Description

ADHESIVE LAYER FOR FLEXIBLE IMAGE DISPLAY DEVICE CONSTITUENT MEMBER, LAMINATE, AND IMAGE DISPLAY DEVICE

Technical Field

[0001]

The present disclosure relates to an adhesive layer for a flexible image display device constituent member, a laminate, and an image display device.

Background Art

[0002]

In recent years, to improve visibility of an image display device, a gap between an image display panel such as a liquid crystal display (LCD), a plasma display panel (PDP), or an electro-luminescence (EL) and a protection panel or a touch panel member disposed on a front surface side (viewing side) thereof is filled with an adhesive layer, an adhesive, or the like, thereby suppressing diffuse reflection occurring in a case where the gap is not filled, that is, diffuse reflection of incident light or emitted light from a display image at an air layer interface.

[0003]

At this time, for example, in a case where the protection panel is made of plastic, gas (referred to as outgas) may be generated from the protection panel, and thus, when the adhesive layer or the adhesive does not have an adhesive strength and a cohesive strength sufficient to resist the gas pressure, the gas remains in the adhesive layer or the adhesive, and when

the temperature becomes high, the remaining gas foams, thereby reducing the visibility of the screen.

[0004]

In addition, recently, a flexible display that is freely bendable has been attracting attention as a next-generation display. An organic electroluminescence (organic EL) display is mainly used as the flexible display.

[0005]

Such an image display device has a laminated structure in which a plurality of member sheets, such as a surface protection film, a cover lens, a circularly polarizing plate, a touch film sensor, and a light emitting element, are bonded to each other with a transparent adhesive layer. Each laminated structure can be regarded as a laminated sheet in which a member sheet and an adhesive layer are laminated.

[0006]

A bendable display device that can be bent has various issues caused by interlayer stress when the device is bent. For example, there is a demand for a laminated sheet that is quickly restored to a flat state without the influence caused by being placed in a bent state when a screen is opened from a folded state.

In addition, the adhesive layer may be peeled off by repeating the folding operation, or a member may be cracked or broken by applying stress to the member which is an adherend. Thus, a laminated sheet having durability against the repeated folding operation at a low temperature, which is a particularly severe condition, is also required.

The adhesive layer in such a flexible image display device is required to have not only optical properties but also flexibility, particularly high durability against bending.

[0007]

In addition to the durability at a low temperature, it is required to suppress a phenomenon in which the adhesive layer itself protrudes at a high temperature and to suppress deformation of the adhesive layer and remaining of a mark when the adhesive layer is bent under a high temperature environment, and from these viewpoints, it is also required to have a high modulus of elasticity.

[0008]

For example, Patent Literature 1 discloses a laminated film with an adhesive layer, which has no possibility of causing disturbance in an image displayed at a folded portion after repeated folding.

Patent Literature 2 discloses a laminate having a double-sided adhesive sheet with a glass transition temperature and a storage modulus of elasticity in predetermined ranges and a flexible member for an image display device, in which peeling or the like is suppressed even in a bending test under an environment close to an actual use environment.

Citation List

Patent Literature

[0009]

Patent Literature 1: JP 2020-196255 A

Patent Literature 2: WO 2018/173896

Summary

Technical Problem

[0010]

In Patent Literatures 1 and 2, to impart sufficient flexibility to a cured product of a resin composition at a low temperature and obtain folding resistance at a low temperature, a base polymer having a low glass transition temperature is used, thereby imparting bending resistance at a high temperature and a low temperature to an adhesive sheet.

However, in a case of using a polymer having a low glass transition temperature, the adhesive strength and the cohesive strength tend to be insufficient.

[0011]

Under such a background, an object of the present disclosure is to provide an adhesive layer for a flexible image display device constituent member, which is excellent in bending suitability and has a good cohesive strength and/or adhesive strength, a laminate, and an image display device.

Solution to Problem

[0012]

That is, the present disclosure has the following aspects.

[1] An adhesive layer for a flexible image display device constituent member, the adhesive layer satisfying the following requirements [I] to [V], in which

the adhesive layer for a flexible image display device constituent member is formed of a resin composition containing a polymer (A), a crosslinking agent (B), and a polymerization initiator (C),

the polymer (A) contains a copolymer composed of a compound in which 50 mass% or more of monomer components contain a (meth)acryloyl group,

the crosslinking agent (B) contains a crosslinking agent having three or more functional groups, and

the polymerization initiator (C) contains a cleavage-type photopolymerization initiator:

[I] a shear storage modulus of elasticity at -20°C (G'(-20°C)) is 300 kPa or less;

[II] a shear storage modulus of elasticity at 85°C (G'(85°C)) is 5.0 kPa or more and 30 kPa or less;

[III] a gel fraction is 45% or more and 95% or less;

[IV] an adhesive strength to a polyethylene terephthalate substrate at 23°C is 5.0 N/cm or more; and

[V] a recovery rate calculated by the following equation from a maximum strain ($\gamma_{max(25)}$) after setting a thickness of the adhesive layer to 0.5 to 1.2 mm and applying a pressure of 10 kPa at a temperature of 25°C for 600 seconds and a strain ($\gamma_{min(25)}$) 600 seconds after unloading the stress is 70% or more:

Recovery rate (%) = $[(\gamma_{max(25)} - \gamma_{min(25)})/\gamma_{max(25)}] \times 100$.

[2] The adhesive layer for a flexible image display device constituent member according to [1], in which the adhesive layer for a flexible image

display device constituent member has an adhesive strength to a glass substrate at 23°C of 4.5 N/cm or more.

[3] The adhesive layer for a flexible image display device constituent member according to [1] or [2], in which the adhesive layer for a flexible image display device constituent member has a maximum strain ($\gamma_{max(25)}$) of 600% or less after setting a thickness to 0.5 to 1.2 mm and applying a pressure of 10 kPa at a temperature of 25°C for 600 seconds.

[4] The adhesive layer for a flexible image display device constituent member according to any one of [1] to [3], in which a glass transition temperature (Tg) of the adhesive layer for a flexible image display device constituent member, defined by a maximum value of Tanδ as obtained by dynamic viscoelasticity measurement in a shear mode at a frequency of 1 Hz, is -15°C or lower.

[5] An adhesive layer for a flexible image display device constituent member with a release film, having a laminated structure of one or more release films and the adhesive layer for a flexible image display device constituent member according to any one of [1] to [4].

[6] A laminate including:

one or more image display device members; and

the adhesive layer for a flexible image display device constituent member according to any one of [1] to [4].

[7] A laminate including:

two image display device constituent members; and

the adhesive layer for a flexible image display device constituent member according to any one of [1] to [4] interposed between the two image display device constituent members.

[8] The laminate according to [7], in which one of the two image display device constituent members is a surface protection panel, and the other is a member formed of any one or a combination of two or more selected from the group consisting of a touch sensor film, an image display panel, a color filter, a polarizing element, and a retardation film.

[9] An image display device including the laminate according to any one of [6] to [8].

[10] The image display device according to [9], in which the image display device is a flexible image display device.

Advantageous Effects

[0013]

According to the present disclosure, it is possible to provide an adhesive layer for a flexible image display device constituent member, which is excellent in bending suitability and has a good cohesive strength and/or adhesive strength, a laminate, and an image display device.

Description of Embodiments

[0014]

Hereinafter, an example of an embodiment of the present disclosure will be described in detail. However, the present disclosure is not limited to the embodiments described below.

Note that in the present disclosure, a "layer" conceptually encompasses a sheet, a film, and a tape.

In addition, when a "panel" is expressed in such a manner as an image display panel, a protection panel, or the like, it encompasses a plate, a sheet, and a film.

[0015]

As used herein, in a case where "x to y" (x and y are any numbers) is described, it encompasses the meaning of "x or more and y or less" and the meaning of "preferably more than x" or "preferably less than y" unless otherwise specified.

In addition, when "x or more" (x is any number) is described, it encompasses the meaning of "preferably larger than x" unless otherwise specified, and when "y or less" (y is any number) is described, it encompasses the meaning of "preferably smaller than y" unless otherwise specified.

Furthermore, "x and/or y (x and y are any configurations)" means at least one of x or y, and means three ways of x only, y only, and x and y.

As used herein, "(meth)acryl" means both acryl and methacryl, "(meth)acrylate" means both acrylate and methacrylate, and "(meth)acryloyl" means both acryloyl and methacryloyl.

In the present specification, for numerical ranges described stepwise, the upper limit value or the lower limit value of a numerical range in a certain step can be optionally combined with the upper limit value or the lower limit value of a numerical range in another step. In a numerical range described

herein, the upper limit value or the lower limit value of the numerical range can be replaced by a value shown in Examples.

Furthermore, as used herein, a main component means a component that greatly affects characteristics of the material, and the content of the component is usually 50 mass% or more, preferably 70 mass% or more, and particularly preferably 90 mass% or more of the entire materials.

[0016]

Adhesive Layer

In one embodiment, the present disclosure provides an adhesive layer for a flexible image display device constituent member (hereinafter, the adhesive layer for a flexible image display device constituent member according to the embodiment may be described as a "present adhesive layer"), the adhesive layer satisfying the following requirements [I] to [V], in which the present adhesive layer is formed of a resin composition containing a polymer (A), a crosslinking agent (B), and a polymerization initiator (C),

the polymer (A) contains a copolymer composed of a compound in which 50 mass% or more of monomer components contain a (meth)acryloyl group,

the crosslinking agent (B) contains a crosslinking agent having three or more functional groups, and

the polymerization initiator (C) contains a cleavage-type photopolymerization initiator:

[I] a shear storage modulus of elasticity at -20°C (G' (-20°C)) is 300 kPa or less;

[II] a shear storage modulus of elasticity at 85°C (G' (85°C)) is 5.0 kPa or more and 30 kPa or less;

[III] a gel fraction is 45% or more and 95% or less;

[IV] an adhesive strength to a polyethylene terephthalate substrate at 23°C is 5.0 N/cm or more; and

[V] a recovery rate calculated by the following equation from a maximum strain ($\gamma_{max(25)}$) after setting a thickness of the adhesive layer to 0.5 to 1.2 mm and applying a pressure of 10 kPa at a temperature of 25°C for 600 seconds and a strain ($\gamma_{min(25)}$) 600 seconds after unloading the stress is 70% or more:

Recovery rate (%) = $[(\gamma_{max(25)} - \gamma_{min(25)})/\gamma_{max(25)}] \times 100$

Hereinafter, a resin composition forming the present adhesive layer will be described in detail.

[0017]

Resin Composition

The resin composition contains the polymer (A), the crosslinking agent (B), and the polymerization initiator (C) as described above. In the present disclosure, the "polymer (A)" is a concept including a prepolymer. Note that the "prepolymer" is produced by partially polymerizing a copolymerization component described below, and is a mixture of a polymer and an unpolymerized copolymerization component.

[0018]

Polymer (A)

Examples of the polymer (A) include a copolymer composed of a compound in which 50 mass% or more of monomer components have a

(meth)acryloyl group, such as an acrylic copolymer produced by polymerizing an alkyl (meth)acrylate and a monomer component copolymerizable with the alkyl (meth)acrylate. Among them, the polymer (A) preferably contains a structural moiety derived from an alkyl (meth)acrylate and a structural moiety derived from a hydroxy group-containing (meth)acrylate, and is particularly preferably an acrylic copolymer containing a structural moiety derived from an alkyl (meth)acrylate (a1) having an alkyl group with 3 or more carbon atoms [hereinafter, may be referred to as an "alkyl (meth)acrylate (a1)"] and a structural moiety derived from a hydroxy group-containing (meth)acrylate (a2), from the viewpoint of adhesive properties. Such an acrylic copolymer is produced by polymerizing copolymerization components including the alkyl (meth)acrylate (a1) and the hydroxy group-containing (meth)acrylate (a2).

[0019]

The copolymerization components may contain components other than the alkyl (meth)acrylate (a1) and the hydroxy group-containing (meth)acrylate (a2), for example, at least one copolymerizable monomer (a3) selected from alkyl (meth)acrylates each having an alkyl group with 1 or 2 carbon atoms and vinyl ester-based monomers [hereinafter, referred to as a "copolymerizable monomer (a3)"], a functional group-containing ethylenically unsaturated monomer (a4), an additional copolymerizable monomer (a5), and the like.

[0020]

The polymer (A) contains the acrylic copolymer in an amount of usually 50 mass% or more, preferably 60 mass% or more, more preferably 70 mass% or more, still more preferably 80 mass% or more, and particularly

preferably 90 mass% or more. The upper limit thereof is not particularly limited, and may be 100 mass%. The content thereof is, for example, in a range of 50 to 100 mass%.

[0021]

Alkyl (Meth)Acrylate (a1)

Examples of the alkyl (meth)acrylate (a1) include aliphatic (meth)acrylates such as linear alkyl (meth)acrylates and branched alkyl (meth)acrylates, and alicyclic (meth)acrylates.

Examples of the aliphatic (meth)acrylates include linear alkyl (meth)acrylates such as n-propyl (meth)acrylate, n-butyl (meth)acrylate, n-pentyl (meth)acrylate, n-hexyl (meth)acrylate, n-heptyl (meth)acrylate, n-octyl (meth)acrylate, n-nonyl (meth)acrylate, n-decyl (meth)acrylate, lauryl (meth)acrylate, n-tridecyl (meth)acrylate, stearyl (meth)acrylate, icosyl (meth)acrylate, heneicosyl (meth)acrylate, and behenyl (meth)acrylate; and branched alkyl (meth)acrylates such as isopropyl (meth)acrylate, isobutyl (meth)acrylate, sec-butyl (meth)acrylate, t-butyl (meth)acrylate, isopentyl (meth)acrylate, neopentyl (meth)acrylate, 2-ethylhexyl (meth)acrylate, isooctyl (meth)acrylate, isononyl (meth)acrylate, isodecyl (meth)acrylate, isostearyl (meth)acrylate, and isoicosyl (meth)acrylate.

Examples of the alicyclic (meth)acrylates include cyclohexyl (meth)acrylate, t-butylcyclohexyl (meth)acrylate, isobornyl (meth)acrylate, 3,3,5-trimethylcyclohexyl (meth)acrylate, and adamantyl (meth)acrylate.

One of these may be used alone or two or more thereof may be used in combination.

[0022]

Among these, linear alkyl (meth)acrylates are preferred from the viewpoint of adhesiveness and restorability. In addition, from the viewpoint of balancing adhesiveness and bendability at a low temperature, linear or branched alkyl (meth)acrylates having an alkyl group with 3 or more and 18 or less carbon atoms, further 16 or less carbon atoms, particularly 12 or less carbon atoms, and especially 8 or less carbon atoms are preferable, and examples thereof include n-propyl (meth)acrylate, n-butyl (meth)acrylate, n-pentyl (meth)acrylate, n-hexyl (meth)acrylate, n-octyl (meth)acrylate, n-nonyl (meth)acrylate, decyl (meth)acrylate, and 2-ethylhexyl (meth)acrylate. Among them, n-butyl (meth)acrylate and 2-ethylhexyl (meth)acrylate are preferable.

