula (a1), R represents an alkyl group, and in a case where a plurality of R exists, the plurality of R may each be the same or different from each other.

[9] The release sheet according to any one of [1] to [8] above, where the base material is a resin film.

[10] The release sheet according to any one of [1] to [9] above, where the release agent layer is a layer including a release agent composition containing an energy ray-curable or thermosetting resin as a main component.

[Advantageous Effects of Invention]

[0007]

The present invention can provide a novel release sheet that can easily separate a base material from a release sheet by using water and can suppress contamination of the water used for the separation of the base material.

[Description of Embodiments]

[0008]

The present invention will be described in detail below with reference to embodiments.

In the present specification, "solid content" refers to a component excluding a diluent solvent, such as water or an organic solvent, from the components contained in a target composition.

5 In the present specification, the lower and upper limits of a preferable numerical range (for example, a range of content) described in series can each be independently combined. For example, from the description "preferably from 10 to 90, more preferably from 30 to 60", the "preferred lower limit (10)" and the "preferred upper limit (60)" can be combined as "from 10 to 60". Similarly, from the description "preferably 10 or greater, more preferably 30 or greater" and the description of "preferably 90 or less, 10 more preferably 60 or less" for an identical item, the "preferred lower limit (10)" and the "preferred upper limit (60)" can be combined as "10 or greater and 60 or less".

Furthermore, in the description of the present specification, for example, "energy ray" is a term meaning a known energy ray such as γ ray, electron beam, ultraviolet radiation, and visible radiation.

15 [0009]

[Release Sheet]

The release sheet of an embodiment of the present invention includes a base material, and an intermediate layer and a release agent layer in this order on at least one surface side of the base material, and the intermediate layer is hydrophilic and water- 20 insoluble.

The release sheet preferably has a structure in which the intermediate layer is directly laminated on the base material from the viewpoint of easily collecting and reusing a resin constituting the base material from the separated base material and the like. Note that "directly laminated" refers to a structure in which no other layer is

included in between the base material and the intermediate layer, and the base material and the intermediate layer are directly in contact with each other.

Furthermore, in one aspect of the release sheet, the base material, the intermediate layer, and a functional layer may be directly laminated in this order. That is, it may have a configuration where each layer is in direct contact with each other, with no other layers between the base material, the intermediate layer, and the functional layer

Each of these layers constituting the release sheet will be described in more detail below.

[0010]

<Base Material>

As a base material, for example, a paper base material and a resin film can be used, and from the viewpoint of easy separation, a resin film is preferred. Furthermore, in a case where a resin film is separated, the component to be collected is a resin. Meanwhile, in a case where a paper base material is separated, the component to be collected is pulp fibers.

As the resin film, for example, a polyester film, such as a polyethylene terephthalate film, a polybutylene terephthalate film, and a polyethylene naphthalate film; a polyolefin film, such as a polyethylene film and a polypropylene film; a polyimide film; a polyamide film; a polycarbonate film; a polyacetate film; an ethylene-vinyl acetate copolymer (EVA) film; an ethylene-(meth)acrylic acid copolymer film; an ethylene-(meth)acrylate copolymer film; a cycloolefin polymer film; a polyurethane film; a polyphenylene sulfide film; and cellophane can be used. Among these, from the viewpoints of heat resistance and strength, a polyester film is preferred. As the polyester film, from the viewpoint of ease of resin collection and regeneration, a polyester film containing polyethylene terephthalate, polybutylene terephthalate, and/or polyethylene

naphthalate, as a main component is preferred. Note that "main component" refers to a component having the largest content among components constituting the film. As the polyester film, a polyethylene terephthalate film, a polybutylene terephthalate film, and a polyethylene naphthalate film are more preferred, and a polyethylene terephthalate film
5 is even more preferred.

[0011]

Furthermore, the base material may be a resin film containing only one type of resin described above or may be a resin film containing two or more types of resins described above. For example, the base material may be a single-layer film containing
10 one resin film or may be a multilayer film in which a plurality of resin films is laminated. From the viewpoint of ease of resin collection, the base material is preferably a single-layer film containing one resin film or a multilayer film in which one resin film is laminated.

Furthermore, the resin film may contain a known filler, a coloring agent, an
15 antistatic agent, an antioxidant, an organic lubricant, a catalyst, and the like.

Furthermore, the resin film may be transparent or, as desired, colored or the like.

Furthermore, at least one surface of the base material may be subjected to a surface treatment, such as sputtering, corona discharge, flame, ultraviolet irradiation, etching treatment such as oxidation, in advance and as necessary.

20 Furthermore, from the viewpoint of further reducing contamination of washing water, the base material is preferably water-insoluble, and more preferably hydrophobic (non-hydrophilic) and water-insoluble.

[0012]

The thickness of the base material is not particularly limited but, from the viewpoints of strength and rigidity, is preferably from 10 to 500 μm , more preferably from 15 to 300 μm , and even more preferably from 20 to 200 μm .

Note that "thickness of base material" means the thickness of the entire base material, and for example, in a case where the multilayer film in which two or more layers are laminated described above is used, the thickness of the base material means the total thickness of all layers constituting the base material.

[0013]

<Intermediate Layer>

The intermediate layer is hydrophilic and water-insoluble. The excellent effects described above are achieved when the release sheet includes the intermediate layer that is hydrophilic and water-insoluble, and the reason thereof is considered as follows.

That is, before the base material is separated from the release sheet, the intermediate layer is adhered to the base material or another layer on the base material side mainly due to hydrogen bonding and anchor effect. In particular, since the intermediate layer is hydrophilic, water easily permeates the interface between the base material and the intermediate layer or the interface between another layer present on the base material side and the intermediate layer when the intermediate layer and water are brought into contact with each other. It is conceived that the water permeated the interface inhibits the hydrogen bonding and thus causes release at the interface and, as a result, the base material is easily separated from the release sheet.

Furthermore, because the intermediate layer is hydrophilic and water-insoluble at the same time, when the intermediate layer and the water to be used at the time of separating the base material from the release sheet (hereinafter, also referred to as "washing water") are brought into contact with each other, the intermediate layer does

not elute into the washing water. Contamination of the washing water can be thus prevented.

[0014]

In the present specification, for determination of "hydrophilicity" of the intermediate layer, a case where the contact angle of water on the base material side surface of the intermediate layer is 55 degrees or less is determined as the intermediate layer being hydrophilic. Furthermore, from the viewpoint of promoting separability of the base material, the contact angle is preferably 50 degrees or less, and more preferably 45 degrees or less. The contact angle is a value obtained by measuring a contact angle of water on a surface (release face) that was in contact with the base material or a layer on the base material side of the intermediate layer after the base material was separated from the release sheet, that is, after the intermediate layer and water are brought into contact with each other and the interface between the base material or the layer on the base material side and the intermediate layer is released. Specifically, the contact angle is a value measured by using a method described in Examples below. Furthermore, the lower limit of the contact angle of water on the base material side surface of the intermediate layer is not particularly limited and, for example, is 0 degrees. In other words, in an aspect of the present invention, the contact angle of water on the base material side surface of the intermediate layer is preferably from 0 to 55 degrees, more preferably from 0 to 50 degrees, and even more preferably from 0 to 45 degrees.

