Description

DOUBLE-SIDED ADHESIVE SHEET, DOUBLE-SIDED ADHESIVE SHEET WITH RELEASE FILM, LAMINATE FOR IMAGE DISPLAY DEVICE USING THE SAME, AND IMAGE DISPLAY DEVICE

Technical Field

[0001]

The present disclosure relates to a double-sided adhesive sheet, a double-sided adhesive sheet with a release film, a laminate for an image display device using the same, 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 (PDP), or an electroluminescence display (ELD) and a protection panel or a touch panel member disposed on the front face side (viewing side) thereof is filled with a resin such as a pressure-sensitive adhesive or an adhesive, thereby suppressing reflection of incident light or emitted light from a displayed image at an air layer interface.

[0003]

For example, Patent Document 1 discloses a method for producing a constituent laminate for an image display device, the constituent laminate having a configuration in which an image display device constituent member is laminated on at least one side of a transparent double-sided adhesive

sheet, the method including bonding an adhesive sheet primarily crosslinked by ultraviolet rays to an image display device constituent member, and then irradiating the adhesive sheet with ultraviolet rays through the image display device constituent member to secondarily cure the adhesive sheet.

[0004]

In addition, Patent Document 2 discloses a pressure-sensitive adhesive sheet containing a (meth)acrylic copolymer having an ultraviolet crosslinkable moiety, as an adhesive sheet useful for a display and a touch panel.

Citation List

Patent Documents

[0005]

Patent Document 1: JP 4971529 B

Patent Document 2: JP 6062740 B

Summary

Technical Problem

[0006]

In recent years, in accordance with needs for power saving, weight reduction, and thinning of image display devices, organic EL has been widely used as an image display panel instead of a liquid crystal panel in the related art.

In addition, in an assembly process of an image display device, when a member such as an image display panel is bonded, irregularities or

unevenness of the bonding member are/is transferred to the front surface side (viewing side) of the image display panel, and the appearance may deteriorate. Therefore, an adhesive sheet used for bonding an image display device constituent member is required to be less likely to be marked due to irregularities or unevenness of the image display device constituent member itself in a process of preparing a laminate for an image display device.

Furthermore, mobile electronic devices are often exposed to the risk of damage due to impact from the usage forms thereof, and in order to protect the members inside the image display device from external impact, the adhesive sheet itself is required to have impact resistance.

[0007]

The adhesive sheets of Patent Documents 1 and 2 have been studied for a laminated configuration using a known image display device constituent member, and the issue of deterioration in appearance described above is not considered.

In addition, in a known flexible adhesive sheet, irregularities or unevenness of a bonding member is easily transferred, and in order to suppress deformation, it is desired to impart hardness to the adhesive sheet, but when the adhesive sheet is simply made too hard, the impact resistance deteriorates. Such a problem is more remarkable as the image display panel is made thinner. Therefore, for increasingly thinner image display devices, an adhesive sheet which has excellent impact resistance but is less likely to be marked during bonding is required.

Further, in recent years, image display devices having a configuration not using a polarizing plate have been becoming popular, and such a

configuration not using a polarizing plate is thinner and lighter than a known configuration using a polarizing plate, and therefore, the above issue becomes more remarkable.

[0008]

The present disclosure has been made under such circumstances, and provides a double-sided adhesive sheet and a double-sided adhesive sheet with a release film, which are excellent in impact resistance and are less likely to be marked during bonding, and a laminate for an image display device, and an image display device.

Solution to Problem

[0009]

As a result of intensive studies in view of such circumstances, the present inventors have found that a double-sided adhesive sheet having excellent impact resistance and being less likely to be marked during bonding can be obtained by setting a tensile modulus of elasticity at 25°C (E') of the double-sided adhesive sheet within a specific range and further setting a modulus of elasticity ratio (E'/G') of the tensile modulus of elasticity at 25°C (E') to a shear storage modulus of elasticity at 25°C (G') within a specific range.

[0010]

That is, the present disclosure has the following aspects.

[1] A double-sided adhesive sheet including a pressure-sensitive adhesive layer formed by curing a pressure-sensitive adhesive composition containing a (meth)acrylic copolymer (A),

in which

a tensile modulus of elasticity at 25°C (E') is from 1.0 to 20 MPa, as calculated as a slope in a section of strain of from 10 to 200% in a stress-strain curve obtained by a tensile test performed at a tensile speed of 300 mm/min and a grip distance of 20 mm for a test piece of 20 mm × 70 mm, and

a modulus of elasticity ratio (E'/G') of the tensile modulus of elasticity at 25°C (E') to a shear storage modulus of elasticity at 25°C (G') as obtained by dynamic viscoelasticity measurement in a shear mode at a frequency of 1 Hz is from 15 to 100.

[2] The double-sided adhesive sheet according to [1], in which a stress relaxation rate (X) as calculated by Equation (I) is 0.50 or less, where an initial modulus of elasticity (G'(0)) is a value of a modulus of elasticity after 0.1 seconds have elapsed from application of a strain of 25% to the pressure-sensitive adhesive layer at 70°C and a relaxation modulus of elasticity (G'(300)) is a value of a modulus of elasticity after 300 seconds have elapsed from application of a strain of 25% to the pressure-sensitive adhesive layer at 70°C.

Stress relaxation rate (X) = (G'(300)/G'(0)) ··· (I)

[3] The double-sided adhesive sheet according to [1] or [2], in which the pressure-sensitive adhesive composition contains a crosslinking agent (B) and a photoinitiator (C).

[4] The double-sided adhesive sheet according to any one of [1] to [3], in which the pressure-sensitive adhesive composition contains an ultraviolet absorber (D).

[5] The double-sided adhesive sheet according to any one of [1] to [4], in which the double-sided adhesive sheet has a gel fraction of from 30 to 90%.

[6] The double-sided adhesive sheet according to any one of [1] to [5], in which a glass transition temperature (Tg) defined by a maximum value of Tanδ as obtained by dynamic viscoelasticity measurement in a shear mode at a frequency of 1 Hz is -10°C or lower.

[7] The double-sided adhesive sheet according to any one of [1] to [6], in which the (meth)acrylic copolymer (A) contains a hydroxy group-containing monomer (a2) and/or a nitrogen-containing monomer (a3) as a constituent unit.

[8] The double-sided adhesive sheet according to [3], in which the photoinitiator (C) is a hydrogen abstraction type photoinitiator.

[9] The double-sided adhesive sheet according to any one of [1] to [8], in which the double-sided adhesive sheet includes a laminate pressure-sensitive adhesive layer in which two or more pressure-sensitive adhesive layers having different shear storage moduli of elasticity at 25°C (G') are laminated adjacent to each other.

[10] The double-sided adhesive sheet according to [9], in which the laminate pressure-sensitive adhesive layer includes a first pressure-sensitive adhesive layer having a lower shear storage modulus of elasticity at 25°C (G') than that of an adjacent pressure-sensitive adhesive layer, and a second pressure-sensitive adhesive layer having a larger shear storage modulus of elasticity at 25°C (G') than that of an adjacent pressure-sensitive adhesive layer.

[11] The double-sided adhesive sheet according to [9] or [10], in which the laminate pressure-sensitive adhesive layer has a three-layer configuration in which the first pressure-sensitive adhesive layer, the second pressure-sensitive adhesive layer, and the first pressure-sensitive adhesive layer are laminated in this order.

[12] The double-sided adhesive sheet according to [10] or [11], in which a pressure-sensitive adhesive composition forming the second pressure-sensitive adhesive layer contains an ultraviolet absorber (D).

[13] The double-sided adhesive sheet according to any one of [10] to [12], in which a content of a crosslinking agent (B) contained in a pressure-sensitive adhesive composition forming the second pressure-sensitive adhesive layer is larger than a content of a crosslinking agent (B) contained in a pressure-sensitive adhesive composition forming the first pressure-sensitive adhesive layer.