From the viewpoint of reducing the refractive index, an alkyl (meth)acrylate having an alkyl group with 4 or more carbon atoms, particularly 6 or more carbon atoms, especially 8 or more carbon atoms, and 18 or less carbon atoms, particularly 16 or less carbon atoms, especially 12 or less carbon atoms is preferred.

[0023]

From the viewpoint of suppressing an increase in shear storage modulus of elasticity (G') at a low temperature to improve bendability, the alkyl (meth)acrylate (a1) is particularly preferably an acrylate.

[0024]

The content of the structural moiety derived from the alkyl (meth)acrylate (a1) with respect to the polymer (A) is usually 50 mass% or more, preferably 60 mass% or more, and particularly preferably 70 mass% or more, and usually 99 mass% or less, preferably 97 mass% or less, and particularly preferably 95 mass% or less, from the viewpoint of suppressing

an increase in shear storage modulus of elasticity (G') at a low temperature, and the range of the content is, for example, from 50 to 99 mass%. When the content of the structural moiety derived from the alkyl (meth)acrylate (a1) is not less than the lower limit value, an increase in shear storage modulus of elasticity (G') at a low temperature tends to be suppressed, and when the content is not more than the upper limit value, the suppression thereof tends to be compatible with other physical properties such as adhesiveness.

[0025]

In a case where the linear alkyl (meth)acrylate and the branched alkyl (meth)acrylate are used in combination, the mass ratio [linear alkyl (meth)acrylate/branched alkyl (meth)acrylate] is usually 1/99 or more, preferably 50/50 or more, and more preferably 65/35 or more, and usually 99/1 or less, preferably 95/5 or less, and more preferably 90/10 or less. The range of the mass ratio is, for example, from 1/99 to 99/1. When the mass ratio of the linear alkyl (meth)acrylate to the branched alkyl (meth)acrylate is within the above range, the adhesive strength tends to be excellent in the resulting adhesive.

[0026]

Hydroxy Group-Containing (Meth)Acrylate (a2)

Examples of the hydroxy group-containing (meth)acrylate (a2) include hydroxyalkyl (meth)acrylates such as 2-hydroxyethyl (meth)acrylate, 4-hydroxybutyl (meth)acrylate, 5-hydroxypentyl (meth)acrylate, 6-hydroxyhexyl (meth)acrylate, and 8-hydroxyoctyl (meth)acrylate; caprolactone-modified hydroxy (meth)acrylates such as caprolactone-modified 2-hydroxyethyl (meth)acrylate; (meth)acrylates having an oxyalkylene structure such as

diethylene glycol (meth)acrylate, polyethylene glycol (meth)acrylate, polypropylene glycol (meth)acrylate, polytetramethylene glycol (meth)acrylate, and polyoxyethylene polyoxypropylene glycol (meth)acrylate; primary hydroxy group-containing (meth)acrylates such as 2-acryloyloxyethyl-2-hydroxyethylphthalate; secondary hydroxy group-containing (meth)acrylates such as 2-hydroxypropyl (meth)acrylate, 2-hydroxybutyl (meth)acrylate, and 3-chloro-2-hydroxypropyl (meth)acrylate; and tertiary hydroxy group-containing (meth)acrylates such as 2,2-dimethyl-2-hydroxyethyl (meth)acrylate. One of these may be used alone or two or more thereof may be used in combination.

[0027]

From the viewpoint of reducing the shear storage modulus of elasticity (G') at a low temperature, among the hydroxy group-containing (meth)acrylates (a2), hydroxy group-containing (meth)acrylates having a hydroxyalkyl group with 1 or more carbon atoms, further 2 or more and 10 or less carbon atoms, further 6 or less carbon atoms, and especially 4 or less carbon atoms, such as 2-hydroxyethyl (meth)acrylate, 4-hydroxybutyl (meth)acrylate, and 2-hydroxypropyl (meth)acrylate are preferable, and primary hydroxy group-containing (meth)acrylates such as 2-hydroxyethyl (meth)acrylate and 4-hydroxybutyl (meth)acrylate are particularly preferable.

[0028]

In addition, in a case of using 2-hydroxyethyl (meth)acrylate and 4-hydroxybutyl (meth)acrylate as the hydroxy group-containing (meth)acrylate (a2), the ratio thereof [2-hydroxyethyl (meth)acrylate/4-hydroxybutyl (meth)acrylate] is usually 30/70 or more, preferably 40/60 or more,

particularly preferably 45/55 or more, and especially preferably 50/50 or more, and usually 95/5 or less, preferably 80/20 or less, particularly preferably 75/25 or less, and especially preferably 70/30 or less, on a mass basis, and the range of the ratio is, for example, from 30/70 to 95/5. When the content ratio of 2-hydroxyethyl (meth)acrylate is not less than the lower limit, the adhesive strength tends to be excellent in the resulting adhesive, and when the content ratio is the upper limit or less, the bending durability tends to be excellent in the resulting adhesive.

[0029]

Note that the hydroxy group-containing (meth)acrylate (a2) is preferably one in which the content ratio of di(meth)acrylate contained as an impurity in the hydroxy group-containing (meth)acrylate (a2) is as small as possible, and specifically, one having 0.5 mass% or less of such di(meth)acrylate is preferably used, particularly preferably 0.2 mass% or less of such di(meth)acrylate, and further preferably 0.1 mass% or less of such di(meth)acrylate.

[0030]

The content of the structural moiety derived from the hydroxy group-containing (meth)acrylate (a2) with respect to the polymer (A) is usually 5 mass% or more, preferably 8 mass% or more, more preferably 10 mass% or more, still more preferably 11 mass% or more, and particularly preferably 12 mass% or more, and is usually 60 mass% or less, preferably 45 mass% or less, more preferably 35 mass% or less, still more preferably 30 mass% or less, and particularly preferably 25 mass% or less, and the range of the content is, for example, from 5 to 45 mass%.

When the content of the structural moiety derived from the hydroxy group-containing (meth)acrylate (a2) is not less than the lower limit value, the adhesive layer tends to be excellent in moist heat resistance, and when the content is not more than the upper limit value, an unintended self-crosslinking reaction can be suppressed, and heat resistance tends to be improved.

[0031]

Copolymerizable Monomer (a3)

In the present disclosure, it is preferable to further contain the copolymerizable monomer (a3) as a copolymerization component from the viewpoint of improving the cohesive strength and further improving the adhesive strength in the resulting adhesive.

[0032]

Examples of the copolymerizable monomer (a3) include methyl (meth)acrylate, ethyl (meth)acrylate, and vinyl acetate. One of these copolymerizable monomers (a3) may be used alone or two or more thereof may be used in combination. Among them, methyl (meth)acrylate and ethyl (meth)acrylate are preferable from the viewpoint of improving the cohesive strength at the usage of the resulting adhesive.

[0033]

In a case where the polymer (A) contains a structural moiety derived from the copolymerizable monomer (a3), the content thereof is usually 1 mass% or more, preferably 10 mass% or more, and more preferably 15 mass% or more, and usually 70 mass% or less, preferably 60 mass% or less, and more preferably 45 mass% or less, with respect to the polymer (A), and the range of the content is, for example, from 1 to 70 mass%. When the

content of the copolymerizable monomer (a3) is not less than the lower limit value, the adhesive layer tends to be excellent in adhesive strength, and when the content is not more than the upper limit value, the adhesive layer tends to have excellent durability.

[0034]

In a case where methyl (meth)acrylate and/or ethyl (meth)acrylate is used as the copolymerizable monomer (a3), the content of the structural moiety derived from methyl (meth)acrylate and/or ethyl (meth)acrylate is usually 1 mass% or more, preferably 2 mass% or more, more preferably 3 mass% or more, and particularly preferably 4 mass% or more, and is usually 40 mass% or less, preferably 30 mass% or less, more preferably 25 mass% or less, and particularly preferably 10 mass% or less, with respect to the polymer (A), and the range of the content is, for example, from 1 to 40 mass%. When the content of the structural moiety derived from methyl (meth)acrylate and/or ethyl (meth)acrylate is not less than the lower limit value, the adhesive layer tends to be excellent in adhesive strength, and when the content is not more than the upper limit value, the polymer (A) tends to have excellent handleability.

[0035]

Functional Group-Containing Ethylenically Unsaturated Monomer (a4)

In the adhesive layer, the functional group-containing ethylenically unsaturated monomer (a4) (excluding the hydroxy group-containing (meth)acrylate (a2)) may be used, as necessary, as a copolymerization component of the polymer (A).

[0036]

Examples of the functional group-containing ethylenically unsaturated monomer (a4) include a functional group-containing monomer having a nitrogen atom, a carboxy group-containing monomer, an acetoacetyl group-containing monomer, an isocyanate group-containing monomer, and a glycidyl group-containing monomer.

Among these, from the viewpoint of imparting a cohesive strength and a crosslinking acceleration action, a functional group-containing monomer having a nitrogen atom is preferable, an amino group-containing monomer and an amide group-containing monomer are more preferable, and an amino group-containing monomer is particularly preferable.

[0037]

Examples of the amino group-containing monomer include primary amino group-containing (meth)acrylates such as aminomethyl (meth)acrylate and aminoethyl (meth)acrylate; secondary amino group-containing (meth)acrylates such as t-butylaminoethyl (meth)acrylate and t-butylaminopropyl (meth)acrylate; and tertiary amino group-containing (meth)acrylates such as ethylaminoethyl (meth)acrylate, dimethylaminoethyl (meth)acrylate, diethylaminoethyl (meth)acrylate, dimethylaminopropyl (meth)acrylate, diethylaminopropyl (meth)acrylate, and dimethylaminopropylacrylamide.

[0038]

Examples of the amide group-containing monomer include (meth)acrylamides; N-alkyl (meth)acrylamides such as N-methyl (meth)acrylamide, N-ethyl (meth)acrylamide, N-propyl (meth)acrylamide, N-n-butyl (meth)acrylamide, diacetone (meth)acrylamide, and N,N'-

methylenebis(meth)acrylamide; N,N-dialkyl (meth)acrylamides such as N,N-dimethyl (meth)acrylamide, N,N-diethyl (meth)acrylamide, N,N-dipropyl (meth)acrylamide, N,N-ethylmethyl acrylamide, and N,N-diallyl (meth)acrylamide; hydroxyalkyl (meth)acrylamides such as N-hydroxymethyl (meth)acrylamide and N-hydroxyethyl (meth)acrylamide; and alkoxyalkyl (meth)acrylamides such as N-methoxymethyl (meth)acrylamide and N-(n-butoxymethyl) (meth)acrylamide.

[0039]

Examples of the carboxy group-containing monomer include (meth)acrylic acid, 2-(meth)acryloyloxyethylhexahydrophthalic acid, 2-(meth)acryloyloxypropylhexahydrophthalic acid, 2-(meth)acryloyloxyethylphthalic acid, 2-(meth)acryloyloxypropylphthalic acid, 2-(meth)acryloyloxyethylmaleic acid, 2-(meth)acryloyloxypropylmaleic acid, 2-(meth)acryloyloxyethylsuccinic acid, 2-(meth)acryloyloxypropylsuccinic acid, crotonic acid, fumaric acid, maleic acid, and itaconic acid.

[0040]

Examples of the acetoacetyl group-containing monomer include 2-(acetoacetoxy)ethyl (meth)acrylate and allyl acetoacetate.

[0041]

Examples of the isocyanate group-containing monomer include 2-(meth)acryloyloxyethyl isocyanate and alkylene oxide adducts thereof.

[0042]

Examples of the glycidyl group-containing monomer include glycidyl (meth)acrylate and allyl glycidyl (meth)acrylate.

[0043]

One of these functional group-containing ethylenically unsaturated monomers (a4) may be used alone or two or more thereof may be used in combination.

[0044]

In a case where the polymer (A) has a structural moiety derived from the functional group-containing ethylenically unsaturated monomer (a4), the content thereof is usually 30 mass% or less, preferably 20 mass% or less, more preferably 10 mass% or less, and particularly preferably 5 mass% or less, with respect to the polymer (A). When the content of the structural moiety derived from the functional group-containing ethylenically unsaturated monomer (a4) is not more than the upper limit value, the polymer (A) tends to be excellent in heat resistance.

[0045]

Additional Copolymerizable Monomer (a5)

In the adhesive layer, an additional copolymerizable monomer (a5) may be used, as necessary, as a copolymerization component of the polymer (A).

[0046]

Examples of the additional copolymerizable monomer (a5) include (meth)acrylates having an alkoxyalkylene glycol skeleton such as methoxydiethylene glycol (meth)acrylate, methoxypolyethylene glycol (meth)acrylate, butoxypolyethylene glycol (meth)acrylate, methoxypolypropylene glycol (meth)acrylate, butoxypolypropylene glycol (meth)acrylate, methoxypolytetramethylene glycol (meth)acrylate, butoxypolytetramethylene glycol (meth)acrylate, methoxypolyoxyethylene

polyoxypropylene glycol (meth)acrylate, and butoxypolyoxyethylene polyoxypropylene glycol (meth)acrylate; aromatic (meth)acrylate-based monomers such as phenyl (meth)acrylate, benzyl (meth)acrylate, phenoxyethyl (meth)acrylate, phenyldiethylene glycol (meth)acrylate, phenoxypolyethylene glycol (meth)acrylate, phenoxypolyethylene glycol-polypropylene glycol-(meth)acrylate, and nonylphenolethyleneoxide adduct (meth)acrylate; and monomers such as acrylonitrile, methacrylonitrile, styrene, α-methylstyrene, vinyl propionate, vinyl stearate, vinyl chloride, vinylidene chloride, alkylvinyl ether, vinyl toluene, vinyl pyridine, vinyl pyrrolidone, dialkyl itaconate, dialkyl fumarate, allyl alcohol, acryl chloride, methyl vinyl ketone, N-acrylamidemethyltrimethyl ammonium chloride, allyltrimethyl ammonium chloride, and dimethyl allyl vinyl ketone. One of these may be used alone or two or more thereof may be used in combination.

[0047]

In addition, in a case of aiming at increasing the molecular weight of the polymer (A), as the additional copolymerizable monomer (a5), for example, a compound having two or more ethylenically unsaturated groups such as ethylene glycol di(meth)acrylate, diethylene glycol di(meth)acrylate, triethylene glycol di(meth)acrylate, polyethylene glycol di(meth)acrylate, propylene glycol di(meth)acrylate, or divinylbenzene may be used in combination in a small amount. Note that these compounds having two or more ethylenically unsaturated groups have high reactivity, and usually do not remain unreacted when used as a polymerization component of the acrylic copolymer.