In the present specification, for determination of "water insolubility" of the intermediate layer, a case where a difference between the contact angle of water on the release agent layer surface and the contact angle of water on the base material side surface of the intermediate layer measured using the method described in Examples below is 30 degrees or greater is determined as the intermediate layer being water-

insoluble. The difference in contact angles is preferably 40 degrees or greater, and more preferably 50 degrees or greater. A case where this difference value is small means that the measurement was performed for a release agent layer which was partially exposed to the surface because components constituting the intermediate layer eluted into water.

5 Furthermore, the upper limit of the difference of contact angles is not particularly limited but is preferably 150 degrees, more preferably 140 degrees, and even more preferably 130 degrees. As described above, lower limits and upper limits described in series can each be combined independently. For example, in an aspect of the present invention, the difference of contact angles is preferably from 30 to 150 degrees, more preferably from
10 40 to 140 degrees, and even more preferably from 50 to 130 degrees.

The contact angle of water on the release agent layer surface is not particularly limited but is typically 80 degrees or greater, preferably 85 degrees or greater, and more preferably 90 degrees or greater. The upper limit of the contact angle of water of the release agent layer surface is typically 150 degrees, preferably 140 degrees, and more
15 preferably 130 degrees. As described above, lower limits and upper limits described in series can each be combined independently. For example, in an aspect of the present invention, the contact angle of water of the release agent layer surface is preferably from 80 to 150 degrees, more preferably from 85 to 140 degrees, and even more preferably from 90 to 130 degrees. The contact angle of water of the release agent layer surface is
20 also a value measured by using a method described in Examples below.

[0015]

From the viewpoint of facilitating exhibition of the effects of the present invention, the intermediate layer is preferably a layer having a siloxane bond (-Si-O-Si-).

For example, the layer having a siloxane bond is preferably a layer formed from
25 a silane-based compound exhibiting polycondensation property by hydrolysis. The

silane-based compound exhibiting polycondensation property by hydrolysis is a compound that gives, when hydrolyzed, a compound that can undergo polycondensation. For example, the silane-based compound exhibiting polycondensation property by hydrolysis may be an alkoxysilane exhibiting polycondensation property by hydrolysis.

5 [0016]

The silane-based compound exhibiting polycondensation property by hydrolysis preferably contains at least one selected from the group consisting of a tetrafunctional silane-based compound represented by the following General Formula (a) and an oligomer thereof as a main component:

10 $\text{Si(OR)}_p(\text{X})_{4-p}$ (a)

where in General Formula (a), R represents an alkyl group, and X represents a halogen atom. In a case where a plurality of R and X exists, the plurality of R and X may each be the same or different from each other. p represents an integer from 0 to 4.

[0017]

15 Examples of the alkyl group that can be selected as R include a methyl group, an ethyl group, an n-propyl group, an isopropyl group, an n-butyl group, a sec-butyl group, an isobutyl group, a tert-butyl group, an n-pentyl group, an n-hexyl group, a neopentyl group, and a methylpentyl group. Among these, from the viewpoint of further improving reactivity of the silane-based compound, a methyl group, an ethyl group, an n-propyl group, or an n-butyl group is preferred, and a methyl group or an ethyl group is
20 more preferred. The alkyl group that can be selected as R may be a straight or branched chain but is preferably a straight chain.

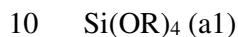
As the halogen atom that can be selected as X is preferably a chlorine atom, a bromine atom, or an iodine atom, and more preferably a chlorine atom.

Note that the silane-based compound represented by General Formula (a) above may be used alone, or two or more types of the silane-based compounds may be used in combination.

[0018]

- 5 Furthermore, the silane-based compound represented by General Formula (a) above preferably includes a silane-based compound in which p in General Formula (a) above is 4.

That is, the tetrafunctional silane-based compound is preferably a tetraalkoxysilane represented by the following General Formula (a1):



where in General Formula (a1), R represents an alkyl group. In a case where a plurality of R exists, the plurality of R may each be the same or different from each other.

[0019]

- Examples of the alkyl group that can be selected as R in General Formula (a1) include those same as R in General Formula (a) above, and the same applies for the preferred aspects thereof.
- 15

More preferred specific examples of the tetraalkoxysilane include tetramethoxysilane, tetraethoxysilane, tetrapropoxysilane, and tetrabutoxysilane.

Among these, from the viewpoints of availability and reactivity in a hydrolysis reaction,

- 20 at least one of tetramethoxysilane or tetraethoxysilane, or a mixture of tetramethoxysilane and tetraethoxysilane is preferred.

[0020]

Note that "main component" in the silane-based compound exhibiting polycondensation property by hydrolysis refers to a silane-based compound having the

largest content in 100 mass% total of the silane-based compound exhibiting polycondensation property by hydrolysis.

In the silane-based compound exhibiting polycondensation property by hydrolysis, the content of the silane-based compound represented by the above General Formula (a) and an oligomer thereof contained as the main component is not particularly limited as long as the content is larger than contents of other silane-based compounds but, for example, is preferably 50 mass% or greater, more preferably 70 mass% or greater, even more preferably 80 mass% or greater, and yet even more preferably 90 mass% or greater, and 100 mass% or less, with respect to 100 mass% total of the silane-based compound exhibiting polycondensation property by hydrolysis. In other words, according to an aspect of the present invention, in the silane-based compound exhibiting polycondensation property by hydrolysis, the content of the silane-based compound represented by the above General Formula (a) and an oligomer thereof contained as the main component is preferably 50 to 100 mass%, more preferably 70 to 100 mass%, even more preferably 80 to 100 mass%, and yet even more preferably 90 to 100 mass%, with respect to 100 mass% total of the silane-based compound exhibiting polycondensation property by hydrolysis.

[0021]

Furthermore, the average degree of polymerization of the oligomer of the tetrafunctional silane-based compound represented by the above General Formula (a) or the oligomer of the tetraalkoxysilane represented by the above General Formula (a1) is not particularly limited and may be, for example, each independently from 2 to 20 or from 2 to 15. That is, it may be, on average, from dimer to eicosamer of each of the silane-based compounds, or may be, on average, from dimer to pentadecamer of each of the silane-based compounds.

Furthermore, the expressions "oligomer of the tetrafunctional silane-based compound represented by the above General Formula (a)" and "oligomer of the tetraalkoxysilane represented by the above General Formula (a1)" are each not simply limited to those obtained by using a monomer of each of the silane-based compounds as a starting material and also include a compound having a structure, in which two or more of the tetrafunctional silane-based compounds represented by the above General Formula (a) or the tetraalkoxysilanes represented by the above General Formula (a1) are condensed, obtained as a result of synthesis using another compound as a starting material. The same applies to the expression "oligomer of mono- to trifunctional silane-based compound" described below.

[0022]

As the silane-based compound exhibiting polycondensation property by hydrolysis, a commercially available product can be used. Preferred examples of the commercially available product include "Colcoat (trade name) N-103X", "Colcoat (trade name) PX", "methyl silicate 51" which is an oligomer of, on average, tetramer of tetramethoxysilane, "methyl silicate 53A" which is an oligomer of, on average, heptamer of tetramethoxysilane, "ethyl silicate 40" which is an oligomer of, on average, pentamer of tetraethoxysilane, "ethyl silicate 48" which is an oligomer of, on average, decamer of tetraethoxysilane, and "EMS-485" which is a mixture of an oligomer of, on average, decamer of tetramethoxysilane and an oligomer of, on average, decamer of tetraethoxysilane (all available from Colcoat Co., Ltd.).