[14] The double-sided adhesive sheet according to any one of [10] to [13], in which a ratio (t2/t1) of a thickness (t2) of the second pressure-sensitive adhesive layer to a thickness (t1) of the first pressure-sensitive adhesive layer is 0.2 or more.

[15] A double-sided adhesive sheet with a release film including:

the double-sided adhesive sheet according to any one of [1] to [14]; and

a release film laminated on the double-sided adhesive sheet.

[16] A laminate for an image display device, the laminate including:

two image display device constituent members; and

the double-sided adhesive sheet according to any one of [1] to [14] interposed between the two image display device constituent members.

[17] An image display device including the laminate for an image display device according to [16].

Advantageous Effects

[0011]

The double-sided adhesive sheet of the present disclosure is excellent in impact resistance and is less likely to be marked during bonding. Accordingly, the double-sided adhesive sheet can be suitably used as a double-sided adhesive sheet used for an image display device, particularly an organic EL image display device.

Description of Embodiments

[0012]

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.

In the present disclosure, "film" 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.

[0013]

As used herein, when "from 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 more than x" unless otherwise specified, and when "y or less" (y is any number) is described, it encompasses the meaning of "preferably less 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. 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 addition, for a numerical range described in the present disclosure, the upper limit value or the lower limit value of the numerical range can be replaced by a value shown in Examples.

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.

Furthermore, as used herein, “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.

[0014]

Adhesive Sheet

A double-sided adhesive sheet according to an example of an embodiment of the present disclosure (hereinafter referred to as "the present adhesive sheet") is a double-sided adhesive sheet including a pressure-sensitive adhesive layer formed by curing a pressure-sensitive adhesive composition containing a (meth)acrylic copolymer (A). A tensile modulus of elasticity at 25°C (E') is from 1.0 to 20 MPa, and a modulus of elasticity ratio (E'/G') of the tensile modulus of elasticity at 25°C (E') to a shear storage modulus of elasticity at 25°C (G') as obtained by dynamic viscoelasticity measurement in a shear mode at a frequency of 1 Hz is from 15 to 100.

Hereinafter, the present adhesive sheet will be described.

[0015]

The present adhesive sheet has a tensile modulus of elasticity at 25°C (E') of from 1.0 to 20 MPa, preferably from 2 to 18 MPa, more preferably from 2.5 to 15 MPa, particularly preferably from 3.0 to 12 MPa, and most preferably from 5.0 to 9.0 MPa, as calculated as a slope in a section of strain of from 10 to 200% in a stress-strain curve obtained by a tensile test performed at a tensile speed of 300 mm/min and a grip distance of 20 mm for a test piece of 20 mm × 70 mm.

When the tensile modulus of elasticity at 25°C (E') is within the above range, an adhesive sheet having moderate elasticity and less likely to be marked during bonding can be obtained.

When the tensile modulus of elasticity at 25°C (E') is at least the above lower limit, an adhesive sheet excellent in cohesive force and less likely to be indented or dented against a local pressure can be obtained, and when the

tensile modulus of elasticity (E') is at most the upper limit, an adhesive sheet having moderate flexibility and stress relaxation properties and excellent in level difference absorbability can be obtained.

[0016]

Examples of the method for adjusting the tensile modulus of elasticity at 25°C (E') include methods of adjusting a composition and a molecular weight of the (meth)acrylic copolymer (A) contained in a pressure-sensitive adhesive composition described below, and types and contents of a crosslinking agent (B) and a photoinitiator (C), and a method of adjusting an irradiation amount of an active energy ray. However, the method is not limited to these methods.

The tensile modulus of elasticity at 25°C (E') can be determined by a method described in Examples.

[0017]

The present adhesive sheet has a shear storage modulus of elasticity at 25°C (G') of preferably from 80 to 1000 kPa, more preferably from 100 to 900 kPa, further preferably from 120 to 800 kPa, particularly preferably from 140 to 700 kPa, and most preferably from 160 to 600 kPa, as obtained by dynamic viscoelasticity measurement in a shear mode at a frequency of 1 Hz.

When the shear storage modulus of elasticity at 25°C (G') is at least the lower limit, the adhesive sheet tends to be excellent in cohesive force, and to be less likely to be indented or dented against a local pressure, and when the shear storage modulus of elasticity (G') is at most the upper limit, the adhesive sheet tends to have moderate flexibility and stress relaxation

properties, and to be excellent in impact resistance and level difference absorbability.

[0018]

The shear storage modulus of elasticity at 25°C (G') is measured, for example, as follows.

The present adhesive sheet is repeatedly laminated to adjust the thickness to 0.7 to 1.2 mm (e.g., 0.8 mm), and then punched out into a circular shape having a diameter of 8 mm. A rheometer is used to perform dynamic viscoelasticity measurement on the obtained sample under conditions of a measurement jig: a parallel plate with a diameter of 8 mm, a frequency: 1 Hz, a measurement temperature: from -50 to 150°C, and a temperature rise rate: 5°C/min, and a value of the shear storage modulus of elasticity at 25°C (G') is read.

[0019]

Note that, for accurate measurement of the shear storage modulus of elasticity (G'), it is necessary to avoid fluctuation of the value under influence of measurement conditions.

By adjusting the thickness of the measurement sample to the range of from 0.7 to 1.2 mm, the shear storage modulus of elasticity (G') can be accurately measured without being affected by the thickness of the adhesive sheet. Note that the phrase "adjusting the thickness (of the measurement sample) to the range of from 0.7 to 1.2 mm" means that, in a case where the thickness of the adhesive sheet as a measurement sample is out of this range, the thickness of the measurement sample is adjusted to this range by, for example, laminating several sheets. The same applies to a case where

the thickness of the measurement sample is specified in another test described herein.

Further, as the size of the parallel plate is smaller, the fluctuation of the value due to the influence of the measurement jig is more easily reduced, but a slip is more likely to occur between the sample and the measurement jig. In order to reduce the measurement error due to the slip, it is preferable to increase the size of the parallel plate to increase a contact area between the sample and the measurement jig, thereby suppressing the slip. Thus, the shear storage modulus of elasticity (G') can be accurately measured without being affected by the measurement jig.

[0020]

Examples of the method for adjusting the shear storage modulus of elasticity at 25°C (G') include methods of adjusting the composition and the molecular weight of the (meth)acrylic copolymer (A) contained in the pressure-sensitive adhesive composition described below, and types and addition amounts of the crosslinking agent (B) and the photoinitiator (C), and a method of adjusting an irradiation amount of an active energy ray. However, the method is not limited to these methods.

[0021]

The present adhesive sheet has a modulus of elasticity ratio (E'/G') of the tensile modulus of elasticity at 25°C (E') to the shear storage modulus of elasticity at 25°C (G') of from 15 to 100, preferably from 18 to 90, more preferably from 21 to 80, particularly preferably from 23 to 70, and most preferably from 25 to 60, as obtained by dynamic viscoelasticity measurement in a shear mode at a frequency of 1 Hz.

When the modulus of elasticity ratio (E'/G') is within the above range, a double-sided adhesive sheet having both moderate elasticity and excellent flexibility and having both indentation resistance and impact resistance at high levels can be obtained.

[0022]

When the modulus of elasticity ratio (E'/G') is at least the above lower limit, a double-sided adhesive sheet having moderate flexibility and stress relaxation properties and excellent in impact resistance and level difference absorbability can be obtained, and when it is at most the upper limit, the adhesive sheet is excellent in cohesive force and excellent in handleability and indentation resistance.

[0023]

Examples of the method for adjusting the modulus of elasticity ratio (E'/G') to the above range include a method of using, as the pressure-sensitive adhesive layer of the present adhesive sheet, a laminate pressure-sensitive adhesive layer in which two or more pressure-sensitive adhesive layers having different shear storage moduli of elasticity at 25°C (G') are laminated adjacent to each other, and a method of configuring the pressure-sensitive adhesive layer to have a structure having an inclined structure in the thickness direction.

