

[DESCRIPTION]

[TITLE OF INVENTION]

RELEASE SHEET

[Technical Field]

5 [0001]

The present invention relates to a release sheet including at least a substrate, and an intermediate layer and a release agent layer in this order on at least one surface side of the substrate.

[Background Art]

10 [0002]

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

In recent years, from the viewpoints of global resource protection,
15 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 applies to the field of release sheets. Since release sheets are generally discarded after use, it is an urgent need to reduce the amount of waste from the
20 viewpoint of earth resource protection, environmental protection, and the like. As one measure to deal with this matter, for example, efforts are underway to separate the substrate and the like with a large resin content from used release sheets, and recover and reuse the resin and the like.

However, a release sheet including a release agent layer cannot easily separate
25 the substrate as it is, and the raw material resin and the like of the substrate cannot be

recovered and regenerated. Therefore, a mechanism capable of easily separating the substrate from the used release sheet is needed. From such a background, a release sheet capable of easily separating a substrate after being used as a release sheet is required.

For example, Patent Document 1 discloses a method of recovering a release film that has been formed on at least one face of a substrate film with an easily soluble resin layer interposed between the substrate film and the release layer, and the method includes recovering only the substrate film by immersing the 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.

10 [Citation List]

[Patent Literature]

[0003]

Patent Document 1: JP 2002-265665 A

[Summary of Invention]

15 [Technical Problem]

[0004]

Meanwhile, if the separability of the substrate from the release sheet is merely improved, trouble such as separation of the substrate from the release sheet occurs during normal use, and problems arise in the original use as a release sheet. That is, the substrate is required to be not separated from the release sheet during use for the original purpose.

Therefore, there is a demand for development of a release sheet which has good substrate adhesion during normal use while the release sheet can easily separate the substrate after use.

25 [0005]

The present invention has been made in light of the above circumstances, and an object of the present invention is to provide a novel release sheet which is a release sheet including a substrate, exhibits good adhesion to the substrate when used as a release sheet, and can easily separate the substrate after use.

5 [Solution to Problem]

[0006]

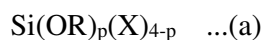
The inventors found that the above problems can be solved by forming a release sheet which is a laminate including a substrate, and an intermediate layer and a release agent layer in this order on at least one surface side of the substrate, in which the
10 intermediate layer is a layer formed from a specific composition for forming the intermediate layer, thereby leading to the present invention.

That is, the present invention provides the following [1] to [9].

[1] A release sheet comprising a laminate comprising a substrate, and an intermediate layer and a release agent layer in this order on at least one surface side of
15 the substrate, in which the intermediate layer is a layer formed from a composition for forming the intermediate layer, the composition containing a silane-based compound (A) exhibiting polycondensation property by hydrolysis, and an acrylate compound (B).

[2] The release sheet according to [1], in which the component (B) is polyfunctional (meth)acrylate having two or more (meth)acryloyl groups per molecule.

20 [3] A release sheet according to [1] or [2], in which the component (A) contains as the main component at least one selected from a tetrafunctional silane-based compound represented by General Formula (a) or an oligomer thereof:



where 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.

[4] The release sheet according to [3], in which the tetrafunctional silane-based compound is tetraalkoxysilane represented by General Formula (a1):



where 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.

[5] The release sheet according to any one of [1] to [4], in which a total content of the component (A) and the component (B) is 80 mass% or more per 100 mass% of the solid content of the composition for forming the intermediate layer.

[6] The release sheet according to any one of [1] to [5], in which the component (B) in the composition for forming the intermediate layer accounts for 50 mass% or less per 100 mass% of the total content of the component (A) and the component (B).

[7] The release sheet according to any one of [1] to [6], in which the substrate is a resin film.

[8] The release sheet according to any one of [1] to [7], in which the substrate and the intermediate layer are directly laminated.

[9] The release sheet according to any one of [1] to [8], in which the substrate is separated from the release sheet by bringing the intermediate layer into contact with water.

[Advantageous Effects of Invention]

[0007]

According to the present invention, it is possible to provide a novel release sheet which is a release sheet including a substrate, exhibits good adhesion to the substrate when used as a release sheet, and can easily separate the substrate after use.

[Description of Embodiments]

5 [0008]

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

In the present specification, the lower and upper limits of a preferable numerical range (e.g., a range of content) described in series can each be independently combined.

10 For example, from the description “preferably from 10 to 90, more preferably from 30 to 60”, the “preferred lower limit (10)” and the “more preferred upper limit (60)” can be combined as “from 10 to 60”. Similarly, from the description “preferably 10 or more, more preferably 30 or more” and the description of “preferably 90 or less, more preferably 60 or less” for an identical item, the “preferred lower limit (10)” and the
15 “more preferred upper limit (60)” can be combined as “10 or more and 60 or less”.

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.

Moreover, in the present specification, for example, “energy rays” is used as a
20 term meaning known energy rays such as γ rays, electron beams, ultraviolet rays, and visible light.

Furthermore, in the present specification, “(meth)acryl” is used as a term meaning either or both “acryl” and “methacryl”. Similarly, “(meth)acrylate” is used as a term meaning either or both “acrylate” and “methacrylate”. Similarly, in the present

specification, “(meth)acryloyl” is used as a term meaning either or both “acryloyl” and “methacryloyl”.