[0023]

Examples of other silane-based compound that may be contained in the silane-based compound include mono- to tri-functional silane-based compounds. However, from the viewpoint of improving hydrophilicity of the intermediate layer, the

tetrafunctional silane-based compound is preferably contained as the main component as described above.

Furthermore, from the viewpoint of promoting a hydrolysis reaction or condensation reaction of the silane-based compound exhibiting polycondensation

5 property by hydrolysis, for example, a catalyst such as an acid catalyst or a metal catalyst may be used.

[0024]

From the viewpoint of ease in water permeation at the time when the intermediate layer and water are brought into contact with each other, the thickness of the
10 intermediate layer is preferably from 0.01 to 1 μm , more preferably from 0.03 to 0.5 μm , and even more preferably from 0.05 to 0.3 μm .

[0025]

<Release Agent Layer>

The release agent layer is preferably a layer formed from the release agent
15 composition.

The release agent composition used for formation of the release agent layer is not particularly limited as long as the release agent composition achieves releasability, and for example, a release agent composition containing a silicone-based compound; a fluorine compound; a long-chain alkyl group-containing compound; or a thermoplastic
20 resin material, such as an olefin-based resin or a diene-based resin, as a main component can be used. Furthermore, use of a release agent composition containing an energy ray-curable or thermosetting resin as a main component is preferred. One type of these release agent compositions may be used alone, or a combination of two or more types of these release agent compositions may be used.

Note that "main component" in the release agent composition refers to a component having the largest content in 100 mass% total of the solid content of the release agent composition.

[0026]

5 In the release agent composition containing a silicone-based compound as the main component, and examples of the silicone-based compound include a silicone-based compound containing an organopolysiloxane as a basic skeleton. Furthermore, examples of the silicone-based compound include a thermosetting silicone-based compound, such as addition reaction type and condensation reaction type silicone-based
10 compounds; and an energy ray-curable silicone-based compound, such as ultraviolet radiation-curable and electron beam-curable silicone-based compounds.

[0027]

 Specific examples of the addition reaction type silicone-based compound include an organopolysiloxane, in which two or more alkenyl groups having from 2 to 10
15 carbons, such as a vinyl group, an allyl group, a propenyl group, and a hexenyl group, are contained in at least one selected from the group consisting of terminals and side chains of a molecule. When such an addition reaction type silicone-based compound is used, a cross-linking agent and a catalyst are preferably used together.

[0028]

20 Examples of the cross-linking agent include an organopolysiloxane having at least two hydrogen atoms bonded to silicon atoms in a molecule, and specific examples thereof include a dimethylsiloxane-methylhydrogensiloxane copolymer having a terminal capped with a dimethylhydrogensiloxy group, a dimethylsiloxane-methylhydrogensiloxane copolymer having a terminal capped with a trimethylsiloxy

group, a methylhydrogenpolysiloxane having a terminal capped with a trimethylsiloxy group, and a poly(hydrogen silsesquioxane).

[0029]

Furthermore, examples of the catalyst include microparticulate platinum,
5 microparticulate platinum adsorbed on a carbon powder carrier, chloroplatinic acid, an alcohol-modified chloroplatinic acid, an olefin complex of chloroplatinic acid, and a platinum group metal-based compound, such as a palladium or rhodium-based compound. By using such a catalyst, curing reaction of the release agent composition can proceed more effectively.

10 [0030]

In the release agent composition containing a fluorine compound as the main component, examples of the fluorine compound include a fluorosilicone compound, a fluorine-boron compound, and a poly(perfluoro alkylene ether)-chain-containing compound.

15 [0031]

In the release agent composition containing a long-chain alkyl group-containing compound as the main component, examples of the long-chain alkyl group-containing compound include a polyvinyl carbamate obtained by reacting a polyvinyl alcohol-based polymer with a long-chain alkyl isocyanate having from 12 to 40 carbons in an alkyl
20 group, an alkyl urea derivative obtained by reacting a polyethylene imine with a long-chain alkyl isocyanate having from 12 to 40 carbons in an alkyl group, and a copolymer of a long-chain alkyl(meth)acrylate having from 12 to 40 carbons in an alkyl group. Furthermore, a long-chain alkyl-modified alkyd resin obtained by using a long-chain fatty acid having from 12 to 40 carbons in an alkyl group as a modification agent for an

alkyd resin obtained by a condensation reaction of a polyhydric alcohol and a polybasic acid.

[0032]

As the release agent composition containing an energy ray-curable resin as a
5 main component, for example, a release agent composition containing an energy ray-curable compound (A) having a reactive functional group selected from the group consisting of (meth)acryloyl groups, alkenyl groups, and a maleimide group, and a polyorganosiloxane (B) is preferred. Because the release agent layer formed from this release agent composition uses an energy ray-curable compound (A) and a
10 polyorganosiloxane (B) that have molecular structures, polarities, and molecular weights that are different from each other, components derived from the polyorganosiloxane (B) is segregated because the polyorganosiloxane (B) is pushed toward the vicinity of an outer surface of the release agent layer after the application and before the curing. By this, the releasability of the release agent layer can be improved.

15 [0033]

(Energy Ray-Curable Compound (A))

The energy ray-curable compound (A) is a component that imparts curability to the release agent layer.

As the energy ray-curable compound (A) (hereinafter, also referred to as
20 "component (A)"), an energy ray-curable compound having a reactive functional group selected from the group consisting of (meth)acryloyl groups, alkenyl groups, and a maleimide group is preferred. Examples of the alkenyl group include an alkenyl group having from 2 to 10 carbons, such as a vinyl group, an allyl group, a propenyl group, and a hexenyl group. One type of component (A) may be used alone, or a combination of
25 two or more types of components (A) may be used.

[0034]

Furthermore, from the viewpoint of curability, the component (A) is preferably a component having three or more of the reactive functional groups in a molecule. As the component (A), by using the energy ray-curable compound having three or more of the reactive functional groups in a molecule, excellent curability, solvent resistance, and
 5 releasability can be achieved even when the release agent layer has a thickness that makes it difficult to cure due to oxygen inhibition.

[0035]

Examples of the component (A) include a polyfunctional (meth)acrylate, such as
 10 dipentaerythritol tri(meth)acrylate, dipentaerythritol tetra(meth)acrylate, dipentaerythritol penta(meth)acrylate, dipentaerythritol hexa(meth)acrylate, pentaerythritol tri(meth)acrylate, and pentaerythritol tetra(meth)acrylate. Among these, as the component (A), use of at least one selected from the group consisting of dipentaerythritol tri(meth)acrylate, dipentaerythritol tetra(meth)acrylate, dipentaerythritol
 15 penta(meth)acrylate, dipentaerythritol hexa(meth)acrylate, pentaerythritol tri(meth)acrylate, and pentaerythritol tetra(meth)acrylate is preferred. By this, excellent curability of the component (A) is achieved even when the release agent composition is applied onto an intermediate layer surface on the base material as a thin film.