The reason why the indentation resistance and the impact resistance are improved by the above design is not clear, but the following mechanism is considered.

In a viscoelastic body such as an adhesive sheet, the relationship of E'≤ 3G' is usually established between the tensile modulus of elasticity (E')

and the shear storage modulus of elasticity (G') as determined in dynamic viscoelasticity measurement under the same temperature and frequency conditions.

However, as described above, when the pressure-sensitive adhesive layer is a laminate pressure-sensitive adhesive layer or has a structure having an inclined structure in the thickness direction, the relationship is not established (E'> 3G').

The present inventors have deeply observed the state of a sample after a bonding test or an impact resistance test, and found that, for ease of indentations and resistance to impact, the modulus of elasticity not only in an infinitesimal deformation (elastic deformation) region given in the dynamic viscoelasticity measurement but also in a large deformation region accompanied by plastic deformation is important. The present inventors have found that, by further expanding the relationship between the tensile modulus of elasticity (E') and the shear storage modulus of elasticity (G') in the dynamic viscoelasticity measurement, and employing such a design that the tensile modulus of elasticity (E') as calculated as a slope in the large deformation region, that is, the section of strain of from 10 to 200%, and the shear storage modulus of elasticity (G') as determined by dynamic viscoelasticity measurement have a specific relationship, not only the indentation resistance can be enhanced, but also more excellent impact resistance can be exhibited. In a case where the pressure-sensitive adhesive layer is the laminate pressure-sensitive adhesive layer described above, an increase in difference in shear storage modulus of elasticity (G') between the

respective layers results in a tendency that the modulus of elasticity ratio (E'/G') increases.

[0024]

From the viewpoint of reducing adhesive overflow, the present adhesive sheet has an initial modulus of elasticity (G'(0)), after 0.1 seconds have elapsed from application of a strain of 25% at 70°C, of usually from 5 to 100 kPa, preferably from 10 to 60 kPa, more preferably from 15 to 50 kPa, and further preferably 20 kPa.

When the lower limit of the initial modulus of elasticity (G'(0)) is the above numerical value or more, the adhesive sheet has a moderate cohesive force, is excellent in handleability, and has a tendency that the peripheral edge portion of the adhesive sheet is hardly crushed at the time of bonding a member, and that adhesive overflow at the end portion can be reduced or eliminated.

In addition, when the upper limit of the initial modulus of elasticity (G'(0)) is the above numerical value or less, in a case where there are irregularities on an adherend, there is a tendency that the irregularities on a surface of the adherend can be filled at the time of bonding.

[0025]

The modulus of elasticity (G'(0)) is measured, for example, as follows.

The adhesive sheet is repeatedly laminated to adjust the thickness to 0.7 to 1.2 mm (e.g., about 0.8 mm), and punched out to have a diameter of 8 mm. A rheometer is used to apply a strain of 25% to the obtained sample at 70°C, and after 0.1 seconds, the modulus of elasticity (G') is read.

[0026]

Examples of the method for adjusting the initial modulus of elasticity (G'(0)) include methods of adjusting the composition and the molecular weight of the (meth)acrylic copolymer (A) contained in a pressure-sensitive adhesive composition described below, and types and blending amounts of the crosslinking agent (B) and the photoinitiator (C), and a method of adjusting an irradiation amount of an active energy ray. However, the method is not limited to these methods.

[0027]

The present adhesive sheet has a relaxation modulus of elasticity (G'(300)) after 300 seconds have elapsed from application of a strain of 25% at 70°C of usually from 0.1 to 20 kPa, preferably from 0.2 to 15 kPa, more preferably from 0.5 to 10 kPa, and further preferably from 1 to 5 kPa.

When the lower limit of the relaxation modulus of elasticity (G'(300)) is the above numerical value or more, the present adhesive sheet tends to have a moderate cohesive force, and to be excellent in handleability, and has a tendency that the peripheral edge portion of the adhesive sheet is hardly crushed at the time of bonding a member, and that adhesive overflow at the end portion can be reduced or eliminated.

When the upper limit of the relaxation modulus of elasticity (G'(300)) is the above numerical value or less, there is a tendency that moderate flexibility is maintained and that wettability to an adherend can be secured.

[0028]

The relaxation modulus of elasticity (G'(300)) is measured, for example, as follows.

The adhesive sheet is repeatedly laminated to adjust the thickness to 0.7 to 1.2 mm (e.g., about 0.8 mm), and punched out to have a diameter of 8 mm. A rheometer is used to apply a strain of 25% to the obtained sample at 70°C, and after 300 seconds, the modulus of elasticity (G') is read.

[0029]

Examples of the method for adjusting the relaxation modulus of elasticity (G'(300)) include methods of adjusting the composition and the molecular weight of the (meth)acrylic copolymer (A) contained in a pressure-sensitive adhesive composition described below, and types and contents of the crosslinking agent (B) and the photoinitiator (C), and a method of adjusting an irradiation amount of an active energy ray. However, the method is not limited to these methods.

[0030]

The present adhesive sheet has a stress relaxation rate (X) of preferably 0.50 or less, more preferably 0.40 or less, further preferably 0.30 or less, particularly preferably 0.20 or less, and especially preferably 0.10 or less, as calculated by Equation (I), where the initial modulus of elasticity (G'(0)) is a value of a modulus of elasticity after 0.1 seconds have elapsed from application of a strain of 25% at a temperature of 70°C and the relaxation modulus of elasticity (G'(300)) is a value of a modulus of elasticity after 300 seconds have elapsed from application of a strain of 25% at a temperature of 70°C. From the viewpoint of suppressing adhesive overflow during bonding, the stress relaxation rate (X) is preferably 0.01 or more, more preferably 0.02 or more, further preferably 0.03 or more, and particularly

preferably 0.04 or more. The range of the above stress relaxation rate (X) is, for example, from 0.01 to 0.50.

Stress relaxation rate (X) = (G'(300)/G'(0)) ··· (I)

[0031]

In a laminate requiring precise bonding such as a laminate for an image display device, when members are bonded, finish bonding is generally performed by a heating and pressurizing treatment using an autoclave.

After the autoclave process is completed or after the product is started to be used, air bubbles may be generated in the peripheral edge portion. One of main causes of generation of such air bubbles is considered to be that air present in an autoclave furnace infiltrates between the bonding member and the adhesive sheet due to elevated pressure in the autoclave furnace during the bonding process.

In the related art, the peripheral end portion of the display is covered with a concealing layer such as a print or a bezel, and thus, such air bubbles do not appear on the appearance. However, in recent years, the peripheral end portion has been narrowed due to the demand for a narrower frame and a frameless design of a display, and improvement in foaming resistance at the peripheral edge portion of the adhesive sheet is strongly desired.

When the stress relaxation rate (X) is within the above range, the adhesive sheet is excellent in stress relaxation properties, and thus is excellent in ability to incorporate a foreign matter or a defect which becomes a starting point of foaming, and air incorporated at the time of bonding a member is likely to diffuse. As a result, there is a tendency that air bubbles are less likely to remain when the adhesive sheet is bonded, and that an

adhesive sheet having excellent foaming resistance during bonding can be obtained.

[0032]

Examples of the method for adjusting the stress relaxation rate (X) include methods of adjusting the composition and the molecular weight of the (meth)acrylic copolymer (A) contained in a pressure-sensitive adhesive composition described below, and types and contents of the crosslinking agent (B) and the photoinitiator (C), and a method of adjusting an irradiation amount of an active energy ray. However, the method is not limited to these methods.