[0048]

In a case where the polymer (A) has a structural moiety derived from the additional copolymerizable monomer (a5), the content thereof is usually 50 mass% or less, preferably 40 mass% or less, and more preferably 20 mass% or less, with respect to the polymer (A). When the content ratio of the additional copolymerizable monomer (a5) is not more than the upper limit value, an unreacted copolymerizable monomer (a5) can be prevented from remaining, and the adhesive layer tends to be excellent in heat resistance and adhesive strength.

[0049]

The polymer (A) can be produced by appropriately selecting the copolymerization components and polymerizing the selected copolymerization components.

[0050]

Examples of the method for polymerizing the polymer (A) include methods known in the related art such as solution polymerization, suspension polymerization, bulk polymerization, emulsion polymerization, and photopolymerization, and among these, solution polymerization is preferable in that the polymer (A) can be produced safely and stably with any monomer composition.

Hereinafter, an example of the preferred method for producing the polymer (A) will be described.

[0051]

First, the above-mentioned copolymerization components and a polymerization initiator are mixed or added dropwise in an organic solvent, and solution polymerization is performed to produce a polymer (A) solution.

[0052]

Organic Solvent

Examples of the organic solvent to be used in the polymerization reaction include aromatic hydrocarbons such as toluene and xylene, aliphatic hydrocarbons such as hexane, esters such as ethyl acetate and butyl acetate, aliphatic alcohols such as N-propyl alcohol and isopropyl alcohol, and ketones such as acetone, methyl ethyl ketone, methyl isobutyl ketone, and cyclohexanone. One of these may be used alone or two or more thereof may be used in combination. Among these solvents, ethyl acetate is preferable.

[0053]

Polymerization Initiator

As the polymerization initiator to be used in the polymerization reaction, an azo-based polymerization initiator or a peroxide-based polymerization initiator, which is a usual radical polymerization initiator, may be used. Examples of the azo-based polymerization initiator include 2,2'-azobis(2-methylbutyronitrile), 2,2'-azobisisobutyronitrile, (1-phenylethyl) azodiphenylmethane, 2,2'-azobis(2,4-dimethylvaleronitrile), 2,2'-azobis(2-cyclopropylpropionitrile), and 2,2'-azobis(4-methoxy-2,4-dimethylvaleronitrile). Examples of the peroxide-based polymerization initiator include benzoyl peroxide, di-t-butyl peroxide, cumene hydroperoxide, lauroyl peroxide, t-butyl peroxypivalate, t-hexyl peroxypivalate, t-hexyl peroxyneodecanoate, diisopropylperoxycarbonate, and diisobutyryl peroxide. One of these may be used alone or two or more thereof may be used in combination. Among these, 2,2'-azobis(2,4-dimethylvaleronitrile) is preferable.

[0054]

The amount of the polymerization initiator used is usually 0.001 parts by mass or more, preferably 0.1 parts by mass or more, more preferably 0.5 parts by mass or more, still more preferably 1 part by mass or more, particularly preferably 1.5 parts by mass or more, and most preferably 2 parts by mass or more, and usually 10 parts by mass or less, preferably 8 parts by mass or less, more preferably 6 parts by mass or less, still more preferably 4 parts by mass or less, particularly preferably 3 parts by mass or less, and most preferably 2.5 parts by mass or less, with respect to 100 parts by mass of the copolymerization components, and the range of the amount used is, for example, from 0.001 to 10 parts by mass. When the amount of the polymerization initiator used is not less than the lower limit value, the polymerization rate of the polymer (A) tends to be high, the residual monomer tends to decrease, and the weight-average molecular weight of the polymer (A) tends to be in an appropriate range. When the amount of the polymerization initiator used is not more than the upper limit value, unintended gelation of the polymer (A) tends to be suppressible.

[0055]

Polymerization Conditions and the Like

For the polymerization conditions of the solution polymerization, polymerization only needs to be performed in accordance with polymerization conditions known in the related art, and for example, the polymerization components and the polymerization initiator are mixed or added dropwise in a solvent, and the polymerization can be performed under predetermined polymerization conditions.

[0056]

The polymerization temperature in the polymerization reaction is usually 40°C or higher, preferably 50°C or higher, more preferably 55°C or higher, and still more preferably 60°C or higher from the viewpoint of allowing stable performance of the reaction, and is usually 120°C or lower, preferably 90°C or lower, more preferably 75°C or lower, and still more preferably 70°C or lower from the viewpoint of allowing stable performance of the reaction, and the range of the polymerization temperature is, for example, from 40 to 120°C. When the polymerization temperature is not lower than the lower limit value, the activity of the polymerization initiator tends to be high, the polymerization rate of the polymer (A) tends to be high, and the residual monomer tends to decrease. When the polymerization temperature is not higher than the upper limit value, unintended gelation of the polymer (A) tends to be suppressible.

[0057]

The polymerization time in the polymerization reaction (the time until the start of additional heat treatment in a case of performing the additional heat treatment described below) is not particularly limited, but is preferably 0.5 hours or longer, particularly preferably 1 hour or longer, still more preferably 2 hours or longer, and especially preferably 5 hours or longer from the final addition of the polymerization initiator. The upper limit of the polymerization time is usually 72 hours, and the range of the polymerization time is, for example, from 0.5 to 72 hours.

Note that the polymerization reaction is preferably performed while refluxing the solvent in view of easy removal of heat.

[0058]

In the production of the polymer (A), to reduce the amount of the residual polymerization initiator, it is preferable to thermally decompose the polymerization initiator by additional heat treatment.

[0059]

The temperature in the additional heat treatment is preferably higher than a 10-hour half-life temperature of the polymerization initiator, specifically, usually 40°C or higher, preferably 55°C or higher, and particularly preferably 75°C or higher from the viewpoint of suppressing gelation, and usually 150°C or lower, preferably 130°C or lower, and particularly preferably 95°C or lower from the viewpoint of suppressing gelation, and the range of the temperature is, for example, from 40 to 150°C. When the temperature in the additional heat treatment is not lower than the lower limit value, an unreacted copolymerization component or polymerization initiator is less likely to remain in the polymer (A), and the temporal stability or thermal stability of the polymer (A) tends to be improved. When the temperature is not higher than the upper limit value, yellowing of the polymer (A) tends to be suppressible.

Thus, the polymer (A) can be produced.

[0060]

The polymer (A) may have a photoactive moiety, for example, a polymerizable carbon-carbon double bond group, introduced into a side chain thereof. This can increase crosslinking efficiency of the resin composition, whereby the resin composition can be crosslinked in a shorter time to increase productivity.

[0061]

Examples of the method for introducing a polymerizable carbon-carbon double bond group into a side chain of the polymer (A) include a method in which a copolymer containing the hydroxy group-containing (meth)acrylate (a2) and the functional group-containing ethylenically unsaturated monomer (a4) described above is prepared, and then the copolymer and a compound having a functional group reactive with these functional groups and a polymerizable carbon-carbon double bond group are subjected to a condensation or addition reaction while maintaining activity of the polymerizable carbon-carbon double bond group.

[0062]

Examples of the combination of these functional groups include an epoxy group (glycidyl group) and a carboxy group, an amino group and a carboxy group, an amino group and an isocyanate group, an epoxy group (glycidyl group) and an amino group, a hydroxy group and an epoxy group, and a hydroxy group and an isocyanate group. Among these combinations of functional groups, a combination of a hydroxy group and an isocyanate group is preferable from the viewpoint of ease of reaction control. Among them, a combination in which the copolymer has a hydroxy group and the compound has an isocyanate group is suitable.

[0063]

Examples of the isocyanate compound having a polymerizable carbon-carbon double bond group include the above-described 2-(meth)acryloyloxyethyl isocyanate and alkylene oxide adducts thereof.

[0064]

The content of the compound having a functional group reactive with the functional group and a polymerizable carbon-carbon double bond group is preferably 10 parts by mass or less, more preferably 5 parts by mass or less, still more preferably 1 part by mass or less, and particularly preferably 0.1 parts by mass or less, with respect to 100 parts by mass of the polymer (A), from the viewpoint of improving adhesiveness and stress relaxation property. Note that the lower limit value is usually 0 parts by mass. The range of the content thereof is, for example, from 0 to 10 parts by mass.

[0065]

In addition to the above-described method, the polymer (A) can also be produced by preparing a syrup composition containing the copolymerization component or prepolymer, the crosslinking agent (B), the polymerization initiator (C), and the like, and irradiating the syrup composition with an active energy ray to polymerize the syrup composition.

[0066]

From the viewpoint of suppressing an increase in the shear storage modulus of elasticity (G') at a low temperature, the glass transition temperature (Tg) of the polymer (A) is preferably -20°C or lower, more preferably -23°C or lower, still more preferably -25°C or lower, particularly preferably -30°C or lower, and especially preferably -40°C or lower. Note that from the viewpoint of preventing adhesive protrusion by maintaining the shear storage modulus of elasticity at a high temperature at an appropriate value, the glass transition temperature (Tg) is usually -70°C or higher, and preferably -50°C or higher. The range of the glass transition temperature (Tg) is, for example, from -70 to -20°C.

[0067]

The glass transition temperature (Tg) is determined by reading a temperature at which a loss tangent (Tanδ) becomes maximum when dynamic viscoelasticity is measured using a dynamic viscoelasticity measuring apparatus in a shear mode at a frequency of 1 Hz.

For example, the polymer (A) is molded into a cylindrical body having a diameter of 8 mm (height: 0.8 mm), and the loss tangent (Tanδ) of the cylindrical body can be measured using a viscoelasticity measuring apparatus ("DHR 2", available from T.A. Instruments) under the following measurement conditions.

[0068]

Measurement Conditions

· Measurement jig: Φ8 mm parallel plate

· Strain: 0.1%

· Frequency: 1 Hz

· Measurement temperature: from -60 to 100°C

· Temperature rise rate: 5°C/min

[0069]

The weight-average molecular weight (Mw) of the polymer (A) is preferably 400000 or more, more preferably 500000 or more, still more preferably 550000 or more, and particularly preferably 600000 or more, from the viewpoint that a resin composition having a high cohesive strength can be produced.

The upper limit value of the weight-average molecular weight (Mw) of the polymer (A) is preferably 1.5 million or less, more preferably 1.2 million or

less, still more preferably 1.1 million or less, and particularly preferably 1 million or less, from the viewpoint of handleability and uniform stirring property.

The range of the weight-average molecular weight (Mw) is, for example, from 400000 to 1.5 million.

[0070]

In the present disclosure, the weight-average molecular weight (Mw) can be determined, for example, as follows.

Method for Measuring Weight-Average Molecular Weight

With a measurement sample produced by dissolving 4 mg of the polymer (A) using 12 mL of tetrahydrofuran (THF), the weight-average molecular weight (Mw) can be determined by measuring a molecular weight distribution curve under the following conditions using a gel permeation chromatography (GPC) analyzer ("HLC-8320GPC", available from Tosoh Corporation).

· Guard column: TSKguardcolumnHXL

· Separation column: TSKgelGMHXL (4 columns)

· Temperature: 40°C

· Injection amount: 100 μL

· Polystyrene conversion

· Solvent: THF

· Flow rate: 1.0 mL/min

[0071]

The content of the polymer (A) is usually 25 mass% or more, preferably 35 mass% or more, more preferably 45 mass% or more, and

particularly preferably 55 mass% or more, and is usually 99.9 mass% or less, preferably 99.5 mass% or less, more preferably 99 mass% or less, still more preferably 95 mass% or less, particularly preferably 90 mass% or less, and most preferably 85 mass% or less, with respect to the resin composition. The range of the content is, for example, from 25 to 99.9 mass%.

[0072]

Crosslinking Agent (B)

The resin composition contains a crosslinking agent (B), and the crosslinking agent (B) contains a polyfunctional crosslinking agent.

This allows the resin composition to efficiently form a crosslinked structure. When a crosslinked structure is formed in the adhesive layer using the resin composition, an adhesive layer having improved shape stability can be produced, and the storage property and the handleability are improved, and the adhesive layer can be prevented from protruding from the end portion during bonding. In addition, when a crosslinked structure is formed in the adhesive layer, it is possible to obtain a good adhesiveness and cohesive strength.

[0073]

In the present adhesive layer, the crosslinking agent (B) contains a crosslinking agent having three or more functional groups. The term "crosslinking agent having three or more functional groups" as used herein means a crosslinking agent including three or more functional groups having polymerization or crosslinking activity in one molecule.

The crosslinking agent (B) preferably contains a crosslinking agent having four or more functional groups, and more preferably contains a

crosslinking agent having five or more functional groups. The crosslinking agent may contain a crosslinking agent having 6 or more functional groups, for example, a crosslinking agent having 7 to 12 functional groups.

When the crosslinking agent (B) contains a crosslinking agent having functional groups in an amount equal to or more than the lower limit, an adhesive layer having a good adhesive strength and/or cohesive strength after curing can be produced. The crosslinking agent having three or more functional groups may include two or more different functional groups.

[0074]

In one embodiment, the crosslinking agent (B) contains a crosslinking agent having three or more functional groups in an amount of 50 mass% or more, preferably 60 mass% or more, more preferably 70 mass% or more, still more preferably 80 mass% or more, and particularly preferably 90 mass% or more, with respect to the total amount of the crosslinking agent. The upper limit thereof is not particularly limited, and may be 100 mass%. The range of the content of the crosslinking agent having three or more functional groups is, for example, from 50 to 100 mass%.

[0075]

Examples of the type of the crosslinking agent (B) include an acrylic crosslinking agent, an isocyanate-based crosslinking agent, an epoxy-based crosslinking agent, an aziridine-based crosslinking agent, a melamine-based crosslinking agent, an aldehyde-based crosslinking agent, an amine-based crosslinking agent, and a metal chelate-based crosslinking agent.

In one embodiment, the crosslinking agent (B) contains an acrylic crosslinking agent. The crosslinking agent (B) preferably contains an acrylic

crosslinking agent because the reaction is easily controlled. In the present embodiment, more preferably, the crosslinking agent (B) contains a polyfunctional (meth)acrylate.

[0076]

Examples of the polyfunctional (meth)acrylate include polyfunctional (meth)acrylic monomers and polyfunctional (meth)acrylic oligomers, which have two or more (meth)acryloyl groups. One of these may be used alone or two or more thereof may be used in combination.