[0036]

20 In a case where the release agent composition contains the component (A), the content of the component (A) is preferably 65 mass% or greater and 98.5 mass% or less, and more preferably 70 mass% or greater and 95 mass% or less, per 100 mass% of the solid content of the release agent composition.

[0037]

25 (Polyorganosiloxane (B))

The polyorganosiloxane (B) is a component that imparts releasability to the release agent layer. Examples of the polyorganosiloxane (B) (hereinafter, also referred to as "component (B)") include polyorganosiloxanes having a straight or branched molecular chain. Furthermore, as the component (B), use of a modified

5 polyorganosiloxane, in which, at least one of terminals or side chains of a molecular chain has a silicon atom of the molecular chain bonded with a reactive functional group selected from the group consisting of a (meth)acryloyl group, an alkenyl group, and a maleimide group directly or via a divalent linking group, is preferred. Examples of the alkenyl group include a vinyl group, an allyl group, and a propenyl group. Furthermore, 10 examples of the divalent linking group include an alkylene group, an alkyleneoxy group, an oxy group, an imino group, a carbonyl group, and a divalent linking group obtained by combining these. The number of carbons of the divalent linking group is preferably from 1 to 30, and more preferably from 1 to 10. One type of component (B) may be used alone, or a combination of two or more types of components (B) may be used.

15 [0038]

According to the modified organopolysiloxane, when the energy ray-curable compound (A) is cured by an energy ray irradiation, the modified organopolysiloxane is incorporated and fixed in a crosslinked structure of a cured product of the energy ray-curable compound (A). By this, transfer of the polyorganosiloxane contained in the 20 release agent layer to an object (e.g., adhesive layer, ceramic green sheet, or base material backside of the release sheet itself) that is in contact with the outer surface of the release agent layer can be suppressed.

[0039]

Examples of the organic group other than the reactive functional group of the 25 component (B) include a monovalent hydrocarbon group containing no aliphatic

unsaturated bond. As this organic group, a plurality of identical or different organic groups may be contained. As the hydrocarbon group, a hydrocarbon group having from 1 to 12 carbons is preferred, and a hydrocarbon group having from 1 to 10 carbons is more preferred. Examples of the hydrocarbon group include an alkyl group such as a methyl group, an ethyl group, and a propyl group, and an aryl group such as a phenyl group and a tolyl group.

[0040]

From the viewpoint of improving releasability of the release agent layer, the component (B) is preferably a component in which 80 mol% or greater of organic groups other than the reactive functional group in the molecule of the component (B) is methyl groups.

[0041]

In a case where the release agent composition contains the component (B), the content of the component (B) is preferably 0.5 mass% or greater and 5 mass% or less, and more preferably 0.7 mass% or greater and 4 mass% or less, per 100 mass% of the solid content of the release agent composition. Therefore, for example, in a case of use in production of a green sheet, application to a base material becomes easier without repelling a ceramic slurry, and releasability of the release sheet is improved.

[0042]

Furthermore, as the blended amounts of the polyorganosiloxane (B) and the energy ray-curable compound (A), the component (B)/component (A) is preferably 0.7/99.3 or greater and 5/95 or less, and more preferably 1/99 or greater and 4.5/95.5 or less. Therefore, for example, in a case of use in production of a green sheet, application onto the release agent layer becomes easier without repelling a ceramic slurry, and releasability of the green sheet from the release sheet is improved.

[0043]

(Photopolymerization Initiator)

Furthermore, the release agent composition may further contain a photopolymerization initiator.

5 From the viewpoints of excellent curability, solvent resistance, and releasability, as the photopolymerization initiator that may be contained in the release agent composition, for example, 2-methyl-1-[4-(methylthio)phenyl]-2-morpholinopropan-1-one, 2-benzyl-2-dimethylamino-1-(4-morpholinophenyl)-butanone-1, and 2-(dimethylamino)-2-[(4-methylphenyl)methyl]-1-[4-(4-morpholinyl)phenyl]-1-butanone
10 are preferred.

One type of these photopolymerization initiators may be used alone, or a combination of two or more types of these photopolymerization initiators may be used.

[0044]

In a case where the release agent composition contains the photopolymerization
15 initiator, the content of the photopolymerization initiator is preferably 1 mass% or greater and 20 mass% or less, and more preferably 3 mass% or greater and 15 mass% or less, per 100 mass% of the solid content of the release agent composition. By this, even when the thickness of the release agent layer is in a range that makes curability difficult to be
20 achieved due to oxygen inhibition, excellent curability, solvent resistance, and releasability can be achieved.

Furthermore, as the release agent composition containing the energy ray-curable resin as the main component, a release agent composition containing an additional component, such as a sensitizer or a reactive monomer, can be used in a range that the effect of the present invention is achieved.

25 [0045]

Furthermore, in a case where the release agent composition containing the energy ray-curable resin as the main component is a release agent composition containing the component (A) and the component (B), the total content of the component (A) and the component (B) and the optionally contained photopolymerization initiator is preferably from 70 to 100 mass%, and more preferably from 80 to 100 mass%.

[0046]

Note that the energy ray-curable resin is less likely to be affected by means of removing foreign substances by chemical treatment because the chemical bond constituting the main chain has a structure that is less likely to be decomposed by an acid or alkali. Because of this, the release sheet containing the release agent layer containing the energy ray-curable resin as the main component becomes a release sheet that can easily remove the release agent layer by employing the configuration of an embodiment of the present invention.

[0047]

Examples of the release agent composition containing the thermosetting resin as the main component include a release agent composition containing a melamine resin as a main component or a release agent composition containing an epoxy resin as a main component. Examples of the release agent composition containing the melamine resin as the main component include a composition containing a melamine resin as the main component, an acid catalyst that thermally cures the melamine resin, and a polyorganosiloxane that imparts releasability to a release agent layer. Furthermore, examples of the release agent composition containing the epoxy resin as the main component include a composition containing an epoxy resin as the main component, an acidic or basic thermosetting catalyst that thermally cures the epoxy resin, and a polyorganosiloxane that imparts releasability to a release agent layer.

[0048]

In a case where the release agent composition contains the thermosetting resin as a main component, the content of the thermosetting resin is preferably 65 mass% or greater and 98.5 mass% or less, and more preferably 70 mass% or greater and 95 mass% or less, per 100 mass% of the solid content of the release agent composition.

Furthermore, in a case where the release agent composition contains the thermosetting resin as the main component, the content of the polyorganosiloxane that imparts releasability to the release agent layer is preferably 1 mass% or greater and 8 mass% or less, and more preferably 2 mass% or greater and 6 mass% or less, per 100 mass% of the solid content of the release agent composition.

Furthermore, in a case where the release agent composition contains the thermosetting resin as the main component, the content of each of the catalysts is each independently preferably 1 mass% or greater and 10 mass% or less, and more preferably 2 mass% or greater and 6 mass% or less, per 100 mass% of the solid content of the release agent composition.

[0049]

Furthermore, in a case where the release agent composition contains the thermosetting resin as the main component, the total content of the thermosetting resin, the polyorganosiloxane that imparts releasability to the release agent layer, and the catalysts is preferably from 70 to 100 mass%, and more preferably from 80 to 100 mass%.