[0033]

The present adhesive sheet has a glass transition temperature (Tg) defined by a maximum value of a loss tangent (Tanδ) of preferably -10°C or lower, more preferably -15°C or lower, further preferably -20°C or lower, and particularly preferably -25°C or lower, as obtained by dynamic viscoelasticity measurement in a shear mode at a frequency of 1 Hz. When the glass transition temperature (Tg) is not more than the above upper limit, there is a tendency that impact resistance and stress relaxation properties can be obtained. On the other hand, the lower limit is preferably -70°C or higher, more preferably -60°C or higher, further preferably -50°C or higher, particularly preferably -40°C or higher, and most preferably -30°C or higher, from the viewpoint of obtaining a double-sided adhesive sheet excellent in handleability and resistance to adhesive overflow. The range of the glass transition temperature (Tg) is, for example, from -70 to -10°C.

[0034]

The glass transition temperature (Tg) is obtained by reading a temperature at which the loss tangent (Tanδ) is a maximum value, that is, a peak temperature, from dynamic viscoelasticity spectrum data in a shear mode obtained by the same method as that of the measurement of the shear storage modulus of elasticity at 25°C (G'(25°C)) described above.

[0035]

Examples of the method for adjusting the glass transition temperature include methods of adjusting the composition and the molecular weight of the (meth)acrylic copolymer (A) contained in the pressure-sensitive adhesive composition described below, and types and addition amounts of the crosslinking agent (B) and the photoinitiator (C), and a method of adjusting an irradiation amount of an active energy ray.

In addition, in a case where the present adhesive sheet is an adhesive sheet having a plurality of layers described later, the glass transition temperature of the present adhesive sheet can also be adjusted by adjusting a glass transition temperature of each layer constituting the present adhesive sheet. However, the method is not limited to these methods.

[0036]

The present adhesive sheet has a gel fraction of preferably from 30 to 90%, more preferably from 35 to 87%, further preferably from 40 to 86%, and particularly preferably from 45 to 85%.

When the gel fraction is at least the above lower limit, a moderate cohesive force tends to be obtained, and when the gel fraction is at most the above upper limit, stress relaxation properties tend to be obtained.

When the gel fraction of the present adhesive sheet is within the above range, the present adhesive sheet tends to have a moderate cohesive force and to be excellent in handleability and shape stability.

The gel fraction can be measured by a method described in Examples.

[0037]

The present adhesive sheet has an adhesive force to soda-lime glass at a temperature of 23°C and a peeling rate of 60 mm/min of usually 1 N/cm or more, preferably 3 N/cm or more, further preferably 5 N/cm or more, and particularly preferably 7 N/cm or more. Note that the upper limit of the adhesive force is preferably 50 N/cm or less, and more preferably 30 N/cm or less. The range of the adhesive force is, for example, from 1 to 50 N/cm.

When the adhesive force of the present adhesive sheet is the above numerical value or more, an end face of the adhesive sheet is not peeled off, and there is a tendency that excellent bonding reliability at the peripheral edge portion can be obtained.

[0038]

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

A polyethylene terephthalate (PET) film having a thickness of 100 μm and the pressure-sensitive adhesive layer of the present adhesive sheet are bonded to each other, and the other face is roll-pressed to soda-lime glass to obtain a bonded product. Thereafter, the bonded product is subjected to an 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 force. When the sample is used to perform peeling at a peeling angle of 180° and a peeling rate of 60 mm/min under an

environment of a temperature of 23°C and a humidity of 50% RH, the peeling force (N/cm) is defined as the adhesive force.

[0039]

Examples of the methods for adjusting the gel fraction and the adhesive force include methods of adjusting the composition and the molecular weight of the (meth)acrylic copolymer (A) contained in the pressure-sensitive adhesive composition described below, and types and addition amounts of the crosslinking agent (B) and the photoinitiator (C), and a method of adjusting an irradiation amount of an active energy ray. However, the method is not limited to these methods.

[0040]

A light transmittance of the present adhesive sheet at a wavelength of 380 nm is usually 10% or less, preferably 6% or less, more preferably 5% or less, and particularly preferably 4% or less. When the light transmittance at a wavelength of 380 nm is within the above range, an image display device constituent member tends to be easily protected from deterioration due to ultraviolet light.

The light transmittance can be measured by a method described in Examples.

[0041]

Examples of the method for adjusting the light transmittance include a method of adjusting the type and the addition amount of the ultraviolet absorber (D) contained in the pressure-sensitive adhesive composition described later. However, the method is not limited to these methods.

[0042]

The present adhesive sheet has a pressure-sensitive adhesive layer obtained by curing a pressure-sensitive adhesive composition containing the (meth)acrylic copolymer (A) as described above.

The pressure-sensitive adhesive composition contains the (meth)acrylic copolymer (A) as a main component (preferably 50 mass% or more, more preferably 60 mass% or more, and particularly preferably 70 mass% or more). The pressure-sensitive adhesive composition contains the (meth)acrylic copolymer (A) as a main component (preferably 70 mass% or more, more preferably 80 mass% or more, and particularly preferably 90 mass% or more) in a resin component.

The pressure-sensitive adhesive composition preferably further contains the crosslinking agent (B) and the photoinitiator (C), and also preferably contains the ultraviolet absorber (D).

Hereinafter, each component contained in the pressure-sensitive adhesive composition will be described in detail.

[0043]

(Meth)acrylic Copolymer (A)

Examples of the (meth)acrylic copolymer (A) include copolymers obtained by polymerizing monomer components copolymerizable with the alkyl (meth)acrylate.

Among these, it is preferable that the (meth)acrylic copolymer (A) contains two or more copolymerization components, and at least one of the copolymerization components is an alkyl (meth)acrylate (a1) having an alkyl group with from 3 to 30 carbon atoms (hereinafter, sometimes referred to as "alkyl (meth)acrylate (a1)").

[0044]

More specific examples of the (meth)acrylic copolymer (A) include copolymers of copolymerization components including an alkyl (meth)acrylate (a1) and, for example, at least one copolymerizable monomer (hereinafter, sometimes referred to as "copolymerizable monomers (a2) to (a10)") selected from the group consisting of a hydroxy group-containing monomer (a2), a nitrogen-containing monomer (a3), a carboxy group-containing monomer (a4), an epoxy group-containing monomer (a5), a vinyl monomer (a6), an alkyl (meth)acrylate monomer (a7) having an alkyl group with 1 or 2 carbon atoms, an alicyclic monomer (a8), a macromonomer (a9), and another copolymerizable monomer (a10), which are copolymerizable with the alkyl (meth)acrylate (a1).

Such a (meth)acrylic copolymer (A) preferably usually has constituent units derived from the copolymerizable monomers (a2) to (a10) contained in the copolymerization components, in addition to a constituent unit derived from the alkyl (meth)acrylate (a1).

Among them, the (meth)acrylic copolymer (A) preferably contains the hydroxy group-containing monomer (a2) and/or the nitrogen-containing monomer (a3) as the constituent unit(s) from the viewpoint of achieving corrosion resistance, adhesiveness, and resistance to wet heat whitening simultaneously in a case where the adherend contains a component having corrosion properties, such as a metal. The (meth)acrylic copolymer (A) particularly preferably contains constituent units derived from the hydroxy group-containing monomer (a2) and the nitrogen-containing monomer (a3) from the viewpoint of further increasing cohesiveness. In addition, in a case

where the adherend contains a component having corrosion properties such as a metal, it is preferable that the (meth)acrylic copolymer (A) does not contain a constituent unit derived from the carboxy group-containing monomer (a4) from the viewpoint of corrosion resistance characteristics.

[0045]

Alkyl (Meth)acrylate (a1)

The alkyl (meth)acrylate (a1) is a linear or branched alkyl (meth)acrylate having an alkyl group with from 3 to 30 carbon atoms, and is represented by the following formula (Chem. 1).