[0009]

[Release Sheet]

5 A release sheet according to the present invention is characterized by being a laminate including a substrate, and an intermediate layer and a release agent layer in this order on at least one surface side of the substrate, in which the intermediate layer is a layer formed from a composition for forming the intermediate layer, the composition containing a silane-based compound (A) exhibiting polycondensation property by
10 hydrolysis, and an acrylate compound (B).

 The release sheet preferably has a structure in which the substrate and the intermediate layer are directly laminated from the viewpoint of easily recovering and reusing a resin constituting the substrate from the separated substrate and the like. Herein, “directly laminated” refers to a structure in which no other layer is included
15 between the substrate and the intermediate layer, and the substrate and the intermediate layer are directly in contact.

 Furthermore, in one aspect of the release sheet, the substrate, the intermediate layer, and the release agent layer may be directly laminated in this order. That is, the release sheet may have a structure in which no other layer is included between the
20 substrate, the intermediate layer, and the release agent layer, and each layer is directly in contact with each other.

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

[0010]

25 <Substrate>

As a substrate, for example, a paper substrate 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 recovered is a resin. Meanwhile, in a case where a paper substrate is separated, the component to be recovered is pulp fibers.

5 As the resin film, for example, a polyester film, such as a polyethylene terephthalate film, polybutylene terephthalate, and polyethylene naphthalate; 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-
 10 (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 recovery and regeneration, a polyester film containing polyethylene terephthalate, polybutylene terephthalate, and/or polyethylene
 15 naphthalate, as a main component is preferred. Herein, “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 is even more preferred.

20 [0011]

Furthermore, the substrate may be a resin film having only one or two or more types of the aforementioned resins. For example, the substrate may be a monolayer film formed by one resin film or may be a multilayer film in which a plurality of resin films are laminated. From the viewpoint of ease of resin recovery, the substrate is preferably

a monolayer film formed by 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 antistatic agent, an antioxidant, an organic lubricant, a catalyst, and the like.

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

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

[0012]

10 The thickness of the substrate 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 .

Herein, “thickness of substrate” means the thickness of the entire substrate, and for example, in a case where the above described multilayer film in which two or more

15 layers are laminated is used, the thickness of the substrate means the total thickness of all layers constituting the substrate.

[0013]

<Intermediate Layer>

The intermediate layer is a layer formed from a composition for forming the
20 intermediate layer. The composition contains a silane-based compound (A) (hereinafter also referred to as “component (A)”) exhibiting polycondensation property by hydrolysis, and an acrylate compound (B) (hereinafter also referred to as “component (B)”).

The excellent effects described above are exerted when the release sheet has the intermediate layer, and the reason thereof is considered as follows.

That is, before the substrate is separated from the release sheet, the intermediate layer is adhered to the substrate or another layer on the substrate side mainly due to hydrogen bonding and anchor effect. In particular, because the intermediate layer has a siloxane bond (-Si-O-Si-), a Si-OH group is partially formed on the surface of the intermediate layer on the substrate side and forms a hydrogen bond with a polar site present on the surface of the substrate. In particular, when the release sheet is immersed in water, the water easily permeates the interface between the substrate and the intermediate layer or the interface between another layer present on the substrate side and the intermediate layer. 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 substrate can be easily separated from the release sheet.

In addition, since the intermediate layer is formed from the composition for forming the intermediate layer containing the acrylate compound (B), the intermediate layer also has a polarity derived from the component (B). Therefore, unlike an intermediate layer formed from only the component (A), it is conceived that an intermolecular force between polar groups acts between the substrate and the intermediate layer instead of hydrogen bonding during normal use as a release sheet, and thereby insufficient adhesion between the substrate and the intermediate layer due to humidity can be prevented.

Therefore, it is possible to obtain a release sheet which has good substrate adhesion when used as a release sheet and can easily separate the substrate after use.

Furthermore, when the intermediate layer is brought into contact with the aforementioned water (hereinafter also referred to as “washing water”) used at the time of separating the substrate from the release sheet, it is possible to prevent and suppress

the elution of the intermediate layer into the washing water. Therefore, contamination of the washing water can be prevented or reduced.

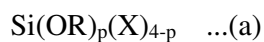
[0014]

(Silane-Based Compound (A) Exhibiting Polycondensation Property By Hydrolysis)

5 The silane-based compound (A) exhibiting polycondensation property by hydrolysis is a compound that gives, when hydrolyzed, a compound that can undergo polycondensation. For example, the component (A) may be alkoxysilane exhibiting polycondensation property by hydrolysis.

[0015]

10 The component (A) preferably contains, as the main component, at least one selected from a tetrafunctional silane-based compound represented by General Formula (a) or an oligomer thereof.



15 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.

[0016]

20 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 more preferred. The alkyl group that can be selected as R may be a straight or branched
25 chain but is preferably a straight chain.

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 one type of 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.

[0017]

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 General Formula (a1).



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.

[0018]

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

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

[0019]

Note that the “main component” in the component (A) refers to a silane-based compound with the largest content per 100 mass% total of the component (A).