[0050]

Furthermore, the release agent layer may contain another additive besides the resin components described above. Examples of such another additive include, for

example, an anti-aging agent, a photostabilizer, a flame retardant, a conductive agent, an antistatic agent, and a plasticizer.

[0051]

Furthermore, from the viewpoint of further reducing contamination of washing
5 water, the release agent layer is preferably water-insoluble, and more preferably hydrophobic (non-hydrophilic) and water-insoluble.

The thickness of the release agent layer can be appropriately selected and is not particularly limited. For example, the thickness is preferably from 0.02 to 5 μm , more preferably from 0.03 to 2 μm , and even more preferably from 0.05 to 1.5 μm .

10 [0052]

The release sheet is typically used at the time of production, transport, and storage of other functional sheets and various parts used for a particular purpose, to protect a surface of these sheets or parts. Practically, the release sheet is often released from the surface and disposed after protecting these parts and the like. Therefore, by use
15 of the release sheet, the base material can be easily separated from the release sheet, and thus such use achieves high contribution to resource protection and environmental protection.

[0053]

<Method for Producing Release Sheet>

20 The method for producing the release sheet is not particularly limited as long as the method can produce the release sheet, and the production can be performed by a known method.

For example, as the method for forming the intermediate layer, the intermediate layer can be formed by a method, in which a composition for intermediate layer

formation or a solution thereof is applied on one face of a base material, and then heated and dried, or cured by energy ray irradiation.

Furthermore, the method for forming the release agent layer can be also appropriately selected based on the type of the release agent layer and is not particularly limited as long as the method can produce the release sheet, and the production can be performed by a known method.

For example, the production can be performed by forming a release agent layer by a method, in which a release agent composition or a solution thereof is applied on the intermediate layer formed on the substrate by the method described above, and then heated and dried or cured by energy ray irradiation.

[0054]

The method for applying the composition for intermediate layer formation, the release agent composition, or a solution of these is not particularly limited, and a known method can be used. Examples thereof include a spin coating method, a spray coating method, a bar coating method, a knife coating method, a roll coating method, a blade coating method, a die coating method, and a gravure coating method.

Furthermore, the drying method and the drying temperature are not particularly limited in a case where the intermediate layer or the release agent layer is dried, and can be appropriately selected based on the properties of a raw material constituting the intermediate layer or the release agent layer. Similarly, in a case where the intermediate layer or the release agent layer is formed by energy ray irradiation, irradiation conditions such as the type, illuminance, and quantity of light of the energy ray can be appropriately selected based on the properties of a raw material constituting the intermediate layer or the release agent layer.

[0055]

As described above, the base material can be separated from the release sheet by bringing the intermediate layer and water into contact with each other. Thus, examples of an aspect of the present invention include a method for separating a base material from a release sheet, the release sheet including the base material, and the intermediate layer that is hydrophilic and water-insoluble and the release agent layer in this order on at least one surface side of the base material, and the method includes bringing the intermediate layer and water into contact with each other to separate the base material from the release sheet.

[0056]

The method for bringing the intermediate layer and water into contact with each other is not particularly limited but it is preferably performed by immersing the release sheet in water.

For example, in a case where the release sheet is a wound roll form, the release sheet may be immersed in a water tank as is in the roll form. In this case, the roll of the release sheet may be allowed to stand still in the water tank, or the water tank may be agitated.

Furthermore, in the middle of the continuous process in between drawing out the release sheet from a feed roll and winding the release sheet by a winding roll (roll-to-roll processing), a treatment such as passing the release sheet drawn out from the feed roll through a water tank or rubbing water to the sheet by a brush may be performed.

Furthermore, after the release sheet was cut, the cut release sheet may be immersed in a water tank. In this case, the cut release sheet may be allowed to stand still in the water tank, or the water tank may be agitated. Alternatively, a treatment such as rubbing water to the cut release sheet by a brush may be performed.

[0057]

The water to be brought into contact with the intermediate layer may be at room temperature but is preferably heated warm water. For example, the temperature is preferably 40°C or higher, and more preferably 60°C or higher. Furthermore, the temperature is preferably lower than 100°C, and more preferably 98°C or lower. As described above, lower limits and upper limits described in series can each be combined independently. For example, in an aspect of the present invention, the temperature of water to be brought into contact with the intermediate layer is preferably 40°C or higher and lower than 100°C, and more preferably 60°C or higher and 98°C or lower.

In the present specification, the water being at "room temperature" means that the temperature is at the same/similar temperature as an indoor environment and means a temperature of water which was not heated by a heat source or the like in the indoor environment. An example of the room temperature is not particularly limited but may be 23°C.

[0058]

As described above, by use of the release sheet, the base material can be easily separated from the release sheet. Furthermore, as described above, the intermediate layer in the release sheet that contributes to separation of the base material can reduce contamination of washing water used at the time of separation of the base material and, in addition, contamination of the washing water is suppressed, and thus a resin collected from the separated base material is also less likely to be contaminated. Furthermore, the suppression of contamination of the washing water also leads to simplification of reuse or waste treatment of the washing water.

Thus, the release sheet can be suitably used for a case where the resin collected from the base material is reused as is or a case where the resin is recycled by

decomposing the resin into monomer or the like that is a raw material constituting the resin.

Furthermore, in a case where the base material is separated by using the release sheet, simplification of the entire process of collecting and recycling of the resin, such as
5 easy separation of the washing water and the separated base material only by filtration of the washing water, can be achieved.

Accordingly, examples of an aspect of the present invention include a method for recycling a resin, the method including a step of separating a base material from a release sheet; and a step of collecting a resin from the base material;

10 the steps are performed by releasing an intermediate layer from a surface of the base material or a surface of a layer on the base material side by bringing the intermediate layer and water into contact with each other by at least using the method for separating a base material using the release sheet described above, the release sheet including the base material, and the intermediate layer and the release agent layer in this
15 order on at least one surface side of the base material. The step of collecting a resin from the base material is not particularly limited and a known method of collecting can be appropriately used based on the type of each resin and raw materials of the resin.

[Examples]

[0059]

20 The present invention will be specifically described with reference to examples below, but the present invention is not limited to the following examples. Physical property values in examples below are values measured by the following methods.

[0060]

[Thicknesses of Substrate, Intermediate Layer, and Release Agent Layer]

The thickness of a base material in a release sheet used in each of Examples and Comparative Examples was measured using a constant pressure thickness meter (model number: "PG-02J", standard specifications: in accordance with JIS K6783:1994, JIS Z1702:1994, and JIS Z1709:1995), available from Teclock Co., Ltd.

- 5 The thickness of an intermediate layer of each of Examples 1 to 4 and Comparative Example 2 was measured by using a spectroscopic ellipsometer (product name "M-2000", available from J.A. Woollam).

- The thickness of a release agent layer of each of Examples and Comparative Examples was measured by using a reflection-type film thickness meter (product name "F20", available from Filmetrics).

[0061]

[Evaluation of Water Insolubility of Intermediate Layer]

The water insolubility of the intermediate layer was determined by using the following methods.