$CH_2=C(R^1)-COO(R^2)$ ··· (Chem. 1)

(In Chem. 1, R^1 represents a hydrogen atom or a methyl group, and R^2 represents a linear or branched alkyl group having from 3 to 30 carbon atoms.)

[0046]

Examples of the alkyl (meth)acrylate represented by the formula (Chem. 1) 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, undecyl (meth)acrylate, lauryl (meth)acrylate, n-tridecyl (meth)acrylate, n-tetradecyl (meth)acrylate, cetyl (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, sec-butyl (meth)acrylate, isobutyl (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, isobornyl (meth)acrylate, isostearyl (meth)acrylate, isoicosyl (meth)acrylate, butyloctyl (meth)acrylate, isomyristyl (meth)acrylate, isocetyl (meth)acrylate, hexyldecyl (meth)acrylate, octyldecyl (meth)acrylate, octyldodecyl (meth)acrylate, and isobehenyl (meth)acrylate. These may be used alone, or two or more thereof may be used in combination.

[0047]

Among these, linear alkyl (meth)acrylates are preferred from the viewpoint of obtaining flexibility. In addition, from the viewpoint of balancing adhesiveness and flexibility, a linear alkyl (meth)acrylate having an alkyl group with from 3 to 20 carbon atoms, further from 5 to 18 carbon atoms, particularly from 6 to 16 carbon atoms, and especially from 7 to 14 carbon atoms is preferable, and for example, n-butyl (meth)acrylate, n-pentyl (meth)acrylate, n-hexyl (meth)acrylate, n-octyl (meth)acrylate, n-nonyl (meth)acrylate, decyl (meth)acrylate, and lauryl (meth)acrylate are preferable.

[0048]

On the other hand, among these, from the viewpoint that a hydrogen abstraction reaction described below is likely to occur during irradiation with an active energy ray, and as a result, a crosslinked structure can be efficiently formed, a branched alkyl (meth)acrylate, that is, an alkyl (meth)acrylate containing a tertiary carbon atom in the alkyl group is preferable. Among these, branched alkyl (meth)acrylates having an alkyl group with from 3 to 20 carbon atoms, further from 5 to 18 carbon atoms, particularly from 6 to 16 carbon atoms, and especially from 7 to 14 carbon atoms are preferable, and for example, isopropyl (meth)acrylate, sec-butyl (meth)acrylate, isobutyl

(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, and isobornyl (meth)acrylate are preferable, and 2-ethylhexyl (meth)acrylate and isobornyl (meth)acrylate are particularly preferable.

[0049]

The proportion of the constituent unit derived from the alkyl (meth)acrylate (a1) to the (meth)acrylic copolymer (A) is usually from 5 to 95 mass%, preferably from 10 to 90 mass%, more preferably from 15 to 85 mass%, and particularly preferably from 20 to 80 mass%. When the proportion of the constituent unit derived from the alkyl (meth)acrylate (a1) is at least the lower limit value, flexibility tends to be excellent, and in a case where the adherend has irregularities, followability to the irregularities tends to be excellent. When the proportion is at most the upper limit value, the effect of a copolymerizable monomer described below is easily obtained, and the adhesive force and the cohesive force tend to be excellent.

[0050]

Hydroxy Group-Containing Monomer (a2)

Examples of the hydroxy group-containing monomer (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; tertiary hydroxy group-containing (meth)acrylates such as 2,2-dimethyl-2-hydroxyethyl (meth)acrylate; and vinyl ethers such as 2-hydroxyethyl vinyl ether, diethylene glycol monovinyl ether, and 4-hydroxybutyl vinyl ether. These may be used alone, or two or more thereof may be used in combination.

The hydroxy group-containing monomer (a2) can improve the adhesive force of the adhesive sheet and can suppress the wet heat whitening. In addition, in a case where the pressure-sensitive adhesive composition contains a thermal crosslinking agent described below, a crosslinking reaction site is formed.

[0051]

Among the hydroxy group-containing monomers (a2), hydroxy group-containing monomers having a hydroxyalkyl group with from 1 to 10 carbon atoms, further from 1 to 6 carbon atoms, and especially from 2 to 4 carbon atoms, such as 2-hydroxyethyl (meth)acrylate, 4-hydroxybutyl (meth)acrylate, 2-hydroxypropyl (meth)acrylate, 2-hydroxyethyl vinyl ether, diethylene glycol monovinyl ether, and 4-hydroxybutyl vinyl ether are preferable, and primary hydroxy group-containing (meth)acrylates such as 2-hydroxyethyl (meth)acrylate and 4-hydroxybutyl (meth)acrylate are particularly preferable.

[0052]

In a case where the (meth)acrylic copolymer (A) has a constituent unit derived from the hydroxy group-containing monomer (a2), the content thereof is usually from 3 to 30 mass%, preferably from 5 to 25 mass%, and particularly preferably from 7 to 20 mass%, with respect to the (meth)acrylic copolymer (A), from the viewpoint of imparting the adhesive force and resistance to wet heat whitening.

[0053]

Nitrogen-Containing Monomer (a3)

Examples of the nitrogen-containing monomer (a3) include an amino group-containing monomer, an amide group-containing monomer, an isocyanate group-containing monomer, and (meth)acrylonitrile. These may be used alone, or two or more thereof may be used in combination. The nitrogen-containing monomer (a3) can improve the cohesive force of the adhesive sheet and can suppress the wet heat whitening. In addition, in a case where a hydrogen abstraction type photoinitiator described below is used, the (meth)acrylic copolymer (A) preferably has a constituent unit derived from the nitrogen-containing monomer (a3). The nitrogen-containing monomer (a3) has an effect of promoting a hydrogen abstraction reaction in a case where the hydrogen abstraction type photoinitiator described below is used.

[0054]

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; tertiary amino group-containing (meth)acrylates such as diethylaminoethyl (meth)acrylate, dimethylaminoethyl (meth)acrylate, dimethylaminopropyl (meth)acrylate, diethylaminopropyl (meth)acrylate, and dimethylaminopropylacrylamide; and monomers such as N-vinylpyrrolidone, methylvinylpyrrolidone, vinylpyridine, vinylpiperidone, vinylpyrimidine, vinylpiperazine, vinylpyrazine, vinylpyrrole, vinylimidazole, vinyloxazole, vinylmorpholine, (meth)acryloylmorpholine, N-vinylacetamide, and N-vinylcaprolactam.

[0055]

Examples of the amide group-containing monomer include (meth)acrylamide; 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-diethylmethyl acrylamide, and N,N-diallyl (meth)acrylamide; hydroxyalkyl (meth)acrylamides such as N-hydroxymethyl (meth)acrylamide and N-hydroxyethyl (meth)acrylamide; alkoxyalkyl (meth)acrylamides such as N-methoxymethyl (meth)acrylamide and N-(n-butoxymethyl) (meth)acrylamide; and maleimides and derivatives thereof. Among these, (meth)acrylamide is preferable.

[0056]

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

isocyanate group may be protected with a blocking agent such as methyl ethyl ketone oxime, 3,5-dimethylpyrazole, 1,2,4-triazole, or diethyl malonate.

[0057]

Among these, from the viewpoint of having a sensitizing action of a hydrogen abstraction reaction by a hydrogen abstraction type photoinitiator described below, and as a result, being able to efficiently form a crosslinked structure, those having a tertiary nitrogen atom are preferable, and tertiary amino group-containing (meth)acrylates, N,N-dialkyl (meth)acrylamide, N-vinylpyrrolidone, acryloylmorpholine, and the like are particularly preferable.

[0058]

In a case where the (meth)acrylic copolymer (A) has a constituent unit derived from the nitrogen-containing monomer (a3), the content thereof is usually from 1 to 45 mass%, preferably from 3 to 40 mass%, particularly preferably from 5 to 35 mass%, and especially preferably from 7 to 30 mass%, with respect to the (meth)acrylic copolymer (A), from the viewpoint of imparting a cohesive force and resistance to wet heat whitening.