In the component (A), as for the silane-based compound represented by General Formula (a) above and an oligomer thereof contained as the main component, the content thereof is not particularly limited as long as the content is larger than other silane-based compound content, but, for example, is preferably 50 mass% or more, more preferably 70 mass% or more, even more preferably 80 mass% or more, yet even more preferably 90 mass% or more, and 100 mass% or less per 100 mass% total of the component (A). In other words, according to one aspect of the release sheet, in the component (A), as for the silane-based compound represented by General Formula (a) above and an oligomer thereof contained as the main component, the content thereof is preferably from 50 to 100 mass%, more preferably from 70 to 100 mass%, even more preferably from 80 to 100 mass%, and yet even more preferably from 90 to 100 mass% per 100 mass% total of the component (A).

[0020]

Furthermore, the average degree of polymerization of the oligomer of the tetrafunctional silane-based compound represented by General Formula (a) above or the oligomer of the tetraalkoxysilane represented by General Formula (a1) above 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, “oligomer of the tetrafunctional silane-based compound represented by General Formula (a)” above and “oligomer of the tetraalkoxysilane represented by General Formula (a1) above” are each not simply limited to those

produced 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 General Formula (a) above or the tetraalkoxysilanes represented by General Formula (a1) above are condensed, produced
5 as a result of synthesis using another compound as a starting material. The same applies to “oligomer of mono- to trifunctional silane-based compound” described below.

[0021]

As the component (A), a commercially available product can be used.

Preferred examples of the commercially available product include “Colcoat (trade name)
10 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
15 oligomer of, on average, decamer of tetramethoxysilane and an oligomer of, on average, decamer of tetraethoxysilane (all available from Colcoat Co., Ltd.).

[0022]

Examples of other silane-based compounds which may be contained as the component (A) include a mono- to trifunctional silane-based compound in the case of a
20 monomer, and an oligomer of a mono- to trifunctional silane-based compound in the case of an oligomer. However, from the viewpoint of improving separability of the substrate, at least one selected from the tetrafunctional silane-based compound represented by General Formula (a) or the oligomer thereof is preferably contained as the main component as previously mentioned.

Furthermore, from the viewpoint of promoting hydrolysis reaction or condensation reaction of the component (A), for example, a catalyst such as an acid catalyst or a metal catalyst may be used for the composition for forming the intermediate layer.

5 [0023]

From the viewpoint that the effects of the present invention are more easily exerted, the component (A) in the composition for forming the intermediate layer accounts for preferably 50 mass% or more, more preferably 60 mass% or more, and even more preferably 70 mass% or more, and preferably 95 mass% or less, more preferably 90
10 mass% or less, and even more preferably 85 mass% or less per 100 mass% of the total content of the component (A) and the component (B). As described above, the lower limits and upper limits described in series can each be combined independently. For example, in one aspect of the release sheet, the component (A) in the composition for forming the intermediate layer accounts for preferably from 50 to 95 mass%, more
15 preferably from 60 to 90 mass%, and even more preferably from 70 to 85 mass% per 100 mass% of the total content of the component (A) and the component (B).

[0024]

(Acrylate Compound (B))

As the acrylate compound (B), from the viewpoint that the effects of the present
20 invention are more easily exerted, for example, polyfunctional (meth)acrylate having two or more (meth)acryloyl groups per molecule is preferred, and polyfunctional (meth)acrylate having three or more (meth)acryloyl groups per molecule is more preferred.

[0025]

As the polyfunctional (meth)acrylate, for example, polyfunctional (meth)acrylate having a structure derived from pentaerythritol is preferred.

Examples of the polyfunctional (meth)acrylate having a structure derived from pentaerythritol include polyfunctional (meth)acrylate, such as 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 (B), use of at least one selected from the group consisting of 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 is preferred, and use of at least one selected from the group consisting of dipentaerythritol penta(meth)acrylate, dipentaerythritol hexa(meth)acrylate, pentaerythritol tri(meth)acrylate, and pentaerythritol tetra(meth)acrylate is more preferred.

15 [0026]

From the viewpoint that the effects of the present invention are more easily exerted, the component (B) in the composition for forming the intermediate layer accounts for preferably 50 mass% or less, more preferably 40 mass% or less, and even more preferably 30 mass% or less, and preferably 5 mass% or more, more preferably 10 mass% or more, and even more preferably 15 mass% or more per 100 mass% of the total content of the component (A) and the component (B). As described above, the lower limits and upper limits described in series can each be combined independently. For example, in one aspect of the release sheet, the component (B) in the composition for forming the intermediate layer accounts for preferably from 5 to 50 mass%, more

preferably from 10 to 40 mass%, and even more preferably from 15 to 30 mass% or less per 100 mass% of the total content of the component (A) and the component (B).

[0027]

Moreover, from the viewpoint that the effects of the present invention are more easily exerted, the total content of the component (A) and the component (B) is preferably 80 mass% or more, more preferably 90 mass% or more, and even more preferably 95 mass% or more, and preferably 100 mass% or less, more preferably 99.5 mass% or less, and even more preferably 99.3 mass% or less per 100 mass% of the solid content of the composition for forming the intermediate layer. As described above, the lower limits and upper limits described in series can each be combined independently. For example, in one aspect of the release sheet, the total content of the component (A) and the component (B) is preferably from 80 to 100 mass%, more preferably from 90 to 99.5 mass%, and even more preferably from 95 to 99.3 mass% per 100 mass% of the solid content of the composition for forming the intermediate layer.