[0077]

Examples of the polyfunctional (meth)acrylic monomer include pentanediol di(meth)acrylate, hexadiol di(meth)acrylate, heptanediol di(meth)acrylate, octanediol di(meth)acrylate, nonanediol di(meth)acrylate, decanediol di(meth)acrylate, undecanediol di(meth)acrylate, dodecanediol di(meth)acrylate, 1,4-butanediol di(meth)acrylate, glycerin di(meth)acrylate, neopentylglycol di(meth)acrylate, glycerin glycidyl ether di(meth)acrylate, tricyclodecane dimethacrylate, tricyclodecane dimethanol di(meth)acrylate, bisphenol-A polyethoxy di(meth)acrylate, bisphenol-A polypropoxy di(meth)acrylate, bisphenol-F polyethoxy di(meth)acrylate, ethylene glycol di(meth)acrylate, trimethylolpropane trioxyethyl (meth)acrylate, ε-caprolactone-modified tris(2-hydroxyethyl) isocyanurate tri(meth)acrylate, pentaerythritol tri(meth)acrylate, propoxylated pentaerythritol tri(meth)acrylate, ethoxylated pentaerythritol tri(meth)acrylate, pentaerythritol tetra(meth)acrylate, propoxylated pentaerythritol tetra(meth)acrylate, ethoxylated pentaerythritol tetra(meth)acrylate, dipentaerythritol hexa(meth)acrylate, polyethylene glycol di(meth)acrylate, polypropylene

glycol di(meth)acrylate, polytetramethylene glycol di(meth)acrylate, tris(acryloxyethyl) isocyanurate, dipentaerythritol penta(meth)acrylate, tripentaerythritol hexa(meth)acrylate, tripentaerythritol penta(meth)acrylate, hydroxypivalic acid neopentylglycol di(meth)acrylate, di(meth)acrylate of ε-caprolactone adduct of hydroxypivalic acid neopentylglycol, trimethylolpropane tri(meth)acrylate, trimethylolpropane polyethoxy tri(meth)acrylate, and ditrimethylolpropane tetra(meth)acrylate.

[0078]

Examples of the polyfunctional (meth)acrylic oligomer include polyfunctional (meth)acrylic oligomers such as polyester (meth)acrylate-based oligomers, epoxy (meth)acrylate-based oligomers, urethane (meth)acrylate-based oligomers, and polyether (meth)acrylate-based oligomers.

[0079]

The crosslinking agent (B) preferably contains a glycol structure or a urethane bond from the viewpoint of imparting appropriate flexibility to the cured product.

[0080]

The content of the crosslinking agent (B) in the resin composition is usually 0.1 parts by mass or more, preferably 0.5 parts by mass or more, and more preferably 1 part by mass or more, with respect to 100 parts by mass of the polymer (A), from the viewpoint of imparting a cohesive strength, an adhesive strength, and shape stability of the adhesive layer, and/or durability when formed into a laminate, and is usually 10 parts by mass or less, preferably 8 parts by mass or less, more preferably 5 parts by mass or less,

and extremely preferably 3 parts by mass or less, from the viewpoint of maintaining flexibility of the adhesive layer. The range of the content of the crosslinking agent (B) is, for example, from 0.1 to 10 parts by mass.

[0081]

Polymerization Initiator (C)

In the present disclosure, the resin composition contains a polymerization initiator (C), and the polymerization initiator (C) contains a cleavage-type photopolymerization initiator.

In the present specification, the "polymerization initiator" is a generic term for compounds which are activated by a stimulus such as heat or light to generate an anion, a cation, a radical, or the like which causes an initiation reaction of polymerization. In the present disclosure, a compound that generates a radical (radical generator, radical polymerization initiator) is preferably used from the viewpoint that the polymerization reactivity is hardly affected by a polar group or a surrounding environment.

The term "photopolymerization initiator" is a generic term for polymerization initiators that are activated by irradiation with active energy rays such as electromagnetic waves or radiation among the above-mentioned polymerization initiators.

The "cleavage-type polymerization initiator" means a polymerization initiator in which a bond in a molecule is cleaved when activated.

Hereinafter, as an example of the embodiment, a case where a cleavage-type photopolymerization initiator (cleavage-type photoradical polymerization initiator) in which the polymerization initiator generates a radical is used will be described in detail, but an initiator other than the radical

polymerization initiator may be used as long as the effects of the present disclosure are achieved.

[0082]

The radical polymerization initiator is roughly classified into two according to a radical generation mechanism. More specifically, the radical polymerization initiator is roughly classified into a cleavage-type radical polymerization initiator that can generate a radical by cleaving a single bond of the initiator itself, and a hydrogen abstraction type radical polymerization initiator that can generate a radical by abstracting hydrogen from a hydrogen donor in the system by the excited initiator.

The cleavage-type radical polymerization initiator is preferable in that the polymer is not unsaturated and can be inhibited from becoming rigid, and in a case of using a cleavage-type photoradical polymerization initiator, it is preferable in that the initiator has high photosensitivity.

On the other hand, in any embodiment, the polymerization initiator (C) may further contain a hydrogen abstraction type radical polymerization initiator. The hydrogen abstraction type radical polymerization initiator is preferable in that the polymer (A) can be incorporated into a crosslinked structure by a hydrogen abstraction reaction, and in a case of using the hydrogen abstraction type radical polymerization initiator, it is preferable in that a photodecomposition product is not generated.

[0083]

In the present disclosure, from the viewpoint of inhibiting the polymer (A) from becoming rigid due to unexpected unsaturation, the polymerization initiator (C) contains a cleavage-type photopolymerization initiator. Preferably,

50 mass% or more of the polymerization initiator (C) is a cleavage-type photopolymerization initiator, more preferably 60 mass% or more, still more preferably 70 mass% or more, and particularly preferably 80 mass% or more is a cleavage-type photopolymerization initiator, and in a certain embodiment, 100 mass% is composed of a cleavage-type photopolymerization initiator.

[0084]

Examples of the cleavage-type photopolymerization initiator include 2,2-dimethoxy-1,2-diphenylethan-1-one, 1-hydroxycyclohexyl phenyl ketone, 2-hydroxy-2-methyl-1-phenyl-propan-1-one, 1-[4-(2-hydroxyethoxy)phenyl]-2-hydroxy-2-methyl-1-propan-1-one, 2-hydroxy-1-{4-[4-(2-hydroxy-2-methyl-propionyl)benzyl]phenyl}-2-methyl-propan-1-one, oligo(2-hydroxy-2-methyl-1-(4-(1-methylvinyl)phenyl)propanone), 2-benzyl-2-dimethylamino-1-(4-morpholinophenyl)butan-1-one, 2-methyl-1-[4-(methylthio)phenyl]-2-morpholinopropan-1-one, 2-(dimethylamino)-2-[(4-methylphenyl)methyl]-1-[4-(4-morpholinyl)phenyl]-1-butanone, bis(2,4,6-trimethylbenzoyl)-phenylphosphine oxide, 2,4,6-trimethylbenzoyldiphenylphosphine oxide, (2,4,6-trimethylbenzoyl)ethoxyphenylphosphine oxide, bis(2,6-dimethoxybenzoyl)2,4,4-trimethylpentylphosphine oxide, and derivatives thereof.

[0085]

The content of the polymerization initiator (C) in the resin composition is usually 0.1 parts by mass or more, and on the other hand, 10 parts by mass or less, preferably 5 parts by mass or less, more preferably 4 parts by mass or less, particularly preferably 3 parts by mass or less, especially preferably 2.5 parts by mass or less, and most preferably 2 parts by mass or

less, with respect to 100 parts by mass of the polymer (A), and the range of the content of the polymerization initiator (C) is, for example, from 0.1 to 10 parts by mass, and the like.

When the content is not less than the lower limit value, curing failure tends to be prevented, and when the content is not higher than the upper limit value, a decrease in solution stability such as precipitation from the resin composition tends to be easily suppressed, and problems of embrittlement and coloration are easily suppressed.

[0086]

Additional Component

The resin composition may appropriately contain, as an "additional component", various additives such as a monofunctional (meth)acrylate, a silane coupling agent, an ultraviolet absorber, a plasticizer, a tackifier, an antioxidant, a light stabilizer, a metal deactivator, an anti-aging agent, a moisture absorbent, a rust inhibitor, and inorganic particles, as necessary, as long as the effects of the present disclosure are not impaired. As necessary, a reaction catalyst such as a tertiary amine-based compound, a quaternary ammonium-based compound, or a tin laurate compound may be appropriately contained. One of these may be used alone or two or more thereof may be used in combination.

[0087]

Monofunctional (Meth)acrylate

The resin composition may further contain a monofunctional (meth)acrylate having one (meth)acryloyl group, as necessary. Containing the monofunctional (meth)acrylate having one (meth)acryloyl group can increase

the molecular weight between crosslinking points of the cured product, and thus the degree of freedom of movement of the molecular chain is increased, and a cured product having an excellent stress relaxation property is easily produced, which is preferable.

[0088]

Examples of the monofunctional (meth)acrylate include ethyl (meth)acrylate, propyl (meth)acrylate, isopropyl (meth)acrylate, butyl (meth)acrylate, isobutyl (meth)acrylate, t-butyl (meth)acrylate, amyl (meth)acrylate, isoamyl (meth)acrylate, 2-ethylhexyl (meth)acrylate, lauryl (meth)acrylate, octyl (meth)acrylate, isooctyl (meth)acrylate, decyl (meth)acrylate, isodecyl (meth)acrylate, dodecyl (meth)acrylate, isododecyl (meth)acrylate, tetradecyl (meth)acrylate, stearyl (meth)acrylate, isostearyl (meth)acrylate, behenyl (meth)acrylate, cyclopropyl (meth)acrylate, cyclobutyl (meth)acrylate, cyclopentyl (meth)acrylate, cyclohexyl (meth)acrylate, cycloheptyl (meth)acrylate, cyclooctyl (meth)acrylate, cyclononyl (meth)acrylate, cyclodecyl (meth)acrylate, isobornyl (meth)acrylate, norbornyl (meth)acrylate, adamantyl (meth)acrylate, tricyclodecanedimethanol acrylate, ethoxylated-o-phenylphenol acrylate, 2-hydroxy-o-phenylphenol propyl acrylate, methoxypolyethylene glycol (meth)acrylate, methoxypolypropylene glycol (meth)acrylate, polyethylene glycol (meth)acrylate, polypropylene glycol (meth)acrylate, phenoxyethylene glycol (meth)acrylate, phenoxydiethylene glycol (meth)acrylate, phenoxypolyethylene glycol (meth)acrylate, 2-(meth)acryloyloxyethylsuccinic acid, 2-(meth)acryloyloxyethyltetrahydrophthalic acid, 2-(meth)acryloyloxyethylhexahydrophthalic acid, 2-

(meth)acryloyloxypropylphthalic acid, 2-(meth)acryloyloxypropylhydrophthalic acid, 2-(meth)acryloyloxypropylhexahydrophthalic acid, benzyl (meth)acrylate, phenoxyethyl (meth)acrylate, 2-naphthyl (meth)acrylate, 9-anthracenyl (meth)acrylate, 1-pyrenylmethyl (meth)acrylate, tricyclodecanedimethanol monoacrylate monocarboxylic acid, dicyclopentanyl acrylate, 2-hydroxyethyl (meth)acrylate, 2-hydroxypropyl (meth)acrylate, 3-hydroxypropyl (meth)acrylate, 2-hydroxybutyl (meth)acrylate, 4-hydroxybutyl (meth)acrylate, trimethylolpropane mono(meth)acrylate, glycerin mono(meth)acrylate, pentaerythritol mono(meth)acrylate, diglycerin mono(meth)acrylate, ditrimethylolpropane mono(meth)acrylate, dipentaerythritol mono(meth)acrylate, ethoxylated trimethylolpropane mono(meth)acrylate, propoxylated trimethylolpropane mono(meth)acrylate, ethoxylated glycerin mono(meth)acrylate, propoxylated glycerin mono(meth)acrylate, ethoxylated pentaerythritol mono(meth)acrylate, propoxylated pentaerythritol mono(meth)acrylate, ethoxylated ditrimethylolpropane mono(meth)acrylate, propoxylated ditrimethylolpropane mono(meth)acrylate, alkylene oxide-modified diglycerin mono(meth)acrylate, alkylene oxide-modified dipentaerythritol mono(meth)acrylate, and the like, and in addition, monofunctional (meth)acrylic oligomers such as monofunctional urethane (meth)acrylate, monofunctional epoxy (meth)acrylate, and monofunctional polyester (meth)acrylate. One of these may be used alone or two or more thereof may be used in combination.

[0089]

Among these, as the monofunctional (meth)acrylic oligomers, monofunctional urethane (meth)acrylate, monofunctional polyester

(meth)acrylate, monofunctional epoxy (meth)acrylate, and the like are preferable, and monofunctional urethane (meth)acrylate is more preferable.

[0090]

The monofunctional urethane (meth)acrylate is particularly effective because it has high polarity and a long chain length, and thus, high restorability is provided by entanglement of polymer chains, and a low shear storage modulus of elasticity is provided by having an oxypropylene structure with high molecular rotation properties.

[0091]

In a case where the monofunctional (meth)acrylate is contained, the content thereof is preferably 1 part by mass or more, more preferably 2 parts by mass or more, and particularly preferably 3 parts by mass or more, with respect to 100 parts by mass of the polymer (A), from the viewpoint of imparting appropriate flexibility to the cured product by adjusting a crosslinking density. The upper limit value is preferably 40 parts by mass or less, more preferably 35 parts by mass or less, and particularly preferably 30 parts by mass or less, and the range of the content is, for example, from 1 to 40 parts by mass.

[0092]

Silane Coupling Agent

The silane coupling agent is an organosilicon compound containing one or more reactive functional groups and one or more alkoxy groups bonded to a silicon atom in the structure. Examples of the reactive functional group include an epoxy group, a (meth)acryloyl group, a mercapto group, a hydroxy group, a carboxy group, an amino group, an amide group, and an

isocyanate group. Among these, from the viewpoint of balance of durability, the reactive functional group is preferably an epoxy group or a mercapto group.

[0093]

The alkoxy group attached to a silicon atom is preferably an alkoxy group with 1 to 8 carbons from the viewpoints of durability and storage stability, and particularly preferably a methoxy group or an ethoxy group. Note that the silane coupling agent may have an organic substituent other than the reactive functional group and the alkoxy group bonded to a silicon atom, such as an alkyl group or a phenyl group.

[0094]

Examples of the silane coupling agent include monomer-type epoxy group-containing silane coupling agents which are silane compounds such as 3-glycidoxypropyltrimethoxysilane, 3-glycidoxypropyltriethoxysilane, 3-glycidoxypropylmethyldiethoxysilane, 3-glycidoxypropylmethyldimethoxysilane, and 2-(3,4-epoxycyclohexyl)ethyltrimethoxysilane, and oligomer-type epoxy group-containing silane coupling agents which are silane compounds produced by hydrolysis and polycondensation of a part of the silane compounds or co-condensation of the silane compounds and alkyl group-containing silane compounds such as methyltriethoxysilane, ethyltriethoxysilane, methyltrimethoxysilane, and ethyltrimethoxysilane; monomer-type mercapto group-containing silane coupling agents which are silane compounds such as 3-mercaptopropyltrimethoxysilane, 3-mercaptopropyltriethoxysilane, γ-mercaptopropyldimethoxymethylsilane, and 3-

mercaptopropylmethyldimethoxysilane, and oligomer-type mercapto group-containing silane coupling agents which are silane compounds produced by hydrolysis and polycondensation of a part of the silane compounds, or co-condensation of the silane compounds and alkyl group-containing silane compounds such as methyltriethoxysilane, ethyltriethoxysilane, methyltrimethoxysilane, and ethyltrimethoxysilane; (meth)acryloyl group-containing silane coupling agents such as 3-acryloxypropyltrimethoxysilane, 3-methacryloxypropyltrimethoxysilane, 3-methacryloxypropylmethyldiethoxysilane, and 3-methacryloxypropyltriethoxysilane; amino group-containing silane coupling agents such as N-2-(aminoethyl)-3-aminopropylmethyldimethoxysilane, N-2-(aminoethyl)-3-aminopropyltrimethoxysilane, 3-aminopropyltrimethoxysilane, 3-aminopropyltriethoxysilane, 3-triethoxysilyl-N-(1,3-dimethyl-butylidene)propylamine, and N-phenyl-3-aminopropyltrimethoxysilane; isocyanate group-containing silane coupling agents such as 3-isocyanatepropyltriethoxysilane; and vinyl group-containing silane coupling agents such as vinyltrimethoxysilane and vinyltriethoxysilane.