[0059]

Carboxy Group-Containing Monomer (a4)

Examples of the carboxy group-containing monomer (a4) 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. These may be used alone, or two or more thereof may be used in combination.

[0060]

In a case where the (meth)acrylic copolymer (A) has a constituent unit derived from the carboxy group-containing monomer (a4), the content thereof is usually from 0.1 to 15 mass%, preferably from 0.3 to 13 mass%, more preferably from 0.5 to 10 mass%, and particularly preferably from 1 to 6 mass%, with respect to the (meth)acrylic copolymer (A).

[0061]

Epoxy Group-Containing Monomer (a5)

Examples of the epoxy group-containing monomer (a5) include glycidyl (meth)acrylate, methylglycidyl (meth)acrylate, 3,4-epoxycyclohexylmethyl (meth)acrylate, and 4-hydroxybutyl (meth)acrylate glycidyl ether. One of these may be used alone or two or more thereof may be used in combination.

[0062]

In a case where the (meth)acrylic copolymer (A) has a constituent unit derived from the epoxy group-containing monomer (a5), the content thereof is usually from 0.1 to 15 mass%, preferably from 0.3 to 13 mass%, more preferably from 0.5 to 10 mass%, and particularly preferably from 1 to 6 mass%, with respect to the (meth)acrylic copolymer (A).

[0063]

Vinyl Monomer (a6)

Examples of the vinyl monomer (a6) include a compound having a vinyl group in the molecule. Examples of such a compound include vinyl ester monomers such as vinyl acetate, vinyl propionate, vinyl laurate, and vinyl

stearate, and aromatic vinyl monomers such as styrene, chlorostyrene, chloromethylstyrene, α-methylstyrene, and other substituted styrenes. One of these may be used alone or two or more thereof may be used in combination.

[0064]

In a case where the (meth)acrylic copolymer (A) has a constituent moiety derived from the vinyl monomer (a6), the content thereof is usually from 1 to 40 mass%, preferably from 5 to 35 mass%, more preferably from 8 to 30 mass%, and particularly preferably from 10 to 25 mass%, with respect to the (meth)acrylic copolymer (A), from the viewpoint of imparting a cohesive force to the adhesive sheet.

[0065]

Alkyl (Meth)acrylate Monomer (a7) Having Alkyl Group with 1 or 2 Carbon Atoms

Examples of the alkyl (meth)acrylate monomer (a7) having an alkyl group with 1 or 2 carbon atoms include methyl (meth)acrylate and ethyl (meth)acrylate. One of these may be used alone or two or more thereof may be used in combination.

[0066]

In a case where the (meth)acrylic copolymer (A) has a constituent unit derived from the alkyl (meth)acrylate monomer (a7) having an alkyl group with 1 or 2 carbon atoms, the content thereof is usually from 1 to 60 mass%, preferably from 5 to 55 mass%, particularly preferably from 10 to 50 mass%, and especially preferably from 15 to 45 mass%, with respect to the (meth)acrylic copolymer (A), from the viewpoint of imparting a cohesive force to the adhesive sheet.

[0067]

Alicyclic Monomer (a8)

Examples of the alicyclic monomer (a8) include cyclohexyl (meth)acrylate, 3,3,5-trimethylcyclohexyl (meth)acrylate, isobornyl (meth)acrylate, dicyclopentanyl (meth)acrylate, dicyclopentenyloxyethyl (meth)acrylate, t-butylcyclohexyl (meth)acrylate, and adamantyl (meth)acrylate. These may be used alone, or two or more thereof may be used in combination.

[0068]

In a case where the (meth)acrylic copolymer (A) has a constituent unit derived from the alicyclic monomer (a8), the content thereof is usually from 0.1 to 15 mass%, preferably from 0.5 to 13 mass%, particularly preferably from 1 to 10 mass%, and especially preferably from 2 to 7 mass%, with respect to the (meth)acrylic copolymer (A), from the viewpoint of imparting a cohesive force to the adhesive sheet.

[0069]

Macromonomer (a9)

The macromonomer (a9) is a monomer that can easily increase the number of carbon atoms in the side chain of the (meth)acrylic copolymer (A), for example, to 20 or more, when formed into the (meth)acrylic copolymer (A) by polymerization.

When the macromonomer (a9) is used as a copolymerization component, the (meth)acrylic copolymer (A) can be a graft copolymer having a constituent moiety (segment) derived from the macromonomer (a9). In addition, characteristics of the main chain and the side chain of the graft

copolymer can be changed by changing the blending ratio of the macromonomer (a9) and the other monomers.

[0070]

The macromonomer (a9) has a radically polymerizable functional group or a functional group such as a hydroxy group, an isocyanate group, an epoxy group, a carboxy group, an amino group, an amide group, or a thiol group. The macromonomer (a9) may have only one of these or two or more thereof in combination.

Among them, the macromonomer (a9) preferably has a radically polymerizable functional group that is copolymerizable with another monomer. One or more radically polymerizable functional groups may be contained, but one radically polymerizable functional group is particularly preferably contained.

In addition, also in a case where the macromonomer (a9) has a functional group, one or more functional groups may be contained, but one functional group is particularly preferably contained.

[0071]

The macromonomer (a9) preferably has a skeleton component formed of a (meth)acrylic copolymer or a vinyl-based polymer.

Examples of the skeleton component of the macromonomer (a9) include the alkyl (meth)acrylate (a1), the vinyl monomer (a6), the alkyl (meth)acrylate monomer (a7) having an alkyl group with 1 or 2 carbon atoms, and the alicyclic monomer (a8). These may be used alone, or two or more thereof may be used in combination.

Among them, it is preferable to use, as the skeleton component, an alkyl (meth)acrylate having an alkyl group with from 1 to 8 carbon atoms, an alicyclic monomer, or an aromatic monomer such as styrene, from the viewpoint of obtaining an adhesive sheet excelling in cohesive force.

On the other hand, use of an alkyl (meth)acrylate having from 9 to 30 carbon atoms is preferred in that an adhesive sheet excelling in flexibility can be obtained.

[0072]

A number-average molecular weight of the macromonomer (a9) is usually from 1000 to 40000, preferably from 1500 to 20000, and more preferably from 2000 to 15000.

The number-average molecular weight of the macromonomer (a9) is a value calibrated with standard polystyrene as measured by gel permeation chromatography (GPC).

[0073]

As the macromonomer (a9), a commonly produced macromonomer (for example, macromonomer available from Toagosei Co., Ltd.) can be appropriately used.

[0074]

In a case where the (meth)acrylic copolymer (A) has a constituent unit derived from the macromonomer (a9), the content thereof is usually from 1 to 30 mass%, preferably from 3 to 20 mass%, and more preferably from 5 to 18 mass%, with respect to the (meth)acrylic copolymer (A). When the content is at least the lower limit value, a force of phase separation between a segment containing the constituent unit derived from the macromonomer (a9) and a

segment formed of another constituent unit becomes strong, and the cohesive force of the adhesive sheet tends to be more excellent. When the content is at most the upper limit value, the phase separation structure is easily collapsed during bonding, and the irregularity followability tends to be more excellent.

[0075]

Another Copolymerizable Monomer (a10)

Examples of the other copolymerizable monomer (a10) 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)acrylates 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; (meth)acrylates having a benzophenone structure such as 4-acryloyloxybenzophenone, 4-acryloyloxyethoxybenzophenone, 4-acryloyloxy-4'-methoxybenzophenone, 4-acryloyloxyethoxy-4'-methoxybenzophenone, 4-acryloyloxy-4'-bromobenzophenone, 4-acryloyloxyethoxy-4'-bromobenzophenone, 4-methacryloyloxybenzophenone, 4-

methacryloyloxyethoxybenzophenone, 4-methacryloyloxy-4'-methoxybenzophenone, 4-methacryloyloxyethoxy-4'-methoxybenzophenone, 4-methacryloyloxy-4'-bromobenzophenone, 4-methacryloyloxyethoxy-4'-bromobenzophenone, and mixtures thereof; and heterocycle-containing (meth)acrylates such as tetrahydrofurfuryl (meth)acrylate. These may be used alone, or two or more thereof may be used in combination.