- 15 (1) Measurement of Contact Angle of Water of Release Agent Layer Surface

The contact angle of water on the release agent layer surface of the release sheet obtained in each of Examples 1 to 4 and Comparative Example 2 was measured. The contact angle was measured by the sessile drop method in accordance with JIS R 3257:1999 by using a contact angle meter (product name "DM-701", available from

- 20 Kyowa Interface Science Co., Ltd.). Distilled water was used as a liquid droplet.

The measurement results are presented in "Contact angle (1)" of Table 1 below.

(2) Measurement of Contact Angle of Water of Base Material Side Surface of Intermediate Layer

- The base material was separated from the intermediate layer, then the contact
25 angle of water of the base material side surface of the intermediate layer was measured

by the following method, and thus the hydrophilicity of the intermediate layer was evaluated.

An adhesive tape (product name "polyester adhesive tape No.31B", available from Nitto Denko Corporation) having a width of 50 mm was adhered onto a release agent layer surface of the release sheet obtained in each of Examples 1 to 4 and Comparative Example 2, and then cut into a size of 50 mm × 50 mm to prepare a test piece.

Then, 300 mL of warm water was charged in a 500 mL glass beaker, and the entire test piece was immersed in the warm water at 90°C and allowed to stand for 3 hours. Thereafter, it was confirmed that the test piece was separated into a laminate, in which the release agent layer and the intermediate layer were carried together on the adhesive tape, and the base material, and the adhesive tape carrying the release agent layer and the intermediate layer was taken out from the warm water and dried at room temperature (23°C) for 24 hours. Thereafter, the contact angle for the surface of the intermediate layer carried on the adhesive tape (surface of the intermediate layer that had been in contact with the base material surface) was measured. The contact angle was measured by the sessile drop method in accordance with JIS R 3257:1999 by using a contact angle meter (product name "DM-701", available from Kyowa Interface Science Co., Ltd.). Distilled water was used as a liquid droplet.

The measurement results are presented in "Contact angle (2)" of Table 1 below.

(3) Method to Determine Whether Intermediate Layer Was Water-Insoluble

The intermediate layer of the release sheet was determined as being water-insoluble for a case where the difference between the value of the contact angle of water of the release agent layer surface of the release sheet measured in (1) above and the value of the contact angle of water of the base material side surface of the intermediate layer

measured in (2) above was 30 degrees or greater. The evaluation results are indicated in Table 1 below.

A case where this difference value of the contact angles is small means that the measurement was performed for the contact angle of the release agent layer which was partially or entirely exposed to the surface because components constituting the intermediate layer eluted into water in the operation of (2) above.

[0062]

[Evaluation of Hydrophilicity of Intermediate Layer]

Based on the result of "(2) Measurement of Contact Angle of Water of Base Material Side Surface of Intermediate Layer" above, the hydrophilicity of the release sheet obtained in each of Examples 1 to 4 and Comparative Example 2 was evaluated.

In a case where the value of the contact angle of water of the base material side surface of the intermediate layer was 55 degrees or less determined by "(2) Measurement of Contact Angle of Water of Base Material Side Surface of Intermediate Layer" above, the intermediate layer was determined as being hydrophilic. The results are presented in Table 1 below.

Note that, in Table 1 below, the value of the contact angle (2) of the intermediate layer formed from polyvinyl alcohol in Comparative Example 2 was high but this was due to the effect of the release agent layer partially exposed to the surface because the intermediate layer of Comparative Example 2 eluted into the warm water in "(2) Measurement of Contact Angle of Water of Base Material Side Surface of Intermediate Layer" above, as described above.

Thus, in Table 1 below, the hydrophilicity evaluation of the intermediate layer was only written for cases where the intermediate layer was water-insoluble.

For reference, in Comparative Example 2, when a laminate sample, in which no release agent layer was formed but only an intermediate layer was formed on a base material, was prepared and a surface of the intermediate layer was measured in accordance with "(1) Measurement of Contact Angle of Water of Release Agent Layer Surface" above, the contact angle was 35.2 degrees. Also from this point, it was confirmed that the intermediate layer of Comparative Example 2 eluted into the warm water due to the treatment of "(2) Measurement of Contact Angle of Water of Base Material Side Surface of Intermediate Layer" above.

[0063]

10 [Production of Release Sheet]

A release sheet was produced by the following method.

[0064]

Example 1

As a base material, a biaxially-oriented polyethylene terephthalate film (thickness: 31 μm) was prepared. Then, as the composition for intermediate layer formation, a silane-based compound exhibiting polycondensation property by hydrolysis (product name "Colcoat (trade name) N-103X", available from Colcoat Co., Ltd.) was prepared and mixed with isopropyl alcohol to adjust the solid concentration to 1.5 mass%.

20 Then, the obtained composition for intermediate layer formation was uniformly applied on one face of the base material by using a bar coater in a manner that the thickness of the intermediate layer after drying became 0.1 μm to form a coating layer, the coating layer was cured by heating at 130°C for one minute, and thus an intermediate layer was formed.

Then, 100 parts by mass of thermosetting addition reaction type silicone ("KS-847H", available from Shin-Etsu Chemical Co., Ltd.) was diluted with toluene, 2 parts by mass of a platinum catalyst ("CAT-PL-50T", available from Shin-Etsu Chemical Co., Ltd.) was added to this to form a solution having the solid concentration of 2.0 mass%,
5 and thus a coating liquid of a release agent composition was obtained. The prepared coating liquid was applied on the intermediate layer formed on the base material by using a bar coater to form a coating layer, the coating layer was cured by heating at 120°C for one minute, and thus a release agent layer having a thickness of 0.1 μm was formed. Thus, a release sheet having a structure in which the base material/the intermediate
10 layer/the release agent layer are laminated in this order was produced.

[0065]

Example 2

An intermediate layer was provided on one face of a base material by the same method as in Example 1.

15 Then, 100 parts by mass (value corresponding to solid content; hereinafter the same) of a methylated melamine resin (product name "MW-30", available from Nippon Carbide Industries Co., Inc.) and 4 parts by mass of a modified polydimethylsiloxane having both terminals of polyorganosiloxane capped with carbinol (product name "KF-6000", available from Shin-Etsu Chemical Co., Ltd.) were diluted with a mixed solvent
20 of isopropyl alcohol and methyl ethyl ketone (mixed ratio (mass ratio) was isopropyl alcohol:methyl ethyl ketone:cyclohexanone = 40:20:20). For the obtained diluted solution, 4.6 parts by mass of p-toluene sulfonic acid (product name "PS-80", available from Shin-Etsu Chemical Co., Ltd.) as an acid catalyst was added and uniformly mixed to obtain a solution having the solid concentration of 2.0 mass%, and thus a coating

liquid of a release agent composition containing a thermosetting resin as a main component was obtained.

The prepared coating liquid was applied on the intermediate layer formed on the base material by using a bar coater to form a coating layer, the coating layer was cured by heating at 120°C for one minute, and thus a release agent layer having a thickness of 0.1 µm was formed. Thus, a release sheet having a structure in which the base material/the intermediate layer/the release agent layer were laminated in this order was produced.

[0066]

10 Example 3

An intermediate layer was provided on one face of a base material by the same method as in Example 1.