One of these may be used alone or two or more thereof may be used in combination.

[0095]

Among these, from the viewpoint of excellent durability, an epoxy group-containing silane coupling agent and a mercapto group-containing silane coupling agent are preferably used, and among these, an epoxy group-containing silane coupling agent is particularly preferable.

[0096]

In a case where the resin composition contains a silane coupling agent, the content thereof is usually 0.005 parts by mass or more, preferably 0.01 parts by mass or more, and particularly preferably 0.05 parts by mass or more, and is usually 10 parts by mass or less, preferably 5.0 parts by mass or less, and particularly preferably 1.0 part by mass or less, with respect to 100 parts by mass of the polymer (A), and the range of the content is, for example, from 0.05 to 10 parts by mass. When the content is within the above range, the adhesive strength and durability tend to be improved.

[0097]

Ultraviolet Absorber

Examples of the ultraviolet absorber include a benzophenone-based ultraviolet absorber, a benzotriazole-based ultraviolet absorber, a triazine-based ultraviolet absorber, a salicylic acid-based ultraviolet absorber, a cyanoacrylate-based ultraviolet absorber, and a benzoxazine-based ultraviolet absorber. One of these ultraviolet absorbers may be used alone or two or more thereof may be used in combination.

[0098]

The content of the ultraviolet absorber is usually 0.01 parts by mass or more, preferably 0.1 parts by mass or more, and more preferably 0.5 parts by mass or more, and is usually 20 parts by mass or less, preferably 15 parts by mass or less, and more preferably 10 parts by mass or less, with respect to 100 parts by mass of the polymer (A), and the range of the content is from 0.01 to 20 parts by mass. When such a content is not less than the lower limit value, light resistance reliability tends to improve. When the content is not more than the upper limit value, yellowing resistance tends to improve.

[0099]

Plasticizer

Examples of the plasticizer include, but are not limited to, at least one selected from the group consisting of polyisobutylene, polyisoprene, polybutadiene, amorphous polyolefins and copolymers thereof, silicone, polyacrylates, oligomeric polyurethanes, and ethylene propylene copolymers, and any combinations or mixtures thereof. Among these, polyisobutylene is preferable.

Examples of the polyisobutylene plasticizer include, of those sold under the name OPPANOL by BASF, in particular, those selected from OPPANOL B series.

[0100]

In a case where the resin composition contains the plasticizer, the content thereof is not particularly limited, and is usually 0.1 parts by mass or more, and preferably 0.5 parts by mass or more, and is usually 20 parts by mass or less, and preferably 15 parts by mass or less, with respect to 100 parts by mass of the polymer (A), and the range of the content is, for example, from 0.1 to 20 parts by mass.

[0101]

Tackifier

The resin composition can contain a tackifier to improve the adhesive strength of the adhesive layer.

Examples of the tackifier include terpene resins such as polyterpenes (e.g., α-pinene-based resins, β-pinene-based resins, and limonene-based resins) and aromatic-modified polyterpene resins (e.g., phenol-modified

polyterpene resins), coumarane-indene resins, petroleum-based resins such as C5-based hydrocarbon resins, C9-based hydrocarbon resins, C5/C9-based hydrocarbon resins, and dicyclopentadiene-based resins, and rosins such as modified rosins, hydrogenated rosins, polymerized rosins, and rosin esters.

[0102]

In a case where the resin composition contains the tackifier, the content thereof is not particularly limited, is usually 0.1 parts by mass or more, and preferably 0.5 parts by mass or more, and is usually 20 parts by mass or less, and preferably 15 parts by mass or less, with respect to 100 parts by mass of the polymer (A), and the range of the content is, for example, from 0.1 to 20 parts by mass.

[0103]

Rust Inhibitor

The resin composition may contain a rust inhibitor to prevent corrosion in a case where an adherend includes a corrosive moiety such as a metal wiring.

Examples of the rust inhibitor include triazoles and benzotriazoles.

[0104]

In a case where the resin composition contains the rust inhibitor, the content thereof is usually 0.01 parts by mass or more, and preferably 0.1 parts by mass or more, and is 5 parts by mass or less, and preferably 3 parts by mass or less, with respect to 100 parts by mass of the polymer (A), and the range of the content is, for example, from 0.01 to 5 parts by mass.

[0105]

Method for Producing Present Adhesive Layer

Next, a method for producing the present adhesive layer will be described.

However, the following description is an example of the method for producing the present adhesive layer, and the present adhesive layer is not limited to one produced by such a production method.

[0106]

The present adhesive layer can be produced by preparing a resin composition containing the polymer (A), the crosslinking agent (B), the polymerization initiator (C), additional components, and the like, as necessary, forming the resin composition into a layer shape, and crosslinking, that is, polymerizing and curing the resin composition, followed by appropriate processing as necessary.

[0107]

The resin composition only needs to be prepared by kneading the raw materials using a temperature-controllable kneader (e.g., a single-screw extruder, a twin-screw extruder, a planetary mixer, a twin-screw mixer, a pressurizing kneader, or the like).

Note that when various raw materials are kneaded, various additives such as a silane coupling agent and an antioxidant may be blended with a resin in advance and then supplied to the kneader, all materials may be melted and mixed in advance and then supplied, or only additives may be concentrated in a resin in advance to prepare a master batch and then supplied.

[0108]

As a method for forming the resin composition into a layer shape, a known method, for example, a wet lamination method, a dry lamination method, an extrusion casting method using a T-die, an extrusion lamination method, a calender method, an inflation method, injection molding, a liquid injection curing method, or the like can be adopted. Among these, in a case of producing the present adhesive layer, a wet lamination method, an extrusion casting method, and an extrusion lamination method are suitable.

[0109]

Curing of the resin composition can be performed by irradiation with an active energy ray or heating, and in a case of using an active energy ray, the present adhesive layer can be produced by irradiating a molded body of the resin composition, for example, a layer-shaped body, with an active energy ray. Note that in addition to the irradiation with an active energy ray, the resin composition can be further cured by heating.

[0110]

The irradiation energy, irradiation time, irradiation method, and the like of an active energy ray are not particularly limited, and it is sufficient that the polymerization initiator (C) can be activated to polymerize the photoreactive component such as a (meth)acrylic acid ester compound.

[0111]

Examples of the active energy ray in the active energy ray irradiation include light rays such as a far ultraviolet ray, an ultraviolet ray, a near ultraviolet ray, an infrared ray, and a visible light ray, and ionizing radiation such as an X-ray, an α-ray, a β-ray, a γ-ray, an electron beam, a proton beam, and a neutron beam. Among these, an ultraviolet ray is preferable from

the viewpoint of suppression of damage to an optical device constituent member and reaction control. In addition, an ultraviolet ray is preferable from the viewpoint of curing speed, and availability, price, and the like of an irradiation device.

[0112]

Examples of light sources for ultraviolet irradiation include a high-pressure mercury lamp, an ultrahigh-pressure mercury lamp, a low-pressure mercury lamp, a carbon arc lamp, a metal halide lamp, a xenon lamp, a chemical lamp, an electrodeless discharge lamp, and an LED lamp, which emit light in a wavelength region of 150 to 450 nm. Among these, a high-pressure mercury lamp, a metal halide lamp, and an LED lamp are preferably used.

[0113]

The active energy ray irradiation amount (cumulative light quantity) is preferably 0.03 J/cm^2 or more, more preferably 0.1 J/cm^2 or more, and still more preferably 0.3 J/cm^2 or more, and is preferably 3 J/cm^2 or less, more preferably 2 J/cm^2 or less, and still more preferably 1.5 J/cm^2 or less, from the viewpoint of curing.

[0114]

The present adhesive layer can also be provided as an adhesive layer with a release film having a configuration in which a release film is laminated on one surface or both surfaces of the adhesive layer. Among them, from the viewpoint of preventing blocking and preventing adhesion of foreign matter, it is preferable to cover both surfaces of the present adhesive layer with a release film.

[0115]

In a case of providing the release film on both surfaces of the present adhesive layer, it is preferable to have a laminate structure in which a light release film having a relatively low peeling strength and a heavy release film having a relatively high peeling strength are laminated.

It is sufficient that when the adhesive layer with a release film in which the release films are provided on both surfaces thereof is used, first, one release film (light release film) is peeled off to expose one surface of the adhesive layer, and an image display device constituent member (referred to as a first member) is bonded to the one surface, and the other release film (heavy release film) is peeled off to expose the other surface of the adhesive layer, and an image display device constituent member (referred to as a second member) is bonded to the other surface.

[0116]

As such a release film, a known release film can be appropriately used.

As the base material of the release film, for example, release paper or those produced by applying a release agent such as a silicone resin to a film such as a polyester film, a polyolefin film, a polycarbonate film, a polystyrene film, an acrylic film, a triacetyl cellulose film, or a fluororesin film and subjecting the resultant to a release treatment can be appropriately selected and used.

Among these, a polyester film is preferable, a polyethylene terephthalate (PET) film is more preferable, and a biaxially stretched PET film is particularly preferable in terms of excellent transparency, mechanical strength, heat resistance, flexibility, and the like.

A release film having a release layer formed by curing a curable silicone-based release agent containing a silicone resin as a main component on the base material may be used.

[0117]

The peeling strength between the adhesive layer and the release film is preferably 0.05 N/cm or more, more preferably 0.06 N/cm or more, and still more preferably 0.07 N/cm or more, and is preferably 1.5 N/cm or less, more preferably 1.2 N/cm or less, and still more preferably 1.0 N/cm or less. The peeling strength between the adhesive layer and the release film is a value measured by a 180° peel test at a test speed of 300 mm/min. When the peeling strength between the adhesive layer and the release film is within the above range, a peeling mark can be prevented when the release film is peeled from the adhesive layer.

[0118]

In general, in a case where an adhesive layer having excellent flexibility is used as an adhesive layer with a release film, when the release film has a high peeling strength, the adhesive layer tends to be deformed and easily have a peeling mark when the release film is peeled off because the adhesive layer is flexible.

Thus, the release film to be used for the adhesive layer having excellent flexibility, particularly the light release film, is preferably a release film that can be peeled off with a force smaller than that of a light release type release film that has been used for general purposes in the related art.

[0119]

However, when the thickness of the release agent layer is increased to make the release film easy to peel off, depending on the type of the release agent used, a component derived from the release agent layer may be transferred and attached to the surface of the adhesive layer, which may impair the reliability of the adhesive layer. Accordingly, it is preferable that the release film have good releasability from the adhesive layer and have a small migration property of the release agent to the adhesive layer.

[0120]

The silicon atom peak intensity of the adhesive surface exposed by peeling off the release film from the present adhesive layer, as measured using an X-ray fluorescence analyzer, is preferably 100 cps or less. When the peak intensity is 100 cps or less, the reliability of the adhesive layer as a laminate is not impaired by the release agent transferred to the adhesive layer, which is preferable. From such a viewpoint, the peak intensity is more preferably 90 cps or less, still more preferably 80 cps or less, and yet still more preferably 70 cps or less. Note that the lower limit is usually 0 cps.

[0121]

The thickness of the release film is not particularly limited. Among them, from the viewpoint of, for example, processability and handleability, the thickness is preferably 10 μm or more, more preferably 25 μm or more, and particularly preferably 35 μm or more, and is preferably 250 μm or less, more preferably 200 μm or less, and particularly preferably 190 μm or less.

[0122]

The release film may be embossed or formed with various irregularities (e.g., conical, pyramidal, or hemispherical irregularities), as necessary. The

surface may be subjected to various types of surface treatment such as corona treatment, plasma treatment, and primer treatment.

[0123]

In another embodiment of the method for producing the present adhesive layer, the resin composition is dissolved in an appropriate solvent, and various coating methods can be used.

In a case of using a coating method, the present adhesive layer can be produced by thermal curing in addition to the curing by the irradiation with an active energy ray. In the case of using a coating method, the thickness of the present adhesive layer can be adjusted by the coating thickness and the solid content concentration of a coating liquid.

[0124]

As the coating method, a known method such as roll coating, die coating, gravure coating, comma coating, screen printing, or bar coating can be adopted.

[0125]

To produce the present adhesive layer using the coating method, for example, the present adhesive layer can be formed by dissolving the resin composition in a solvent, coating the release film, a member sheet, or a flexible image display device constituent member with the dissolved resin composition, drying the coated resin composition, and curing the dried resin composition by irradiation with an active energy ray.

Further, a release film may be laminated, as necessary, on the present adhesive layer produced by the coating method. In this case, the dissolved resin composition may be coated on a release film, dried, and cured by

irradiation with an active energy ray, and then a release film may be laminated thereon, or the dissolved resin composition may be coated on a release film, and dried, and a release film may be laminated thereon, and then curing by irradiation with an active energy ray may be performed to form the present adhesive layer.

[0126]

Such a solvent is not particularly limited as long as it dissolves the resin composition, and examples thereof include ester-based solvents such as methyl acetate, ethyl acetate, butyl acetate, methyl acetoacetate, and ethyl acetoacetate, ketone-based solvents such as acetone, methyl ethyl ketone, and methyl isobutyl ketone, aromatic solvents such as toluene and xylene, and alcohol-based solvents such as methanol, ethanol, and propyl alcohol. One of these may be used alone or two or more thereof may be used in combination. Among these, ethyl acetate, acetone, methyl ethyl ketone, and toluene are preferable from the viewpoint of solubility, a drying property, cost, and the like, and ethyl acetate is particularly suitably used.

[0127]

The content of the solvent is preferably 600 parts by mass or less, more preferably 500 parts by mass or less, still more preferably 400 parts by mass or less, and particularly preferably 300 parts by mass or less, with respect to 100 parts by mass of the polymer (A), from the viewpoint of the drying property. Meanwhile, the content is preferably 1 part by mass or more, more preferably 50 parts by mass or more, even more preferably 100 parts by mass or more, and particularly preferably 150 parts by mass or more.