[0028]

(Photopolymerization Initiator (C))

Moreover, the composition for forming the intermediate layer preferably further contains a photopolymerization initiator (C).

The photopolymerization initiator (C) (hereinafter also referred to as “component (C)”) is a component that improves the curability of the composition for forming the intermediate layer in a case where the composition for forming the intermediate layer is cured by using energy rays such as ultraviolet rays.

From the viewpoints of excellent curability and solvent resistance, as the component (C), 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 are preferred.

One type of component (C) may be used alone, or a combination of two or more types of components (C) may be used.

5 [0029]

In a case where the composition for forming the intermediate layer contains the component (C), the component (C) content is preferably 1 part by mass or more, more preferably 3 parts by mass or more, and even more preferably 5 parts by mass or more, and preferably 25 parts by mass or less, more preferably 20 parts by mass or less, and
 10 even more preferably 15 parts by mass or less, with respect to 100 parts by mass of the component (B). As described above, the lower limits and upper limits described in series can each be combined independently. For example, in one aspect of the release sheet, in a case where the composition for forming the intermediate layer contains the component (C), the component (C) content is preferably from 1 to 25 parts by mass,
 15 more preferably from 3 to 20 parts by mass, and even more preferably from 5 to 15 parts by mass, with respect to 100 parts by mass of the component (B).

[0030]

Moreover, from the viewpoint that the effects of the present invention are more easily exerted, in a case where the composition for forming the intermediate layer
 20 contains the component (C), the total content of the component (A), the component (B), and the component (C) content is preferably 80 to 100 mass%, more preferably from 85 to 100 mass%, even more preferably from 90 to 100 mass%, further preferably from 95 to 100 mass%, and further more preferably from 98 to 100 mass% per 100 mass% of the solid content of the composition for forming the intermediate layer.

25 [0031]

From the viewpoint that the effects of the present invention are more easily exerted, the thickness of the intermediate layer is preferably from 0.02 to 1 μm , more preferably from 0.03 to 0.5 μm , and even more preferably from 0.04 to 0.3 μm .

[0032]

5 <Release Agent Layer>

The release agent layer is preferably a layer made of the release agent 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, as a main component, a
10 silicone-based compound; a fluorine compound; a long-chain alkyl group-containing compound; or a thermoplastic resin material, such as an olefin-based resin or a diene-based resin 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
15 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 the “main component” in the release agent composition refers to a component having the largest content per 100 mass% of the solid content of the release agent composition.

20 [0033]

In the release agent composition containing a silicone-based compound as the main component, 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
25 compound, such as addition reaction type and condensation reaction type silicone-based

compounds; and an energy ray-curable silicone-based compound, such as ultraviolet radiation-curable and electron beam-curable silicone-based compounds.

[0034]

Specific examples of the aforementioned addition reaction type silicone-based compound include organopolysiloxane, in which two or more alkenyl groups having two to ten carbons, such as a vinyl group, an allyl group, a propenyl group, and a hexenyl group, are provided to terminals and/or 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.

10 [0035]

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).

15

[0036]

Furthermore, examples of the aforementioned catalyst include microparticulate platinum, 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.

20

25 [0037]

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.

5 [0038]

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 produced by reacting a polyvinyl alcohol-based polymer with a long-chain alkyl isocyanate having from 12 to 40 carbons in an alkyl
10 group, an alkyl urea derivative produced 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 produced by using a long-chain fatty acid having from 12 to 40 carbons in an alkyl group as a modification agent for an
15 alkyd resin produced by a condensation reaction of a polyhydric alcohol and a polybasic acid may be used.

[0039]

For the release agent composition containing an energy ray-curable resin as a main component, for example, a release agent composition containing an energy ray-
20 curable compound (D), which has a reactive functional group selected from a (meth)acryloyl group, an alkenyl group, or a maleimide group, and polyorganosiloxane (E) is preferred. Because the release agent layer formed from this release agent composition uses an energy ray-curable compound (D) and the polyorganosiloxane (E), which have molecular structures, polarities, and molecular weights that are different from
25 each other, components derived from the polyorganosiloxane (E) are segregated because

the polyorganosiloxane (E) 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.

[0040]

5 (Energy Ray-Curable Compound (D))

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

As the energy ray-curable compound (D) (hereinafter also referred to as “component (D)”), an energy ray-curable compound having a reactive functional group
10 selected from a (meth)acryloyl group, an alkenyl group, or 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 (D) may be used alone, or a combination of two or more types of components (D) may be used.

15 [0041]

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

[0042]

Examples of the component (D) include polyfunctional (meth)acrylate, such as dipentaerythritol tri(meth)acrylate, dipentaerythritol tetra(meth)acrylate, dipentaerythritol
25 penta(meth)acrylate, dipentaerythritol hexa(meth)acrylate, pentaerythritol

tri(meth)acrylate, and pentaerythritol tetra(meth)acrylate. Among these, as the component (D), use of at least one selected from the group consisting of dipentaerythritol tri(meth)acrylate, dipentaerythritol tetra(meth)acrylate, dipentaerythritol penta(meth)acrylate, dipentaerythritol hexa(meth)acrylate, pentaerythritol tri(meth)acrylate, or pentaerythritol tetra(meth)acrylate is preferred. By this, good curability of the component (D) is achieved even when the release agent composition is applied to the surface of the intermediate layer on the substrate as a thin film.