Then, 94 parts by mass of a mixture of dipentaerythritol pentaacrylate and dipentaerythritol hexaacrylate (product name "ARONIX (trade name) M-400", available from Toagosei Co., Ltd.; solid content: 100 mass%) as polyfunctional acrylates, 1 part by mass of an acryl-modified polydimethylsiloxane (product name "X-22-164A", available from Shin-Etsu Chemical Co., Ltd.; solid content: 100 mass%), and 5 parts by mass of a photopolymerization initiator (product name "Omnirad (trade name) 907", available from IGM Resins B.V. (2- methyl-1-[4-(methylthio)phenyl]-2-morpholinopropan-1-one; solid content: 100 mass%)) were diluted with a mixed solvent of isopropyl alcohol and methyl ethyl ketone (mixed ratio (mass ratio) was isopropyl alcohol:methyl ethyl ketone = 3:1) to form a solution having the solid concentration of 20 mass%, and thus a coating liquid of a release agent composition containing an energy ray-curable resin as a main component was obtained.

The prepared coating liquid was applied on the formed intermediate layer on the base material by using a bar coater and dried at 80°C for one minute, and thus a coating layer was obtained. Then, the coating layer was irradiated with ultraviolet radiation (cumulative light quantity: 250 mJ/cm²) to form a release agent layer (thickness: 1 μm),
5 and thus a release sheet having a structure in which the base material/the intermediate layer/the release agent layer were laminated in this order was produced.

[0067]

Example 4

A release sheet having a structure in which the base material/the intermediate
10 layer/the release agent layer were laminated in this order was produced in the same manner as in Example 1 except for forming an intermediate layer by changing the composition for intermediate layer formation of Example 1 as follows.

As the composition for intermediate layer formation, 100 parts by mass, in terms of solid content, of a silane-based compound exhibiting polycondensation property by
15 hydrolysis (product name "methyl silicate 53A", available from Colcoat Co., Ltd.), 35 parts by mass of distilled water, and 2.0 parts by mass, in terms of solid content, of p-toluenesulfonic acid (product name "PS-80", available from Shin-Etsu Chemical Co., Ltd.) as an acid catalyst were mixed, and after the solid concentration was adjusted to 40
20 mass% by using isopropyl alcohol, the mixture was agitated for 20 minutes. Then, the solid concentration was adjusted to 1.5 mass% by using isopropyl alcohol, and thus a composition for intermediate layer formation was obtained.

Then, the obtained composition for intermediate layer formation was uniformly applied on one face of the base material by using a bar coater in a manner that the thickness of the intermediate layer after drying became 0.1 μm to form a coating layer,

the coating layer was cured by heating at 120°C for one minute, and thus an intermediate layer was formed.

[0068]

Comparative Example 1

- 5 A release sheet having a structure in which the base material/the release agent layer were laminated in this order was produced in the same manner as in Example 1 except for forming no intermediate layer of Example 1.

[0069]

Comparative Example 2

- 10 As a base material, a biaxially-oriented polyethylene terephthalate film (thickness: 31 μm) was prepared.

- Then, 2 mass% aqueous solution of a partially saponified polyvinyl alcohol resin ("GOHSENOL (trade name) GL-05", available from Mitsubishi Chemical Corporation) was uniformly applied on one face of the base material in a manner that the thickness
15 after drying became 0.1 μm , and heated at 120°C for one minute, and thus an intermediate layer was formed. Besides this, a release agent layer was formed in the same manner as in Example 1, and thus a release sheet having a structure in which the base material/the intermediate layer/the release agent layer were laminated in this order was produced.

- 20 [0070]

[Separability of Substrate]

- The release sheet obtained by the methods described in Examples and Comparative Examples was cut into a size of 50 mm $\times$ 50 mm, and thus a test piece was obtained. Then, 300 mL of warm water at 90°C was charged in a 500 mL glass beaker,
25 and the entirety of one test piece was immersed in the warm water and allowed to stand

for 1 hour while the temperature was maintained at 90°C. Then, the test piece taken out from the warm water was immersed in distilled water at room temperature (23°C) to wash, and thus a sample for separability evaluation was obtained.

For the sample, separability of the base material was evaluated based on the detected amount of nitrogen (N) and silicon (Si) which are specific elements derived from the chemical composition of the release agent layer measured for the base material surface on the side where the release agent layer was provided, by X-Ray Photoelectron Spectroscopy (XPS). Proportion of each element was calculated based on the following equation. A case where a specific element derived from the chemical composition of the release agent layer was less than 0.05 atom% was determined as the release agent layer being separated and removed from the base material surface. The results are presented in Table 2 below. Note that, in Table 2, a case where the proportion was less than 0.05 atom% was written as undetected (N.D.).

In each calculation equation below, N represents a nitrogen element amount, Si represents a silicon element amount, C represents a carbon element amount, and O represents an oxygen element amount.

- Nitrogen (N) element proportion (atom%) = $[N/(C + O + N + Si)] \times 100$
- Silicon (Si) element proportion (atom%) = $[Si/(C + O + N + Si)] \times 100$

[0071]

[Evaluation of Contamination of Washing Water]

(i) Measurement of COD Value

The release sheet obtained by the methods described in Examples 1 to 4 and Comparative Example 2 was cut into a size of 50 mm × 50 mm, and thus a test piece was obtained. Then, 100 mL of distilled water as washing water was charged in a 200 mL glass beaker and heated to 90°C, and the entirety of ten test pieces was immersed in the

washing water and allowed to stand for 1 hour while the temperature was maintained at 90°C. Thereafter, all the test pieces were taken out from the beaker, the maintenance of the temperature was stopped, and the washing water was cooled to room temperature (23°C) in an environment at room temperature (23°C). After completion of the cooling, the washing water was filtered by using a polyethylene mesh (#380), the water temperature was adjusted to 25°C, the COD value of the washing water was measured by using a water quality tester (product name "PACKTEST (trade name) COD", model: WAK-COD-2, available from Kyoritsu Chemical-Check Lab., Corp.) and evaluated based on the following criteria. The results are presented in Table 2 below.

- A (washing water was not contaminated): the COD value was less than 10 mg/L
 - F (washing water was contaminated): the COD value was 10 mg/L or greater
- [0072]

(ii) Measurement of Dry Weight of Eluted Component

Furthermore, as a method different from (i) above, the contamination of the washing water was also evaluated by measuring the dry weight of component eluted into the washing water using the following method.

The release sheet obtained in Example 1 and Comparative Example 2 was cut into a size of 100 mm × 100 mm, and thus a test piece was produced. Then, 1500 mL of distilled water was charged in a 2000 mL glass beaker, and the entirety of ten test pieces were immersed in water and allowed to stand at 90°C for 3 hours. Thereafter, the base material separated from the test piece was taken out from the water, and the intermediate layer-attached release agent layer floated on water surface was filtered to obtain water content that was used in the elution. This was repeatedly subjected to heating and drying, and vacuum drying, and the component eluted from the release sheet into the

water was obtained, and the weight thereof was measured. The result is presented in Table 2 below as an amount of elution.