[0128]

The solvent content in the resin composition after drying is preferably 1 mass% or less, more preferably 0.5 mass% or less, particularly preferably 0.1 mass% or less, and most preferably 0 mass%.

[0129]

The drying temperature is usually 40°C or higher, preferably 45°C or higher, more preferably 50°C or higher, and particularly preferably 55°C or higher, and is usually 150°C or lower, preferably 140°C or lower, more preferably 130°C or lower, and particularly preferably 120°C or lower, and the temperature range is, for example, from 40 to 150°C. When the temperature is within the above range, the solvent can be removed efficiently and relatively safely while suppressing thermal deformation of the release film.

[0130]

The drying time is usually 1 minute or longer, and preferably 3 minutes or longer, and is usually 30 minutes or shorter, preferably 25 minutes or shorter, and more preferably 20 minutes or shorter, and the time range is, for example, from 1 to 30 minutes. When the drying time is within the above range, the solvent can be efficiently and sufficiently removed.

[0131]

Examples of the drying method include drying with a dryer or a hot roll, and drying by blowing hot air to the film. Among these, a dryer is preferably used because uniform and easy drying is possible. One of these may be used alone or two or more thereof may be used in combination.

[0132]

The present adhesive layer produced by the coating method may be provided with the above-mentioned release film on at least one surface from

the viewpoint of preventing blocking and preventing adhesion of foreign matter.

That is, the present adhesive layer produced by the coating method can also be provided as an adhesive layer with a release film (adhesive layer laminate) having a configuration in which a release film is laminated on one surface or both surfaces of the adhesive layer.

[0133]

In addition, in a case where the resin composition is a syrup composition containing a copolymerization component and/or a prepolymer produced by partially polymerizing the copolymerization component, the crosslinking agent (B), the polymerization initiator (C), and the like, the present adhesive layer can be produced by the following production method (syrup method).

[0134]

In the syrup method, the syrup composition is prepared and irradiated with an active energy ray to perform polymerization. Thereafter, the syrup composition to which the additional crosslinking agent (B), the polymerization initiator (C), and the like are added as necessary is coated on a release film or the like by using the above-described coating method, and further, the syrup composition is cured by irradiation with an active energy ray or heating, whereby the present adhesive layer can be produced.

The crosslinking agent (B), the polymerization initiator (C), and the like may be added to the syrup composition from the beginning or after the completion of the prepolymerization. Furthermore, in the syrup method, the polymerization and the curing may be performed in one process.

[0135]

In another embodiment of the syrup method, the present adhesive layer can be prepared by dissolving the syrup composition in a solvent, coating a release film with the dissolved syrup composition, drying the coated syrup composition, and performing polymerization and curing by irradiation with an active energy ray.

[0136]

In the syrup method, the release film, the active energy ray, the solvent, and the like, the preparation method of the resin composition, the coating method, the irradiation conditions of the active energy ray, the drying conditions, and the like only need to be in accordance with the above description.

[0137]

The present adhesive layer produced by the syrup method may be provided with the above-mentioned release film on at least one surface thereof from the viewpoint of preventing blocking and preventing adhesion of foreign matter.

That is, the present adhesive layer produced by the syrup method can also be provided as an adhesive layer with a release film (adhesive layer laminate) having a configuration in which a release film is laminated on one surface or both surfaces of the adhesive layer.

[0138]

The present adhesive layer produced in this manner may be a single layer consisting only of the present adhesive layer formed of the resin

composition, or may be a multilayer in which the present adhesive layer or another adhesive layer is laminated in a plurality of layers.

[0139]

Viscoelastic Properties of Present Adhesive Layer

Shear Storage Modulus of Elasticity (G')

Hereinafter, the shear storage modulus of elasticity (G') that the adhesive layer may have will be described in detail. The shear storage modulus of elasticity at a particular temperature (X°C) is described herein as the shear storage modulus of elasticity (G'(X°C)). The shear storage modulus of elasticity (G'(X°C)) is measured, for example, as follows.

The adhesive layer is repeatedly laminated to adjust the thickness to 0.7 to 1.2 mm (e.g., 0.8 mm), and then punched out to have a diameter of 8 mm. A rheometer is used to perform dynamic viscoelasticity measurement on the prepared sample under conditions of a parallel plate with a diameter of 8 mm as a measurement jig, a frequency of 1 Hz, a measurement temperature of -50 to 150°C, and a temperature rise rate of 5°C/min, and a value of the shear storage modulus of elasticity at each temperature (G') is read.

[0140]

In one embodiment of the present disclosure, the shear storage modulus of elasticity at -30°C (G'(-30°C)) of the adhesive layer is usually 100 kPa or more, preferably 150 kPa or more, more preferably 200 kPa or more, and still more preferably 250 kPa or more, and is usually 1200 kPa or less, preferably 1000 kPa or less, more preferably 700 kPa or less, and still more preferably 600 kPa or less.

[0141]

When the shear storage modulus of elasticity at -30°C (G'(-30°C)) of the adhesive layer is not less than the lower limit, it is possible to produce an adhesive layer having an appropriate cohesive strength and shape stability, and when the shear storage modulus of elasticity at -30°C (G'(-30°C)) of the adhesive layer is not more than the upper limit, for example, in a laminate or a layered body formed by attaching the present adhesive layer to a member sheet, the interlayer stress at the time of bending the laminate or the layered body can be reduced particularly at a low temperature to a high temperature, and peeling or destruction of the member sheet or the flexible image display device constituent member due to the stress can be suppressed.

[0142]

In one embodiment of the present disclosure, the shear storage modulus of elasticity at -20°C (G'(-20°C)) of the adhesive layer is 300 kPa or less, preferably 250 kPa or less, more preferably 200 kPa or less, and still more preferably 180 kPa or less, and is usually 10 kPa or more, preferably 30 kPa or more, more preferably 50 kPa or more, still more preferably 100 kPa or more, and particularly preferably 120 kPa or more.

[0143]

When the shear storage modulus of elasticity (G'(-20°C)) of the adhesive layer at -20°C is not more than the upper limit, flexibility can be maintained even at a low temperature, and an adhesive layer having good bending suitability at low temperatures can be produced. In addition, when the shear storage modulus of elasticity (G'(-20°C)) of the adhesive layer at -20°C is not less than the lower limit, an appropriate cohesive strength can be achieved at a low temperature.

[0144]

In one embodiment of the present disclosure, the shear storage modulus of elasticity at 25°C (G'(25°C)) of the adhesive layer is usually 5 kPa or more, preferably 10 kPa or more, more preferably 15 kPa or more, still more preferably 20 kPa or more, and particularly preferably 30 kPa or more, and is usually 100 kPa or less, preferably 80 kPa or less, and more preferably 50 kPa or less.

[0145]

When the shear storage modulus of elasticity of the adhesive layer at 25°C (G'(25°C)) is not less than the lower limit, it is possible to produce an adhesive layer having good shape stability, and when the shear storage modulus of elasticity of the adhesive layer at 25°C (G'(25°C)) is not more than the upper limit, it is possible to produce an adhesive layer having high adhesiveness.

[0146]

In one embodiment of the present disclosure, the shear storage modulus of elasticity at 60°C (G'(60°C)) of the adhesive layer is usually 5 kPa or more, preferably 10 kPa or more, more preferably 15 kPa or more, and still more preferably 20 kPa or more, and is usually 40 kPa or less, preferably 35 kPa or less, and more preferably 30 kPa or less.

[0147]

When the shear storage modulus of elasticity at 60°C (G'(60°C)) of the adhesive layer is not less than the lower limit, an adhesive layer having good shape stability can be produced, and when the shear storage modulus of

elasticity at 60°C (G'(60°C)) of the adhesive layer is not more than the upper limit, an adhesive layer having high adhesiveness can be produced.

[0148]

In one embodiment of the present disclosure, the shear storage modulus of elasticity at 85°C (G'(85°C)) of the adhesive layer is 5.0 kPa or more, more preferably 8 kPa or more, still more preferably 10 kPa or more, and particularly preferably 12 kPa or more, and is 30 kPa or less, preferably 28 kPa or less, more preferably 27 kPa or less, and still more preferably 26 kPa or less.

[0149]

When the shear storage modulus of elasticity at 85°C (G'(85°C)) of the adhesive layer is not less than the lower limit, an adhesive layer having a sufficient degree of cure and shape stability at a high temperature can be produced, and when the shear storage modulus of elasticity at 85°C (G'(85°C)) of the adhesive layer is not more than the upper limit, an adhesive layer having a moderate flexibility without an excessively high degree of cure can be produced.

[0150]

Examples of the method for adjusting the shear storage modulus of elasticity (G') at each temperature to the above range include a method of adjusting a composition and a molecular weight of the polymer (A), and types and contents of the crosslinking agent (B) and the polymerization initiator (C), and a method of adjusting an active energy ray irradiation amount. However, the method is not limited to these methods.

[0151]

Glass Transition Temperature

In one embodiment, the adhesive layer according to the present disclosure has a glass transition temperature (Tg) defined by the maximum value of Tanδ obtained by dynamic viscoelasticity measurement in a shear mode at a frequency of 1 Hz of preferably -15°C or lower, more preferably -20°C or lower, still more preferably -25°C or lower, and particularly preferably -30°C or lower, and usually -100°C or higher, preferably -90°C or higher, more preferably -80°C or higher, and still more preferably -70°C or higher. The range of the glass transition temperature is, for example, -100 to -15°C. When the glass transition temperature is not higher than the upper limit value, an adhesive layer exhibiting good bending suitability even in a low temperature environment tends to be producible. In addition, when the glass transition temperature is not lower than the lower limit value, appropriate cohesiveness tends to be achievable.

[0152]

The glass transition temperature (Tg) is obtained by reading a temperature at which a loss tangent (Tanδ) is a maximum value, that is, a peak temperature, from dynamic viscoelasticity spectrum data in the shear mode obtained by the same measurement method as that of the shear storage modulus of elasticity (G') described above.

Note that in the viscoelasticity spectrum, the "peak temperature" in a case where a plurality of maximum values are present is a temperature at which the maximum value is the highest.

[0153]

Examples of a method for adjusting the glass transition temperature (Tg) to the above range include a method of adjusting a composition and a molecular weight of the polymer (A), and types and contents of the crosslinking agent (B) and the polymerization initiator (C), and a method of adjusting an active energy ray irradiation amount. However, the method is not limited to these methods.

[0154]

From the viewpoint of achieving an appropriate cohesive strength, the gel fraction of the adhesive layer is 45% or more, preferably 50% or more, more preferably 55% or more, and still more preferably 60% or more, and from the viewpoint of achieving appropriate flexibility, the gel fraction is 95% or less, preferably 90% or less, more preferably 85% or less, still more preferably 80% or less, and particularly preferably 75% or less, and the range of the gel fraction is, for example, from 45 to 95%.

[0155]

The gel fraction is measured, for example, as follows.

The present adhesive layer whose mass has been measured in advance and a 150 mesh SUS (stainless) wire mesh are prepared. Next, the present adhesive layer is wrapped with the SUS wire mesh and immersed in ethyl acetate at 23°C for 24 hours. Thereafter, the resultant is dried at 70°C for 4.5 hours, the mass of the resultant is measured together with the SUS wire mesh. The mass of the SUS wire mesh is subtracted from the measured mass to determine the mass of the undissolved present adhesive layer remaining in the wire mesh (mass after immersion). Then, a percentage of the mass of the undissolved present adhesive layer remaining in the wire mesh

(mass after immersion) to the mass of the present adhesive layer before immersion in ethyl acetate (mass before immersion) is calculated as a gel fraction (%).

[0156]

Examples of the method for adjusting the gel fraction to the above range include a method of adjusting a composition and a molecular weight of the polymer (A), and types and contents of the crosslinking agent (B) and the polymerization initiator (C), and a method of adjusting an active energy ray irradiation amount. However, the method is not limited to these methods.

[0157]

Adhesive Strength

In one embodiment, the present adhesive layer has an adhesive strength of 5.0 N/cm or more to a plasma-treated polyethylene terephthalate (PET) substrate at a temperature of 23°C and a peeling rate of 300 mm/min.

When the adhesive strength to the PET substrate is 5.0 N/cm or more, the end face of the adhesive layer is not peeled off, and excellent bonding reliability at the peripheral edge portion can be achieved. From such a viewpoint, the adhesive strength to the PET substrate is more preferably 6.0 N/cm or more, still more preferably 6.5 N/cm or more, and particularly preferably 8.0 N/cm or more. Note that the upper limit of the adhesive strength is not particularly limited, but is usually 50 N/cm, and preferably 30 N/cm from the viewpoint of reworkability, and the range of the adhesive strength is, for example, from 5.0 to 50 N/cm.

[0158]

In one embodiment, the present adhesive layer preferably has an adhesive strength to a plasma-treated glass substrate of 4.5 N/cm or more at a temperature of 23°C and a peeling rate of 300 mm/min.

When the adhesive strength to the glass substrate is 4.5 N/cm or more, the end face of the present adhesive layer is not peeled off, and excellent bonding reliability at the peripheral edge portion tends to be achievable. From such a viewpoint, the adhesive strength to the glass substrate is more preferably 5.0 N/cm or more, and still more preferably 6.0 N/cm or more. Note that the upper limit of the adhesive strength is not particularly limited, but is usually 50 N/cm, and preferably 30 N/cm from the viewpoint of reworkability and the range of the adhesive strength is, for example, from 4.5 to 50 N/cm.

[0159]

The adhesive strength is measured, for example, as follows.

A polyethylene terephthalate (PET) film having a thickness of 100 μm and the present adhesive layer are bonded to each other, and the other surface is roll-pressed to plasma-treated polyethylene terephthalate (PET) or soda-lime glass substrate to produce a bonded product. Thereafter, the bonded product is subjected to autoclaving treatment (temperature: 60°C, gauge pressure: 0.2 MPa, 20 minutes) for finish bonding, and the resultant is used as a sample for measuring the adhesive strength. When the sample is used to perform peeling at a peeling angle of 180° and a peeling rate of 300 mm/min under an environment of a temperature of 23°C and a humidity of 50% RH, the peeling strength (N/cm) is defined as the adhesive strength.

[0160]

Recovery Rate

For the present adhesive layer, a recovery rate calculated by the following equation from the maximum strain ($\gamma_{max(25)}$) after setting a thickness to 0.5 to 1.2 mm and applying a pressure of 10 kPa at a temperature of 25°C for 600 seconds and the strain ($\gamma_{min(25)}$) 600 seconds after unloading the stress is preferably 70% or more, and more preferably 75% or more. Note that a higher recovery rate is preferable, and thus, the upper limit of the recovery rate is 100%, and the range of the recovery rate is, for example, from 70 to 100%.

Recovery rate (%) = $[(\gamma_{max(25)} - \gamma_{min(25)})/\gamma_{max(25)}] \times 100$

In addition, the maximum strain ($\gamma_{max(25)}$) is preferably 600% or less, more preferably 550% or less, still more preferably 500% or less, particularly preferably 400% or less, and particularly preferably 350% or less.