[0043]

In a case where the release agent composition contains the component (D), the component (D) accounts for preferably from 65 mass% to 98.5 mass%, and more preferably from 70 mass% to 95 mass% per 100 mass% of the solid content of the release agent composition.

[0044]

(Polyorganosiloxane (E))

The polyorganosiloxane (E) is a component that imparts releasability to the release agent layer. Examples of the polyorganosiloxane (E) (hereinafter also referred to as “component (E)”) include polyorganosiloxanes having a straight or branched molecular chain. Furthermore, as the component (E), use of modified 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 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, 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 in which these are combined.

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 (E) may be used alone, or a combination of two or more types of components (E) may be used.

[0045]

5 According to the modified organopolysiloxane, when the energy ray-curable compound (D) 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 (D). By this, transfer of the polyorganosiloxane contained in the release agent layer to an object (e.g., pressure sensitive adhesive layer, ceramic green
10 sheet, or substrate backside of the release sheet itself) that is in contact with the outer surface of the release agent layer can be suppressed.

[0046]

Examples of the organic group other than the reactive functional group of the component (E) include a monovalent hydrocarbon group containing no aliphatic
15 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
20 group and a tolyl group.

[0047]

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

[0048]

In a case where the release agent composition contains the component (E), the component (E) accounts for preferably from 0.5 mass% to 5 mass%, and more preferably from 0.7 mass% to 4 mass% 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 substrate becomes easier without repelling a ceramic slurry, and releasability of the release sheet is improved.

[0049]

Furthermore, as the blended amounts of the polyorganosiloxane (E) and the energy ray-curable compound (D), the component (E)/component (D) is preferably from 0.7/99.3 to 5/95, and more preferably from 1/99 to 4.5/95.5. 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.

[0050]

(Photopolymerization Initiator)

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

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, and 2-benzyl-2-dimethylamino-1-(4-morpholinophenyl)-butanone-1, 2-(dimethylamino)-2-[(4-methylphenyl)methyl]-1-[4-(4-morpholinyl)phenyl]-1-butanone 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.

[0051]

5 In a case where the release agent composition contains the photopolymerization initiator, the photopolymerization initiator content is preferably from 1 mass% to 20 mass%, and more preferably from 3 mass% to 15 mass%, 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 achieved due to oxygen inhibition, excellent curability, solvent resistance, and releasability can be achieved.

10 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.

[0052]

15 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 (D) and the component (E), the total content of the component (D), the component (E), and the optionally contained photopolymerization initiator is preferably from 70 to 100 mass%, and more preferably from 80 to 100 mass%.

20 [0053]

Note that the energy ray-curable resin is less likely to be affected by means of removing foreign substance 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 including the release agent layer containing
25 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.

[0054]

Examples of the release agent composition containing the thermosetting resin as
5 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
10 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.

15 [0055]

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

20 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 from 1 mass% to 8 mass%,
and more preferably from 2 mass% to 6 mass%, 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 from 1 mass% to 10 mass%, and more preferably from 2 mass% to 6 mass%, per 100 mass% of the solid content of the release agent composition.

5 [0056]

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

10 mass%.

[0057]

Furthermore, the release agent layer may contain another additive besides the resin components described above. Examples of such another additive include an anti-aging agent, a photostabilizer, a flame retardant, a conductive agent, an antistatic agent, and a plasticizer.

15

[0058]

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 .

20 [0059]

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

of the release sheet, the substrate can be easily separated from the release sheet, and thus such use achieves high contribution to resource protection and environmental protection.

[0060]

<Method for Producing Release Sheet>

5 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, the intermediate layer can be formed by a method for forming the intermediate layer having in order: applying the composition for forming the intermediate
10 layer or a solution thereof to one surface of the substrate, then heating and drying the composition for forming the intermediate layer or the solution thereof, and thermally curing the component (A) in the composition for forming the intermediate layer to form a coating layer; and irradiating the coating layer with energy rays to energy ray-cure the component (B) in the composition for forming the intermediate layer to form the
15 intermediate layer, or the like.

[0061]

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
20 performed by a known method.

For example, the release agent layer can be formed and prepared by a forming method including in order: applying the release agent composition or a solution thereof to the intermediate layer formed on the substrate by the aforementioned method or the like, and then heating and drying the release agent composition or the solution thereof to form

the coating layer; and irradiating the coating layer with energy rays to be energy ray-cured to form the release agent layer, or the like.

[0062]

5 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.

10 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
15 selected based on the properties of a raw material constituting the intermediate layer or the release agent layer.

[0063]

As described above, the substrate can be separated from the release sheet by bringing the intermediate layer into contact with water. Thus, one aspect of the present
20 invention includes a method for separating a substrate characterized by bringing the intermediate layer into contact with water to separate the substrate from a release sheet, in which the release sheet includes the substrate, and the intermediate layer and the release agent layer in this order on at least one surface side of the substrate.

[0064]

The method for bringing the intermediate layer into contact with water 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.

[0065]

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 of the water to be in contact with the intermediate layer is preferably 40°C or more, and more preferably 60°C or more. Furthermore, the temperature is preferably lower than 100°C, and more preferably 98°C or lower. As described above, the 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 from 60°C to 98°C.