Note that, because the base material and the release agent layer constituting the release sheet obtained in each of Example 1 and Comparative Example 2 are water-insoluble, the component eluted in this method is the component of the intermediate layer. Thus, the method can be used as an evaluation method to determine whether the intermediate layer in the release sheet is water-insoluble or not. Furthermore, the value of the amount of elution in Table 2 below indicates a value of (dry weight of eluted component)/(area of immersed release sheet) (unit: $\mu\text{g}/\text{m}^2$).

[0073]

[Table 1]

Table 1

	Release agent layer	Intermediate layer	Water insolubility of intermediate layer				Hydrophilicity of intermediate layer (*5)
	Raw material, etc. (1*)	Raw material, etc.	Contact angle (1) of release agent layer [degree]	Contact angle (2) of intermediate layer [degree]	Difference in contact angles [(1) - (2)] [degree]	Evaluation Result (*4)	
Example 1	Silicone	Silane-based compound (*2)	105.8	30.7	75.1	Water-insoluble	Hydrophilic
Example 2	Methylated melamine resin	Silane-based compound (*2)	95.4	18.1	77.3	Water-insoluble	Hydrophilic
Example 3	Polyfunctional acrylate	Silane-based compound (*2)	92.9	39.1	53.8	Water-insoluble	Hydrophilic
Example 4	Polyfunctional acrylate	Silane-based compound (*2)	93.8	27.4	65.4	Water-insoluble	Hydrophilic
Comparative Example 1	Silicone	-	-	-	-	-	-
Comparative Example 2	Silicone	Polyvinyl alcohol	105.2	90.8 (*3)	14.4	Water soluble	-

(*1): Main component of the raw material constituting the release agent layer.

(*2): Silane-based compound exhibiting polycondensation property by hydrolysis, which is formable of a layer having a siloxane bond.

(*3) Due to the intermediate layer being eluted into the washing water. The contact angle before elution was 35.2 degrees (reference value).

(*4): "Water insoluble": The difference between the contact angle (1) and the contact angle (2) was 30 degrees or greater.

(*5): “Hydrophilic”: The contact angle (2) of the intermediate layer was 55 degrees or less.

[0074]

[Table 2]

5 Table 2

	Release agent layer	Intermediate layer	Separability of substrate		Contamination of washing water	
	Raw material, etc. (1*)	Raw material, etc.	N [Atom%]	Si [Atom%]	COD [Result/mg/L]	Elution amount [$\mu\text{g}/\text{m}^2$]
Example 1	Silicone	Silane-based compound (*2)	-	N.D.	A/less than 10	0
Example 2	Methylated melamine resin	Silane-based compound (*2)	N.D.	N.D.	A/less than 10	-
Example 3	Polyfunctional acrylate	Silane-based compound (*2)	N.D.	N.D.	A/less than 10	-
Example 4	Polyfunctional acrylate	Silane-based compound (*2)	N.D.	N.D.	A/less than 10	-
Comparative Example 1	Silicone	-	-	24.7	-	-
Comparative Example 2	Silicone	Polyvinyl alcohol	-	N.D.	F/20 or greater	84

(*1): Main component of the raw material constituting the release agent layer.

(*2): Silane-based compound exhibiting polycondensation property by hydrolysis, which is formable of a layer having a siloxane bond.

10 [0075]

As presented in Table 2, from the evaluation results of separability of the base material using the release sheets of Examples 1 to 4, it was confirmed that the base material can be separated from the release sheet, in which the base material, the intermediate layer formed from the silane-based compound exhibiting polycondensation property by hydrolysis on the base material, and the release agent layer were provided in this order, by bringing the intermediate layer and water into contact with each other to release the intermediate layer from the base material surface. Furthermore, in a case where the base material was separated from the release sheet by using the release sheet of each of Examples 1 to 4, since the intermediate layer was water-insoluble, the COD value in the washing water used during the separation of the base material was low, and it

was confirmed that the release sheets were each excellent as a release sheet used in the method for separating the base material with less environmental impact.

Meanwhile, in a case where the release sheet of Comparative Example 1 was used, it was confirmed that an Si element was detected on the release agent layer side of the base material even after the separability evaluation of the base material was performed, and the release agent layer was not removed on the base material, and the base material was not separated.

Furthermore, in a case where the release sheet of Comparative Example 2 was used, the base material layer was separated by bringing the intermediate layer and water into contact with each other. However, since the intermediate layer was water soluble, it was confirmed that the COD value in the washing water used during the separation of the base material increased.

[Industrial Applicability]

[0076]

As described above, in a case where the base material is separated by bringing the intermediate layer and water into contact with each other using the release sheet of an embodiment of the present invention, because the intermediate layer is insoluble in the used washing water, contamination of the washing water can be suppressed compared to conventional products. Thus, for example, in a process of separating the base material, the used washing water can be treated by a simple method such as filtration treatment, and thus burden of liquid-waste treatment can be reduced. Reuse of the washing water also becomes easy, which is beneficial.

Thus, from the viewpoint of being capable of simplifying or omitting liquid-waste treatment process of the washing water, from the viewpoint of being capable of reuse the washing water, and the like, use of the release sheet of an embodiment of the

present invention is effective to reduce environmental impacts compared to known technologies. Furthermore, from the viewpoint of leading to cost reduction for the separation of the base material due to simplification of liquid-waste treatment process and the like, use of the release sheet of an embodiment of the present invention is

5 industrially, remarkably effective.

[CLAIMS]

[Claim 1]

A release sheet comprising a base material and an intermediate layer and a release agent layer in this order on at least one surface side of the base material, the
5 intermediate layer being hydrophilic and water-insoluble.

[Claim 2]

The release sheet according to claim 1, wherein a contact angle of water on the base material side surface of the intermediate layer is 55 degrees or less.
10

[Claim 3]

The release sheet according to claim 1 or 2, wherein a difference between a contact angle of water on the release agent layer surface and a contact angle of water on the base material side surface of the intermediate layer is 30 degrees or greater.
15

[Claim 4]

The release sheet according to any one of claims 1 to 3, wherein the intermediate layer is directly laminated on the base material.

20 [Claim 5]

The release sheet according to any one of claims 1 to 4, wherein the intermediate layer is a layer having a siloxane bond.

[Claim 6]

The release sheet according to claim 5, wherein the layer having a siloxane bond is a layer formed from a silane-based compound exhibiting polycondensation property by hydrolysis.

5 [Claim 7]

The release sheet according to claim 6, wherein the silane-based compound comprises, as a main component, at least one selected from the group consisting of a tetrafunctional silane-based compound represented by the following General Formula (a) and an oligomer thereof:



where in General Formula (a), R represents an alkyl group, and X represents a halogen atom, in a case where a plurality of R and X exists, the plurality of R and X may each be the same or different from each other, and p represents an integer from 0 to 4.

15 [Claim 8]

The release sheet according to claim 7, wherein the tetrafunctional silane-based compound is a tetraalkoxysilane represented by the following General Formula (a1):



where in General Formula (a1), R represents an alkyl group, and in a case where a
20 plurality of R exists, the plurality of R may each be the same or different from each other.

[Claim 9]

The release sheet according to any one of claims 1 to 8, wherein the base material is a resin film.

[Claim 10]

The release sheet according to any one of claims 1 to 9, wherein the release agent layer is a layer comprising a release agent composition containing an energy ray-curable or thermosetting resin as a main component.