[0076]

In a case where the (meth)acrylic copolymer (A) has a constituent unit derived from the other copolymerizable monomer (a10), the content thereof is usually from 1 to 30 mass%, preferably from 3 to 20 mass%, and more preferably from 5 to 15 mass%, with respect to the (meth)acrylic copolymer (A).

[0077]

The method for producing the (meth)acrylic copolymer (A) is not particularly limited. For example, copolymerization components including the alkyl (meth)acrylate (a1) and, if necessary, at least one selected from the group consisting of the copolymerizable monomers (a2) to (a10) are polymerized.

[0078]

Examples of the polymerization method include known methods in the related art such as solution polymerization, suspension polymerization, bulk polymerization, and emulsion polymerization, and among these, solution polymerization is preferable in that an acrylic resin can be produced safely and stably with any monomer composition.

Thus, the (meth)acrylic copolymer (A) can be obtained.

[0079]

The (meth)acrylic copolymer (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 pressure-sensitive adhesive composition, whereby the pressure-sensitive adhesive composition can be crosslinked in a shorter time to increase productivity.

[0080]

Examples of the method for introducing a polymerizable carbon-carbon double bond group into a side chain of the (meth)acrylic copolymer (A) include a method in which a copolymer containing functional group-containing ethylenically unsaturated monomers such as the above-described hydroxy group-containing monomer (a2), nitrogen-containing monomer (a3), carboxy group-containing monomer (a4), and epoxy group-containing monomer (a5) is produced, 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.

[0081]

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.

[0082]

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.

[0083]

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, further 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 (meth)acrylic copolymer (A), from the viewpoint of improving adhesiveness and stress relaxation properties. Note that the lower limit value is usually 0 parts by mass.

[0084]

A weight-average molecular weight (Mw) of the (meth)acrylic copolymer (A) is usually from 50000 to 1500000, preferably from 70000 to 1000000, more preferably from 100000 to 800000, and further preferably from 150000 to 600000.

When the weight-average molecular weight (Mw) is at least the lower limit, the present adhesive sheet obtained tends to have a high cohesive force.

When the weight-average molecular weight (Mw) is at most the upper limit, the handleability and uniform stirring properties tend to be excellent.

The weight-average molecular weight of the (meth)acrylic copolymer (A) is a value calibrated with standard polystyrene as measured by gel permeation chromatography (GPC).

[0085]

Crosslinking Agent (B)

The pressure-sensitive adhesive composition preferably contains the crosslinking agent (B) from the viewpoint of promoting a crosslinking reaction. This allows the pressure-sensitive adhesive composition to efficiently form a crosslinked structure. In addition, when a crosslinked structure is formed in the adhesive sheet using the pressure-sensitive adhesive composition, it is possible to prevent the adhesive overflow during storage or during bonding, and to obtain good adhesiveness and cohesive force.

However, when the (meth)acrylic copolymer (A) causes a hydrogen abstraction reaction by an action of the photoinitiator (C) described below or the like and the crosslinked structure can be sufficiently formed in the (meth)acrylic copolymer (A) and/or between the (meth)acrylic copolymers (A), the crosslinking agent (B) is not necessarily contained.

[0086]

Examples 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. Among these, an isocyanate-based crosslinking agent is preferably used in terms of excellent reactivity with the (meth)acrylic copolymer (A). On the other hand, from the

viewpoint of ease of reaction control and imparting active energy ray curability, an acrylic crosslinking agent is preferable, and among them, a polyfunctional (meth)acrylate is preferably used.

[0087]

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

[0088]

Examples of the polyfunctional (meth)acrylic monomer include pentanediol di(meth)acrylate, hexanediol 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, neopentylglycol 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.

[0089]

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.

[0090]

Among these crosslinking agents (B), polyfunctional (meth)acrylate-based monomers and oligomers having a glycol structure are preferable from the viewpoint of imparting moderate flexibility to the cured product. From the viewpoint of imparting a cohesive force, an acrylic acid adduct of pentaerythritol or dipentaerythritol, or an alkoxylate thereof is preferable.

[0091]

In a case where the pressure-sensitive adhesive composition contains the crosslinking agent (B), the content thereof is usually from 0.1 to 25 parts by mass, preferably from 0.5 to 22 parts by mass, more preferably from 0.7 to 20 parts by mass, and particularly preferably from 1 to 18 parts by mass with respect to 100 parts by mass of the (meth)acrylic copolymer (A), from the

viewpoint of being able to impart shape stability of the adhesive sheet and durability when the adhesive sheet is formed into a laminate for an image display device.

When the content of the crosslinking agent (B) is at least the above lower limit, there is a tendency that the shape stability of the adhesive sheet and the durability when the adhesive sheet is formed into a laminate for an image display device can be imparted.

When the content of the crosslinking agent (B) is at most the above upper limit, the flexibility of the adhesive sheet tends to be maintained.

[0092]

In a case where the present adhesive sheet has two or more pressure-sensitive adhesive layers, the crosslinking agent (B) may be contained in the pressure-sensitive adhesive composition forming at least one layer, or may be contained in the pressure-sensitive adhesive compositions forming all the pressure-sensitive adhesive layers.

At this time, the content of the crosslinking agent (B) is based on the total mass of the (meth)acrylic copolymer (A) in all the pressure-sensitive adhesive layers constituting the present adhesive sheet.

[0093]

In addition, in a case where the present adhesive sheet has a first pressure-sensitive adhesive layer and a second pressure-sensitive adhesive layer described later, it is preferable that the content of the crosslinking agent (B) contained in the pressure-sensitive adhesive composition forming the second pressure-sensitive adhesive layer is larger than the content of the crosslinking agent (B) contained in the pressure-sensitive adhesive

composition forming the first pressure-sensitive adhesive layer. With such a configuration, the modulus of elasticity ratio (E'/G') described above is easily adjusted, and there is a tendency that it is easy to perform functional separation of inverse properties such as stress relaxation properties and shape retention properties for each layer.

[0094]

Further, in a case where the present adhesive sheet has a configuration having at least three layers of an outermost layer, a backmost layer and an intermediate layer described later, it is preferable that the intermediate layer is formed from a pressure-sensitive adhesive composition having a larger content of the crosslinking agent (B) than the outermost layer and the backmost layer, from the viewpoint of achieving both cutting processability and bonding reliability.

[0095]

Photoinitiator (C)

The pressure-sensitive adhesive composition preferably contains the photoinitiator (C). The photoinitiator (C) is a compound that generates a radical by an active energy ray. The pressure-sensitive adhesive composition contains the photoinitiator (C), and thus can be photocured.

The photoinitiator (C) is roughly classified into two types according to a radical generation mechanism. More specifically, the photoinitiator is roughly classified into a cleavage type photoinitiator that can generate a radical by cleaving a single bond of the photoinitiator itself, and a hydrogen abstraction type photoinitiator that can generate a radical by abstracting hydrogen from a

hydrogen donor in the system by the excited initiator. These may be used alone, or two or more thereof may be used in combination.

The cleavage type photoinitiator is preferable in that it has high photosensitivity.

On the other hand, the hydrogen abstraction type photoinitiator is preferable in that no photodecomposition product is generated, and in that the (meth)acrylic copolymer (A) can be incorporated into a crosslinked structure by a hydrogen abstraction reaction.