[0066]

As previously mentioned, by using the release sheet, the substrate can be easily separated from the release sheet by bringing the intermediate layer into contact with water. Therefore, the release sheet does not need to use an acidic or alkaline solution, an organic solvent, or the like in order to separate the substrate from the release sheet, for example, and is also suitable from the viewpoint of reducing the environmental load.

On the other hand, the release sheet has good adhesion to the substrate during normal use.

Thus, the release sheet can avoid problems caused by separation of the substrate when the release sheet is used for the original purpose, and after use as the release sheet, the substrate can be easily separated. The release sheet can be suitably used for a case where the resin recovered from the separated substrate is reused as it 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.

[0067]

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

Furthermore, as previously mentioned, the intermediate layer in the release sheet that contributes to separation of the substrate can also reduce contamination of washing water used at the time of separation of substrate. Therefore, since contamination of the washing water can be suppressed, recontamination of the resin or the like recovered from the separated substrate by the washing water hardly occurs. Furthermore, the

suppression of contamination of the washing water also leads to simplification of reuse or waste treatment of the washing water.

Accordingly, examples of an aspect of the present invention include a method for recycling a resin, the method including, at least, a step of separating a substrate from
5 a release sheet by releasing an intermediate layer from a surface of the substrate or a surface of a layer on the substrate side by bringing the intermediate layer into contact with water by using the method for separating a substrate using the release sheet described above, the release sheet including the substrate, and the intermediate layer and the release agent layer in this order on at least one surface side of the substrate; and a step
10 of recovering a resin from the substrate. The step of recovering a resin from the substrate is not particularly limited and a known method of recovering can be appropriately used based on the type of each resin and raw materials of the resin.

[Examples]

[0068]

15 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.

[0069]

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

20 The thickness of a substrate 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.

The thickness of the intermediate layer of each of Examples and Comparative Examples was measured by using a spectroscopic ellipsometer (product name “M-2000” available from J.A. Woollam).

5 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).

[0070]

[Production of Release Sheet]

A release sheet was produced by the following method.

10 [0071]

Example 1

As the substrate, a biaxially-stretched polyethylene terephthalate film (thickness: 31 μm) was prepared.

Next, a silane-based compound “A1” (product name “Colcoat (trade name) N-15 103X” available from Colcoat Co., Ltd.) exhibiting polycondensation property by hydrolysis and a mixture “B1” (product name “ARONIX (trade name) M-400” available from TOAGOSEI CO., LTD.) of dipentaerythritol pentaacrylate and dipentaerythritol hexaacrylate, which are polyfunctional acrylates, were mixed at a solids ratio (mass ratio) of 80:20. 10 parts by mass of a photopolymerization initiator (product name “Omnirad 20 (trade name) 907” (2-methyl-1 [4-(methylthio)phenyl]-2-morpholinopropan-1-one available from IGM Resins B. V., solids content 100 mass%)) was added to 100 parts by mass of the polyfunctional acrylate to prepare the composition for forming the intermediate layer. Thereafter, isopropyl alcohol was mixed to prepare a coating liquid of the composition for forming the intermediate layer with a solid content of 1.0 mass%.

Next, the resulting coating liquid of the composition for forming the intermediate layer was applied to one surface of the substrate by using a bar coater and dried at 130°C for one minute, resulting in the formation of a coating layer.

Subsequently, the coating layer was irradiated with ultraviolet rays (integrated light quantity: 250 mJ/cm²), resulting in the formation of an intermediate layer (thickness: 0.04 μm).

Then, 94 parts by mass of a mixture “B1” (solid content 100 mass%) of dipentaerythritol pentaacrylate and dipentaerythritol hexaacrylate, which are polyfunctional polyacrylates, 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 the photopolymerization initiator (product name “Omnirad (trade name) 907” (2-methyl-1-[4-(methylthio)phenyl]-2-morpholinopropan-1-one available from IGM Resins B.V., solid content 100 mass%)) were diluted with a mixed solvent of isopropyl alcohol and methyl ethyl ketone (mixed ratio (mass ratio) of isopropyl alcohol to methyl ethyl ketone = 3:1), resulting in the formation of a coating liquid of the release agent composition with a solid content of 20 mass%.

The resulting coating liquid was applied on the intermediate layer formed on the substrate by using a bar coater and dried at 80°C for one minute, resulting in the formation of a coating layer. Then, the coating layer was irradiated with ultraviolet rays (integrated light quantity: 250 mJ/cm²) to form a release agent layer (thickness: 1 μm), resulting in the formation of a release sheet having a structure in which the substrate, the intermediate layer, and the release agent layer were laminated in this order.

[0072]

Example 2

A release sheet was prepared in the same manner as in Example 1 except that a silane-based compound "A1" (product name "Colcoat (trade name) N-103X" available from Colcoat Co., Ltd.,) exhibiting polycondensation property by hydrolysis of the composition for forming the intermediate layer and a mixture "B1" (product name "ARONIX (trade name) M-400" available from TOAGOSEI CO., LTD.) of dipentaerythritol pentaacrylate and dipentaerythritol hexaacrylate, which are polyfunctional acrylates, in Example 1 were mixed at a solid ratio (mass ratio) of 90:10.