In a specific embodiment, the thickness in the recovery rate test is 0.6 mm or more and 1.00 mm or less, and may be 0.8 mm.

[0161]

When the present adhesive layer has such a recovery rate, it is possible to produce an adhesive layer having excellent flexibility in which a crease due to being placed in a bent state does not remain even in a case where the present adhesive layer is attached to a member sheet and a folding operation is performed at a low temperature or a high temperature.

[0162]

Room Temperature Dynamic Bending Test

It is preferable that the present adhesive layer not show a crease and peeling at the interface with the adherend after a room temperature dynamic bending test. The conditions of the dynamic bending test at room temperature

are not particularly limited, and a common method can be used. The evaluation values in the present specification can be measured by a method described in Examples described below.

[0163]

Static Bending Test at High Temperature and High Humidity

It is preferred that the present adhesive layer does not peel off at the interface with the adherend after a static bending test at a high temperature and a high humidity, and has high restorability (for example, the inner angle of a bent portion is 30° or more). The conditions of the static bending test at a high temperature and a high humidity are not particularly limited, and a common method can be used. The evaluation values in the present specification can be measured by a method described in Examples described below.

[0164]

Preferred Use of Present Adhesive Layer

The present adhesive layer is suitably used for bonding of an optical member in an embodiment. Specifically, the adhesive layer is suitably used for bonding members constituting a display, particularly members used for producing a display, and is suitably used as an adhesive layer for bonding an image display panel and an image display device constituent member such as a protection panel or a touch panel disposed on the front side (viewing side) thereof, or a member constituting the image display device constituent member.

Note that the same image display device constituent member as that described below can be used.

[0165]

Laminate

In one embodiment, the present disclosure is a laminate including one or more image display device members and the adhesive layer. (Hereinafter, the laminate according to the present embodiment may be referred to as the "present laminate")

In one embodiment, the present laminate is a laminate including two image display device constituent members and the adhesive layer interposed between the two image display device constituent members.

Among the components of the present laminate, the adhesive layer may employ the configuration and characteristics of the adhesive layer described above as they are. Hereinafter, elements other than the present adhesive layer will be described.

[0166]

Image Display Device Constituent Member

Examples of the image display device constituent member constituting the present laminate include flexible image display device constituent members. Examples of the flexible image display device constituent members include an image display panel such as an organic electroluminescence (EL) display, a cover lens (cover film), a surface protection panel (surface protection film), a polarizing plate, a color filter, a polarizing element, a retardation film, a barrier film, a viewing angle compensation film, a brightness enhancement film, a contrast enhancement film, a diffusion film, a semi-transmissive reflection film, an electrode film, a transparent conductive film, a metal mesh film, and a touch sensor film. Any one of these is used, or

any two or more of these are used in combination. Examples include a combination of a flexible display and another flexible image display device constituent member, and a combination of a cover lens and another flexible image display device constituent member.

Among them, it is preferable that one of the two image display device constituent members be a surface protection panel, and the other be a member formed of any one or a combination of two or more selected from the group consisting of a touch sensor film, an image display panel, a color filter, a polarizing element, and a retardation film.

[0167]

Note that the flexible image display device constituent member means a bendable member, in particular, a repeatedly bendable member. In particular, the flexible image display device constituent member is preferably a member that can be fixed in a curved shape with a radius of curvature of 25 mm or more, and in particular, a member that can withstand repeated bending actions with a radius of curvature of less than 25 mm and more preferably less than 3 mm.

[0168]

In the configuration described above, examples of the main component of the flexible image display device constituent member include resin sheets or glass.

Examples of the material of such a resin sheet include polyester resins, cycloolefin resins, triacetyl cellulose resins, poly(methyl methacrylate) resins, polyurethane, epoxy resins, polyimide resins, and aramid resins. One of these resins may be used alone or two or more of these resins may be used in

combination. Among these, the resin sheet is preferably a resin sheet containing, as a main component, at least one resin selected from the group consisting of polyester resins, cycloolefin resins, triacetyl cellulose resins, poly(methyl methacrylate) resins, epoxy resins, polyimide resins, aramid resins, and polyurethane resins.

The "main component" herein refers to a component that accounts for the highest weight ratio among the components constituting the flexible image display device constituent member, specifically a component accounting for 50 mass% or more, preferably 55 mass% or more, and particularly preferably 60 mass% or more of the resin composition (resin sheet) forming the flexible image display device constituent member.

In addition, the flexible image display device constituent member may be made of thin film glass.

[0169]

In the configuration described above, either one of the two flexible image display device constituent members, that is, a first flexible image display device constituent member, particularly has a tensile strength at 25°C measured in accordance with ASTM D882 of preferably 10 MPa or more, more preferably 15 MPa or more, and particularly preferably 20 MPa or more, and preferably 900 MPa or less, more preferably 800 MPa or less, and particularly preferably 700 MPa or less.

With a tensile strength (ASTM D882) at 25°C of the one flexible image display device constituent member in the above range, the member is less likely to crack even when bent, which is preferred.

[0170]

In addition, the other flexible image display device constituent member, that is, a second flexible image display device constituent member, has a tensile strength at 25°C measured in accordance with ASTM D882 of preferably 10 MPa or more, more preferably 15 MPa or more, and particularly preferably 20 MPa or more, and preferably 900 MPa or less, more preferably 800 MPa or less, and particularly preferably 700 MPa or less.

With a tensile strength (ASTM D882) at 25°C of the other flexible image display device constituent member in the above range, the member is less likely to crack even when bent, which is preferred.

[0171]

Examples of the flexible image display device constituent member having a high tensile strength include polyimide films, polyester films, and aramid films. The tensile strength of these is usually 900 MPa or less.

On the other hand, examples of the flexible image display device constituent member having a slightly low tensile strength include triacetyl cellulose (TAC) films and cycloolefin polymer (COP) films. The tensile strength of these is usually 10 MPa or more.

The present flexible laminate can suppress a defect, such as a crack, by the action of the present adhesive layer even in a flexible image display device constituent member made of such a material having a slightly low tensile strength.

[0172]

Method for Producing Present Laminate

A method for producing the present laminate is not particularly limited, and as described above, for example, the adhesive layer may be formed by

applying the resin composition onto the image display device constituent member, preferably onto the flexible image display device constituent member, or the adhesive layer may be formed in advance and then bonded to the image display device constituent member, preferably to the flexible image display device constituent member.

[0173]

Image Display Device

One embodiment of the present disclosure is an image display device comprising the laminate. (Hereinafter, it may be referred to as the "present image display device".) For example, there can be exemplified an image display device having a structure made by combining a laminate having a configuration in which two image display device constituent members are bonded to each other via the present adhesive layer, and another image display device constituent member.

In this case, examples of the "other image display device constituent member" include an FPC cable, a reflection sheet, a light guide plate and a light source, a diffusion film, a prism sheet, a liquid crystal panel, an organic EL panel, an antireflection film, a color filter, a polarizing plate, a retardation plate, a glass substrate, a surface protection film, and a composite integrated body of these members.

Specific examples of the present image display device include a liquid crystal display, an organic EL display, an inorganic EL display, an electronic paper, a plasma display, and a microelectromechanical system (MEMS) display used in a personal computer, a portable terminal, a game machine, a

television (TV), a car navigation system, a touch panel, a pen tablet, and the like.

[0174]

Flexible Image Display Device

In one embodiment, the image display device is a flexible image display device. (Hereinafter, it may be referred to as the "present flexible image display device".) The flexible image display device is an image display device in which a laminate for a flexible image display device having a configuration in which two flexible image display device constituent members are bonded to each other via the present adhesive layer is incorporated. For example, the laminate for a flexible image display device, the laminate having a configuration in which two flexible image display device constituent members are bonded to each other via the present adhesive layer, is laminated on another image display device constituent member, whereby the present flexible image display device provided with the laminate can be formed.

[0175]

The "flexible image display device" refers to an image display device that does not leave a bending mark even when repeatedly bent, can be quickly restored to a state before bending when the bending is released, and can display an image without distortion even when bent.

More specifically, there can be exemplified an image display device composed of a member that can be fixed in a curved shape with a radius of curvature of 25 mm or more, and in particular, a member that can withstand

repeated bending actions with a radius of curvature of less than 25 mm, more preferably a radius of curvature of less than 3 mm.

[0176]

One characteristic of the present laminate is that even when the folding operation is performed under a high temperature environment, delamination and cracking of the laminate can be prevented, and the restorability is also good, which can produce a flexible image display device having excellent flexibility.

Examples

[0177]

The present disclosure will be described more specifically with reference to Examples below, but the present disclosure is not limited to the Examples below to the extent such that the essence of the present disclosure is not exceeded.

[0178]

Various Evaluation Conditions

The adhesive layer with a release film prepared in each of Examples and Comparative Examples described below was used to perform various evaluations below.

[0179]

Shear Storage Modulus of Elasticity (G') at -30°C to 85°C, and Glass Transition Temperature

From the adhesive layer with a release film prepared in each of Examples and Comparative Examples, the release film on one side was

removed and the adhesive layer was laminated with a hand roller, repeatedly, to adjust the thickness to about 0.8 mm, and was punched out in a circular shape having a diameter of 8 mm to prepare a sample. The resulting sample was placed in a rheometer ("DHR-2", available from T.A. Instruments), and dynamic viscoelasticity measurement was performed under conditions of a parallel plate with a diameter of 8 mm as a measurement jig, a frequency of 1 Hz, a measurement temperature of -50 to 150°C, and a temperature rise rate of 5°C/min, and the values of shear storage modulus of elasticity (G') and the shear loss modulus of elasticity (G'') at -30°C, -20°C, 25°C, 60°C, and 85°C were read.

The glass transition temperature (Tg) was determined from the maximum value of Tanδ defined by the ratio of the shear storage modulus of elasticity (G') and the shear loss modulus of elasticity (G'').

[0180]

Adhesive Strength to Glass

Preparation of Sample

A plate made of soda-lime glass was prepared and treated with atmospheric pressure plasma using a mixed gas of nitrogen and oxygen to have a water contact angle of about 10°, and this was used as a substrate.

From the adhesive layer with a release film prepared in each of Examples and Comparative Examples, the release film on one side was removed, and a PET film (available from Mitsubishi Chemical Corporation, S100, thickness: 50 μm) was attached as a backing film with a hand roller. This was cut into a strip of 10 mm wide × 150 mm long, and the surface of the adhesive layer exposed by peeling off the remaining release film was bonded

to the surface of the substrate with a hand roller. The resulting laminate was subjected to an autoclaving treatment (60°C, gauge pressure of 0.2 MPa, 20 minutes) for finish bonding, thereby preparing a sample for measuring the adhesive strength.

Measurement of Adhesive Strength

The adhesive layer was peeled off from the substrate together with the backing film while the resulting sample for measuring the adhesive strength was pulled at an angle of 180° and a peeling rate of 300 mm/min under conditions of 23°C and 50% RH, and the tensile strength (N/cm) was measured with a load cell to obtain the adhesive strength.

[0181]

Measurement of Adhesive Strength to PET

The adhesive strength to PET was measured in the same manner as in the measurement of the adhesive strength to glass except that a PET film (S100, available from Mitsubishi Chemical Corporation, 50 μm) treated with atmospheric-pressure plasma using a mixed gas of nitrogen and oxygen so as to have a water contact angle of about 40° was used as a substrate in the preparation of the sample.

[0182]

Recovery Rate

From the adhesive layer with a release film prepared in each of Examples and Comparative Examples, the release film was removed, and a plurality of the adhesive layers were laminated to prepare a laminate having a thickness of 0.8 mm.

From the resulting laminate of the adhesive layer, a cylindrical body having a diameter of 8 mm (height: 0.8 mm) was punched out, and this was used as a sample.

The recovery rate of the sample was measured using a viscoelasticity measuring apparatus ("DHR 2", available from T.A. Instruments) under the following measurement conditions.

That is, the recovery rate was calculated from the strain after the pressure of 10 kPa was applied at 25°C for 600 seconds ($\gamma_{max(25)}$) and the strain after the stress was unloaded and 600 seconds passed ($\gamma_{min(25)}$) by the following equation.

Recovery rate (%) = $[(\gamma_{max(25)} - \gamma_{min(25)})/\gamma_{max(25)}] \times 100$

[0183]

Gel Fraction

From the adhesive layer with a release film prepared in each of Examples and Comparative Examples, the release film was removed, and about 0.1 g of an adhesive layer piece was collected from the exposed adhesive layer. The collected adhesive layer piece was wrapped in a SUS mesh (#150) having a mass (X) which had been formed into a bag in advance, the mouth of the bag was closed to prepare a sample, and a mass (Y) of the sample was measured. The sample was stored in a dark place at 23°C for 24 hours in a state of being immersed in ethyl acetate, then the sample was taken out and heated at 70°C for 4.5 hours to evaporate ethyl acetate, and the mass (Z) of the dried sample was measured. The gel fraction was calculated from the measured masses using the following equation.

Gel fraction (%) = $[(Z - X)/(Y - X)] \times 100$

[0184]

Bending Test

(1) Room Temperature Dynamic Bending Test

From the adhesive layer with a release film prepared in each of Examples and Comparative Examples, the release film was removed, and a transparent polyimide (CPI) film ("C_50", available from Kolon, thickness of 50 μm) and a PET film ("Diafoil S-100", available from Mitsubishi Chemical Corporation, 50 μm in thickness) were roll-bonded to the exposed adhesive surface of the adhesive layer to prepare a laminate composed of CPI film/adhesive layer/PET film, and the laminate was then cut into 40 mm × 100 mm to prepare an evaluation sample for a dynamic bending test.

The prepared evaluation sample was set in a bending tester ("DLDMLH-FS", available from Yuasa System Co., Ltd.) in such a manner that the CPI film was on the inner side, and a bending test was performed under the following test conditions under a test environment of 23°C (normal temperature).

- Test temperature: 23°C (normal temperature)
- Curvature radius r: 1.5 mm
- Test speed: 60 rpm
- Number of test times: 200000 times

[0185]

The evaluation samples after the test under the test environment of 23°C (normal temperature) were visually observed, and a sample in which the adhesive layer had a crease and a sample in which peeling was observed at the interface between the adherend and the adhesive layer were evaluated as

"× (no good)", and a sample in which there was no change in the visual observation was evaluated as "◯ (good)".

[0186]

(2) Static Bending Test at High Temperature and High Humidity

From the adhesive layer with a release film prepared in each of Examples and Comparative Examples, the release film was removed, and a transparent polyimide (CPI) film ("C_50", available from Kolon, 50 μm in thickness) and a PET film ("Diafoil S-100", available from Mitsubishi Chemical Corporation, 50 μm in thickness) were roll-bonded to the exposed adhesive surface of the adhesive layer to prepare a laminate composed of CPI film/adhesive layer/PET film, and the laminate was then cut into 40 mm × 100 mm to prepare an evaluation sample for a static bending test.

The prepared evaluation sample was fixed by bending at a curvature radius r of 2.0 mm in such a manner that the CPI film was inside, and stored under the environment of 65°C and 90% RH for 24 hours, and then the jig was opened to evaluate the restorability after 1 hour.

[0187]

The evaluation samples after the test were visually observed, and for the prevention of peeling, a sample in which the adhesive layer had a crease and a sample in which peeling was observed at the interface between the adherend and the adhesive layer were evaluated as "× (no good)", and a sample in which there was no change in the visual observation was evaluated as "◯ (good)".

In addition, for the restorability, a sample where the inner angle of the bent portion was less than 30° was evaluated as "× (no good)", and a sample

where the inner angle of the bent portion was 30° or more was evaluated as "◯ (good)".

[0188]

Prior to the examples, the following raw materials were prepared.

[0189]

Polymer (A)

Copolymers containing monomer components shown in Table 1 at ratios based on parts by mass shown in Table 1 were prepared. The weight-average molecular weight of each polymer is shown in Table 1.

[0190]

[Table 1]

	Monomer component (parts by mass)			Weight-average molecular weight (Mw)
	2EHA	BA	HEA	
A-1	65	25	10	790000
A-2	65	25	10	1270000
A-3	77.5	12.5	10	760000
A-4	90	0	10	710000

[0191]

Note that in Table 1, 2EHA means 2-ethylhexyl acrylate, BA means butyl acrylate, and HEA means 2-hydroxyethyl acrylate.

[0192]

The following compounds were prepared as the crosslinking agent (B), the polymerization initiator (C), and an additional component.

[0193]

Crosslinking Agent (B)

· (B-1): Polytetramethylene glycol diacrylate (bifunctional, "A-PTMG65", available from Shin-Nakamura Chemical Co., Ltd.)

· (B-2): Urethane acrylate (bifunctional, "SUA-008", available from Asia Industry Co., Ltd.)

· (B-3): Trimethylolpropane triacrylate (trifunctional, "TMPT", available from Shin-Nakamura Chemical Co., Ltd.)

· (B-4): Urethane acrylate (hexafunctional, "RUA-071", available from Asia Industry Co., Ltd.)

· (B-5): Dipentaerythritol hexaacrylate (hexafunctional, "DPHA", available from Nippon Kayaku Co., Ltd.)

Polymerization Initiator (C)

· (C-1): 2-hydroxy-2-methyl-1-phenyl-propan-1-one (cleavage-type photoradical polymerization initiator, "Omnirad 1173", available from IGM Resins B.V.)

· (C-2): Mixture of 2,4,6-trimethylbenzophenone and 4-methylbenzophenone (hydrogen abstraction type radical polymerization initiator, "Esacure TZT", available from IGM Resins B.V.)

[0194]

Additional Component (D)

· (D-1): Monofunctional urethane acrylate ("LD301", available from AGC Inc.)

· (D-2): Silane coupling agent (3-glycidyloxypropyltrimethoxysilane, "KBM403", available from Shin-Etsu Chemical Co., Ltd.)

[0195]

Example 1

1.5 parts by mass of the crosslinking agent (B-5), 2.0 parts by mass of the polymerization initiator (C-1), 25 parts by mass of the monofunctional urethane acrylate (D-1), and 0.5 parts by mass of the silane coupling agent (D-2) were uniformly mixed with 100 parts by mass of the polymer (A-1) to prepare a resin composition.

[0196]

Next, the resin composition was spread in a layer shape on a release film (PET film available from Mitsubishi Chemical Corporation) having a thickness of 100 μm and subjected to a silicone release treatment in such a manner that the thickness of the resin composition was 50 μm. In addition, a release film (PET film available from Mitsubishi Chemical Corporation) having a thickness of 75 μm and subjected to the silicone release treatment was laminated on the layer-shaped resin composition.

Thereafter, both surfaces of the layer-shaped resin composition were irradiated with light having a wavelength of 365 nm through the release films using a high-pressure mercury lamp in such a manner that the cumulative light quantity was 1000 mJ/cm^2, thereby producing an adhesive layer with a release film having a structure in which the release film, the adhesive layer, and the release film were laminated in this order.

[0197]

Examples 2 to 12 and Comparative Examples 1 to 4

Adhesive layers with a release film were prepared in the same manner as in Example 1 except that the respective components and the blending ratios thereof based on parts by mass were as shown in Tables 2 and 3, and

the cumulative light quantity at the time of irradiation with light was changed to 1300 mJ/cm^2 only in Example 11.

[0198]

[Table 2]

(parts by mass)

		Example 1	Example 2	Example 3	Example 4	Example 5	Example 6	Example 7	Example 8
Polymer (A)	A-1	100	100	100	100	100	100	—	—
	A-2	—	—	—	—	—	—	100	100
	A-3	—	—	—	—	—	—	—	—
	A-4	—	—	—	—	—	—	—	—
Crosslinking agent (B)	B-1	—	—	—	—	—	—	—	—
	B-2	—	—	—	—	—	—	—	—
	B-3	—	3.0	5.0	—	—	—	—	—
	B-4	—	—	—	5.0	—	—	—	—
	B-5	1.5	—	—	—	3.0	5.0	1.5	1.5
Polymerization initiator (C)	C-1	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0
	C-2	—	—	—	—	—	—	—	—
Others (D)	D-1	25	25	25	25	25	25	25	15
	D-2	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5

[0199]

[Table 3]

(parts by mass)

		Example 9	Example 10	Example 11	Example 12	Comparative Example 1	Comparative Example 2	Comparative Example 3	Comparative Example 4
Polymer (A)	A-1	—	—	—	—	100	100	—	—
	A-2	—	—	—	—	—	—	100	100
	A-3	100	100	—	—	—	—	—	—
	A-4	—	—	100	100	—	—	—	—
Crosslinking agent (B)	B-1	—	—	—	—	10	—	—	—
	B-2	—	—	—	—	—	10	—	—
	B-3	—	—	—	—	—	—	—	—
	B-4	—	—	—	—	—	—	—	—
	B-5	3.0	5.0	2.0	3.0	—	—	—	3.0
Polymerization initiator (C)	C-1	2.0	2.0	1.0	2.0	2.0	2.0	2.0	—
	C-2	—	—	—	—	—	—	—	2.0
Others (D)	D-1	25	25	5	—	25	25	25	25
	D-2	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5

[0200]

Measurement and Evaluation of Physical Properties

The adhesive layers prepared in Examples and Comparative Examples were subjected to the various measurements and evaluations described above. The evaluation results of the adhesive layers are summarized in Tables 4 and 5.

[0201]

[Table 4]

			Example 1	Example 2	Example 3	Example 4	Example 5	Example 6	Example 7	Example 8
Thickness		μm	50	50	50	50	50	50	50	50
UV irradiation: Cumulative light quantity		J/cm^2	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Shear storage modulus of elasticity (G')	-30°C	kPa	289	325	452	365	334	424	322	366
	-20°C		125	146	200	172	150	203	149	168
	25°C		27	30	42	37	34	50	43	46
	60°C		14	16	23	20	17	30	26	29
	85°C		11	11	17	14	13	23	20	22
Glass transition temperature (Tg)		°C	-45	-44	-44	-45	-44	-45	-46	-43
Adhesive strength	PET	N/cm	12.2	8.6	8.2	10.2	12.4	9.5	9.8	12.8
	Glass		12.5	7.6	10.1	9.5	9.6	6.2	8.8	11.9
Recovery rate	Maximum strain	%	545	386	164	272	242	88	136	122
	Recovery rate		72	78	88	83	84	92	88	87
Gel fraction		%	53	53	64	66	66	76	74	73

Room temperature dynamic bending test		Evaluation	○	○	○	○	○	○	○	○
Static bending test at high temperature and high humidity	Peeling prevention	Evaluation	○	○	○	○	○	○	○	○
	Restorability		○	○	○	○	○	○	○	○

[0202]

[Table 5]

			Example 9	Example 10	Example 11	Example 12	Comparative Example 1	Comparative Example 2	Comparative Example 3	Comparative Example 4
Thickness		μm	50	50	50	50	50	50	50	50
UV irradiation: Cumulative light quantity		J/cm^2	1.0	1.0	1.3	1.0	1.0	1.0	1.0	1.0
Shear storage modulus of elasticity (G')	-30°C	kPa	397	458	438	597	232	228	208	291
	-20°C		169	200	176	217	104	112	101	142
	25°C		36	45	31	34	19	28	28	51
	60°C		20	26	13	17	7	15	15	36
	85°C		14	19	8	12	4	10	11	31
Glass transition temperature (Tg)		°C	-43	-43	-39	-37	-47	-48	-46	-45

Adhesive strength	PET	N/cm	7.8	6.7	11.3	6.3	5.8	6.1	4.6	2.6
	Glass		6.1	4.7	11.5	8.0	5.9	7.2	14.1	4.6
Recovery rate	Maximum strain	%	343	161	519	189	N.D	636	1047	70
	Recovery rate		79	87	76	87	N.D	74	50	87
Gel fraction		%	63	72	55	74	0	40	0	83
Room temperature dynamic bending test		Evaluation	○	○	○	○	×	○	○	○
Static bending test at high temperature and high humidity	Peeling prevention		○	○	○	○	○	○	○	×
	Restorability		○	○	○	○	×	×	×	×

[0203]

It was found that the adhesive layers of Comparative Examples 1 to 3 had a low gel fraction and an insufficient degree of cure.

The adhesive layer of Comparative Example 4 had a shear storage modulus of elasticity (G') at 85°C that was too high.

The adhesive layers of Examples 1 to 12 all had gel fractions and shear storage moduli of elasticity (G') at -20°C and 85°C in appropriate ranges.

[0204]

Comparative Example 1 was poor in shape stability and was unfit for the recovery rate test.

In addition, it was found that the adhesive layers of Comparative Examples 2 and 3 had a very large maximum strain in the recovery rate test, and did not satisfy shape retention characteristics at the time of bending.

In addition, the adhesive layers of Comparative Examples 1 to 3 all had poor restorability in the static bending test under a high temperature and a high humidity, and were not suitable for applications such as a foldable display in a high temperature environment.

Furthermore, the adhesive layer of Comparative Example 4 had insufficient flexibility, and had insufficient adhesiveness to the PET substrate. In addition, peeling was confirmed in the static bending test under a high temperature and a high humidity, and the restorability was also insufficient.

[0205]

The adhesive layers of Examples 1 to 12 all exhibited a suitable adhesive strength to both glass and PET substrates.

In addition, in the restorability test, the maximum strain was within a suitable range, and in all cases, the recovery rate was as good as 70% or more.

In addition, good results were exhibited in both the dynamic bending test at room temperature and the static bending test under a high temperature and a high humidity, showing that the adhesive layers endure severe environments and repeated or long-term bending and have high durability required for applications such as a rollable panel and a foldable panel.

[0206]

As described above, according to the present disclosure, it is possible to provide an adhesive layer, which is excellent in bending suitability and has a good cohesive strength and/or adhesive strength, an adhesive layer with a release film, a laminate, an image display device, and an adhesive layer for an image display device constituent member.

[0207]

Specific embodiments of the present disclosure have been described in the above Examples, but the above Examples are merely illustrative and are not to be construed as limiting. Various modifications apparent to those skilled in the art are intended to be within the scope of the present disclosure.

Industrial Applicability

[0208]

The adhesive layer of the present disclosure is excellent in bending suitability and has a good cohesive strength and/or adhesive strength. Thus, the adhesive layer of the present disclosure can be suitably utilized as an adhesive layer used in an image display device.

Claims

[Claim 1]

An adhesive layer for a flexible image display device constituent member, the adhesive layer satisfying requirements [I] to [V],

wherein

the adhesive layer for a flexible image display device constituent member is formed of a resin composition containing a polymer (A), a crosslinking agent (B), and a polymerization initiator (C),

the polymer (A) contains a copolymer composed of a compound in which 50 mass% or more of monomer components contain a (meth)acryloyl group,

the crosslinking agent (B) contains a crosslinking agent having three or more functional groups, and

the polymerization initiator (C) contains a cleavage-type photopolymerization initiator:

[I] a shear storage modulus of elasticity at -20°C (G'(-20°C)) is 300 kPa or less;

[II] a shear storage modulus of elasticity at 85°C (G'(85°C)) is 5.0 kPa or more and 30 kPa or less;

[III] a gel fraction is 45% or more and 95% or less;

[IV] an adhesive strength to a polyethylene terephthalate substrate at 23°C is 5.0 N/cm or more; and

[V] a recovery rate calculated by the following equation from a maximum strain ($\gamma_{max(25)}$) after setting a thickness of the adhesive layer to 0.5 to 1.2 mm

and applying a pressure of 10 kPa at a temperature of 25°C for 600 seconds and a strain ($\gamma_{min(25)}$) 600 seconds after unloading the stress is 70% or more:

Recovery rate (%) = $[(\gamma_{max(25)} - \gamma_{min(25)})/\gamma_{max(25)}] \times 100$.

[Claim 2]

The adhesive layer for a flexible image display device constituent member according to claim 1, wherein the adhesive layer for a flexible image display device constituent member has an adhesive strength to a glass substrate at 23°C of 4.5 N/cm or more.

[Claim 3]

The adhesive layer for a flexible image display device constituent member according to claim 1, wherein the adhesive layer for a flexible image display device constituent member has a maximum strain ($\gamma_{max(25)}$) of 600% or less after setting a thickness of the adhesive layer to 0.5 to 1.2 mm and applying a pressure of 10 kPa at a temperature of 25°C for 600 seconds.

[Claim 4]

The adhesive layer for a flexible image display device constituent member according to claim 1, wherein a glass transition temperature (Tg) of the adhesive layer for a flexible image display device constituent member, defined by a maximum value of Tanδ as obtained by dynamic viscoelasticity measurement in a shear mode at a frequency of 1 Hz, is -15°C or lower.

[Claim 5]

An adhesive layer for a flexible image display device constituent member with a release film, having a laminated structure of one or more release films and the adhesive layer for a flexible image display device constituent member according to any one of claims 1 to 4.

[Claim 6]

A laminate comprising:

one or more image display device members; and

the adhesive layer for a flexible image display device constituent member according to any one of claims 1 to 4.

[Claim 7]

A laminate comprising:

two image display device constituent members; and

the adhesive layer for a flexible image display device constituent member according to any one of claims 1 to 4 interposed between the two image display device constituent members.

[Claim 8]

The laminate according to claim 7, wherein one of the two image display device constituent members is a surface protection panel, and the other is a member formed of any one or a combination of two or more selected from the group consisting of a touch sensor film, an image display panel, a color filter, a polarizing element, and a retardation film.

[Claim 9]

An image display device comprising the laminate according to claim 6.

[Claim 10]

The image display device according to claim 9, wherein the image display device is a flexible image display device.