[0073]

Example 3

A release sheet was prepared in the same manner as in Example 1 except that a silane-based compound "A1" (product name "Colcoat (trade name) N-103X" available from Colcoat Co., Ltd) exhibiting polycondensation property by hydrolysis of the composition for forming the intermediate layer and a mixture "B1" (product name "ARONIX (trade name) M-400" available from TOAGOSEI CO., LTD.) of dipentaerythritol pentaacrylate and dipentaerythritol hexaacrylate, which are polyfunctional acrylates, in Example 1 were mixed at a solid ratio (mass ratio) of 50:50.

[0074]

Example 4

A release sheet was prepared in the same manner as in Example 1 except that the polyfunctional acrylate "B1" in the composition for forming the intermediate layer in Example 1 was replaced by a mixture "B2" (product name "ARONIX (trade name) M-305" available from TOAGOSEI CO., LTD.) of pentaerythritol triacrylate and pentaerythritol tetraacrylate, which are polyfunctional acrylates.

[0075]

Comparative Example 1

A release sheet having a structure in which the substrate and 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.

[0076]

5 Comparative Example 2

A release sheet was prepared in the same manner as in Example 1 except that the mixture “B1” of dipentaerythritol pentaacrylate and dipentaerythritol hexaacrylate, which are polyfunctional acrylates, and the photopolymerization initiator in Example 1 were not mixed as components of the composition for forming the intermediate layer.

10 [0077]

Comparative Example 3

As the substrate, a biaxially-stretched polyethylene terephthalate film (thickness: 31 μm) was prepared.

Next, an amorphous polyester resin “P” (product name “VYLON (trade name)
15 GK-640” available from Toyobo Co., Ltd.) was diluted with methyl ethyl ketone (MEK) to prepare a diluted solution with a solid content of 1 mass%.

Then, the resulting diluted solution was uniformly applied on one face of the substrate such that the thickness after drying became 0.04 μm and heated at 130°C for one minute, and thus an intermediate layer was formed.

20 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 substrate, the intermediate layer, and the release agent layer were laminated in this order was produced.

[0078]

[Separability of Substrate]

The release sheet produced by the methods described in Examples and Comparative Examples was cut into a size of 50 mm × 50 mm to prepare a test piece. Then, 300 mL of warm water at 90°C was charged into a glass beaker with a volume of 500 mL, and the entirety of one test piece was immersed in the warm water and allowed
5 to stand for two hours while the temperature was maintained at 90°C. Thereafter, the test piece taken out from the warm water, was immersed in distilled water at room temperature to wash, and thus a sample for separability evaluation was prepared.

The thickness of the thin film layer was measured by using a spectroscopic ellipsometer (product name “M-2000” available from J. A. Woollam) and a reflective
10 film thickness meter (product “F20” available from Filmetrics) on the surface side of the substrate on which the release agent layer had been provided. Subsequently, the separability of the substrate was evaluated based on the detected amount of silicon (Si) which is a specific element derived from the chemical composition of the release agent layer and the intermediate layer and measured by X-Ray Photoelectron Spectroscopy
15 (XPS) on the surface. In a case where all of the measured thicknesses of the thin film layers are the measurement precision or less (10 nm or less), the proportion of each element is calculated by the following Formula, and the specific element derived from the chemical composition of the release agent layer and the intermediate layer is less than 0.05 atom%, the thin film layer is not present on the surface of the substrate. For this
20 result, it was judged that the release agent layer and the intermediate layer corresponding to the thin film layers were not present on the surface of the substrate, that is, the substrate could be separated from the release sheet. The results are presented in Table 1 below.

Note that, in Table 1, the case where the specific element was less than 0.05 atom% was denoted as “A”, and the case where the specific element was 0.05 atom% or more was denoted as “F”.

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.

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

[0079]

[Substrate Adhesion]

For each of the release sheets produced by the methods described in Examples and Comparative Examples, the release agent layer side was stuck to a 20 mm wide acrylic adhesive tape (product name “31B Tape” available from Nitto Denko Corporation) by using a hand roller under conditions of a temperature of 23°C and a relative humidity of 50% R. H., and allowed to stand for 30 minutes to prepare a test piece.

Next, the release sheet side of the test piece was fixed to a SUS plate by using a tensile tester, and the 31B tape side was removed in a direction of 180° at a release angle of 180° and a release speed of 300 mm/min by using a tensile tester (product name “AG-IS500N” available from Shimadzu Corporation). After the 31B tape was removed by this treatment, the thicknesses of the thin film layers on the surface to which the 31B tape had been stuck were measured by using a spectroscopic ellipsometer (product name “M-2000” available from J. A. Woollam) and a reflective film thickness meter (product name “F20” available from Filmetrics). Subsequently, the surface was subjected to X-ray photoelectron spectroscopy (XPS) in the same manner as in the evaluation of the separability of the substrate. The adhesion of the substrate was evaluated based on the

detected amount of silicon (Si), which is a specific element derived from the chemical composition measured by XPS. In a case where the release agent layer and the intermediate layer of the release sheet were released by the release treatment of the 31B tape and the substrate surface was exposed, the measured thicknesses of the thin film layers were all the measurement precision or less (10 nm or less), and the silicon (Si) element proportion (atom%) on the measurement surface is less than the minimum detection value of less than 0.05 atom% (Si element was not detected).

The case where the release agent layer was not released was denoted as “A”, and the case where the release agent layer was released and the substrate was exposed was denoted as “F”.

The results are presented in Table 1 below.

[0080]

[Table 1]

Table 1

	Proportion of intermediate layer resin component [mass%]				Separability of substrate	Substrate adhesion
	A1	B1	B2	P		
Example 1	80	20			A	A
Example 2	90	10			A	A
Example 3	50	50			A	A
Example 4	80		20		A	A
Comparative Example 1					F	A
Comparative Example 2	100				A	F
Comparative Example 3				100	F	F

15

[0081]

In Table 1, the details of materials represented by abbreviations shown in the column of the resin component proportion in the composition for forming the intermediate layer (proportion of intermediate layer resin component) are as follows.

<Silane-Based Compound (A) Exhibiting Polycondensation Property By Hydrolysis>

- 5 • “A1”: silane-based compound exhibiting polycondensation property by hydrolysis, product name “Colcoat (trade name) N-103X” (available from COLCOAT Co., Ltd.)

[0082]

<Acrylate Compound (B)>

- 10 • “B1”: a mixture of dipentaerythritol pentaacrylate and dipentaerythritol hexaacrylate, which are polyfunctional acrylates, product name “ARONIX (trade name) M-400” (available from TOAGOSEI CO., LTD.)

 • “B2”: a mixture of pentaerythritol triacrylate and pentaerythritol tetraacrylate, which are polyfunctional acrylates, product name “ARONIX (trade name) M-305”

- 15 (available from TOAGOSEI CO., LTD.)

[0083]

<Another Compound>

 • “P”: an amorphous polyester resin, product name “VYLON (trade name) GK-640” (available from Toyobo Co., Ltd.)

- 20 Note that, in Table 1, the “proportion of intermediate layer resin component” represents each component content (mass%) based on 100 mass% of the total content of the component (A) and the component (B).

[0084]

- 25 As shown in Table 1, from the evaluation results of the separability of the substrate using the release sheets of Examples 1 to 4, it was confirmed that the substrate

can be separated from the release sheet, which is a laminate including the substrate, and the intermediate layer formed from the composition for forming the intermediate layer containing the component (A) and the component (B) and the release agent layer in this order on the substrate, by bringing the intermediate layer into contact with water to
5 release the intermediate layer from the surface of the substrate.

Moreover, it was also confirmed that the release sheets of Examples 1 to 4 had good separability of the substrate by the aforementioned method, while having good adhesion to the substrate during normal use.

[0085]

10 On the other hand, in a case where the release sheet of Comparative Example 1 was used, because the release sheet did not include the intermediate layer, an Si element was detected on the release agent layer side of the substrate even after the evaluation of the separability of the substrate was conducted, and it was confirmed that the release agent layer was not removed from the substrate, and the substrate could not be separated.

15 Moreover, in a case where the release sheet of Comparative Example 2, which did not contain the component (B) as the component forming the intermediate layer, was used, the substrate layer was separated by bringing the intermediate layer into contact with water. However, it was confirmed that the adhesion to the substrate was poor during normal use.

20 Furthermore, in a case where the release sheet of Comparative Example 3, which did not contain either the component (A) or (B) as the component forming the intermediate layer, was used, it was confirmed that the substrate could not be separated as in Comparative Example 1, and it was also confirmed that the adhesion to the substrate was poor during normal use.

[CLAIMS]

[Claim 1]

A release sheet comprising a laminate comprising a substrate, and an intermediate layer and a release agent layer in this order on at least one surface side of the substrate,

wherein

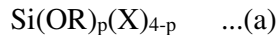
the intermediate layer is a layer formed from a composition for forming the intermediate layer, the composition containing a silane-based compound (A) exhibiting polycondensation property by hydrolysis, and an acrylate compound (B).

10 [Claim 2]

The release sheet according to claim 1, wherein the component (B) is polyfunctional (meth)acrylate having two or more (meth)acryloyl groups per molecule.

[Claim 3]

The release sheet according to claim 1 or 2, wherein the component (A) comprises, as a main component, at least one selected from a tetrafunctional silane-based compound represented by General Formula (a) or an oligomer thereof:



where 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.

[Claim 4]

The release sheet according to claim 3, wherein the tetrafunctional silane-based compound is tetraalkoxysilane represented by General Formula (a1):



where 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.

[Claim 5]

The release sheet according to any one of claims 1 to 4, wherein a total content
5 of the component (A) and the component (B) is 80 mass% or more per 100 mass% of a solid content of the composition for forming the intermediate layer.

[Claim 6]

The release sheet according to any one of claims 1 to 5, wherein the component
(B) in the composition for forming the intermediate layer accounts for 50 mass% or less
10 per 100 mass% of the total content of the component (A) and the component (B).

[Claim 7]

The release sheet according to any one of claims 1 to 6, wherein the substrate is a resin film.

[Claim 8]

15 The release sheet according to any one of claims 1 to 7, wherein the substrate and the intermediate layer are directly laminated.

[Claim 9]

The release sheet according to any one of claims 1 to 8, wherein the substrate is separated from the release sheet by bringing the intermediate layer into contact with
20 water.