[0096]

Examples of the hydrogen abstraction type photoinitiator include intermolecular hydrogen abstraction type photoinitiators such as benzophenone, 4-methylbenzophenone, 2,4,6-trimethylbenzophenone, 4-phenylbenzophenone, 3,3'-dimethyl-4-methoxybenzophenone, methyl 2-benzoylbenzoate, 4-[(4-methylphenyl)thio]benzophenone, 4-acryloyloxybenzophenone, 4-acryloyloxyethoxybenzophenone, 4-acryloyloxy-4'-methoxybenzophenone, 4-acryloyloxyethoxy-4'-methoxybenzophenone, 4-acryloyloxy-4'-bromobenzophenone, 4-acryloyloxyethoxy-4'-bromobenzophenone, 4-methacryloyloxybenzophenone, 4-methacryloyloxyethoxybenzophenone, 4-methacryloyloxy-4'-methoxybenzophenone, 4-methacryloyloxyethoxy-4'-methoxybenzophenone, 4-methacryloyloxy-4'-bromobenzophenone, and 4-methacryloyloxyethoxy-4'-bromobenzophenone; and intramolecular hydrogen abstraction type photoinitiators such as methylbenzoylformate, methyl benzoylformate, oxyphenylacetic acid-2-(2-oxo-2-phenyl-acetoxy-ethoxy)ethyl ester, and

oxyphenylacetic acid-2-(2-hydroxy-ethoxy)ethyl ester. These may be used alone, or two or more thereof may be used in combination.

[0097]

Among the intermolecular hydrogen abstraction type photoinitiators, 4-methylbenzophenone, 2,4,6-trimethylbenzophenone, and a photoinitiator (c1) having a radically polymerizable functional group having a carbon-carbon double bond and a structure that generates a radical in the molecule, for example, 4-acryloyloxybenzophenone, 4-methacryloyloxybenzophenone, 4-acryloyloxyethoxybenzophenone, 4-acryloyloxy-4'-methoxybenzophenone, 4-acryloyloxyethoxy-4'-methoxybenzophenone, and 4-methacryloyloxybenzophenone are preferable, and 4-methylbenzophenone, 2,4,6-trimethylbenzophenone, and 4-methacryloyloxybenzophenone are more preferable. The photoinitiator (c1) having a radically polymerizable functional group having a carbon-carbon double bond and a structure that generates a radical in the molecule tends to be incorporated into the polymerization structure after photoreaction, thereby suppressing bleed-out of the photoinitiator and improving the cohesive force of the adhesive sheet.

In addition, the intramolecular hydrogen abstraction type photoinitiator is preferable in that not only the hydrogen donor in the system but also the photoinitiator itself can be a starting point of radical generation, and methylbenzoylformate is more preferable.

[0098]

Examples of the cleavage type photoinitiator 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.

[0099]

In the present disclosure, the photoinitiator (C) is preferably a hydrogen abstraction type photoinitiator, from the viewpoint of increasing the cohesive force of the adhesive sheet.

[0100]

Also, in the present disclosure, it is preferable to contain an intermolecular hydrogen abstraction type photoinitiator and an intramolecular hydrogen abstraction type photoinitiator as the photoinitiator (C), from the viewpoint of increasing the cohesive force of the adhesive sheet.

[0101]

In addition, in the present disclosure, it is preferable to contain the photoinitiator (c1) having a radically polymerizable functional group having a carbon-carbon double bond and a structure that generates a radical in the molecule, and a hydrogen abstraction type photoinitiator (c2) other than the photoinitiator (c1) as the photoinitiator (C).

By containing the photoinitiator (c1) having a radically polymerizable functional group having a carbon-carbon double bond and a structure that generates a radical in the molecule and the hydrogen abstraction type photoinitiator (c2) other than the photoinitiator (c1), the cohesive force of the adhesive sheet can be increased, and when the adhesive sheet has active energy ray curability, the adhesive sheet can be excellent in secondary curability after being bonded to an adherend.

Note that the hydrogen abstraction type photoinitiator (c2) means a hydrogen abstraction type photoinitiator other than the photoinitiator (c1) having a radically polymerizable functional group having a carbon-carbon double bond and a structure that generates a radical in the molecule, among the hydrogen abstraction type photoinitiators described above.

Among the hydrogen abstraction type photoinitiators (c2), an intramolecular hydrogen abstraction type photoinitiator is preferable in that not only a hydrogen donor in the system but also the photoinitiator itself can be a starting point of radical generation, and methylbenzoylformate is more preferable.

[0102]

In a case where the pressure-sensitive adhesive composition contains the photoinitiator (C), the content thereof is usually 10 parts by mass or less, preferably 5 parts by mass or less, more preferably 4 parts by mass or less, and particularly preferably 3 parts by mass or less, with respect to 100 parts by mass of the (meth)acrylic copolymer (A). The lower limit value is usually 0.1 parts by mass. The range of the content of the photoinitiator (C) is, for example, from 0.1 to 10 parts by mass. In a case where two or more types of

photoinitiators (C) are used in combination, the content is the total amount of the photoinitiators (C) used.

The lower and upper limits of the content of the photoinitiator (C) can be combined in any way.

[0103]

In a case where the photoinitiator (C) contains the photoinitiator (c1) having a radically polymerizable functional group having a carbon-carbon double bond and a structure that generates a radical in the molecule and the hydrogen abstraction type photoinitiator (c2) other than the photoinitiator (c1), the content mass ratio (c2/c1) of the photoinitiator (c2) to the photoinitiator (c1) is usually from 0.5 to 10, preferably from 1 to 8, and more preferably from 2 to 6.

[0104]

Ultraviolet Absorber (D)

The pressure-sensitive adhesive composition preferably contains the ultraviolet absorber (D). By containing the ultraviolet absorber (D), there is a tendency that deterioration of the adhesive sheet itself or an adherend due to ultraviolet rays can be suppressed.

When the pressure-sensitive adhesive composition contains the ultraviolet absorber (D), it is preferable to cure the pressure-sensitive adhesive composition with light having a wavelength other than the absorption wavelength for the ultraviolet absorber (D) for photocuring.

[0105]

Examples of the ultraviolet absorber (D) include a benzophenone-based ultraviolet absorber, a benzotriazole-based ultraviolet absorber, a

triazine-based ultraviolet absorber, a salicylic acid-based ultraviolet absorber, and a cyanoacrylate-based ultraviolet absorber. One of these ultraviolet absorbers (D) can be used alone, or two or more thereof can be used in combination.

[0106]

Examples of the benzophenone-based ultraviolet absorber include 2,4-dihydroxybenzophenone, 2-hydroxy-4-methoxybenzophenone, 2-hydroxy-4-octoxybenzophenone, 2-hydroxy-4-benzyloxybenzophenone, 2-hydroxy-4-methoxy-5-sulfoxybenzophenone, 2-hydroxy-4-methoxy-5-sulfoxytrihydratebenzophenone, 2,2'-dihydroxy-4-methoxybenzophenone, 2,2',4,4'-tetrahydroxybenzophenone, 2,2'-dihydroxy-4,4'-dimethoxybenzophenone, 2,2'-dihydroxy-4,4'-dimethoxy-5-sodiumsulfoxybenzophenone, bis(5-benzoyl-4-hydroxy-2-methoxyphenyl)methane, 2-hydroxy-4-n-dodecyloxybenzophenone, and 2-hydroxy-4-methoxy-2'-carboxybenzophenone.

[0107]

Examples of the benzotriazole-based ultraviolet absorber include 2-(2-hydroxy-5-methylphenyl)benzotriazole, 2-(2-hydroxy-5-tert-octylphenyl)benzotriazole, 2-(2-hydroxy-3,5-dicumylphenyl)phenylbenzotriazole, 2-(2-hydroxy-3-tert-butyl-5-methylphenyl)-5-chlorobenzotriazole, 2,2'-methylenebis[4-(1,1,3,3-tetramethylbutyl)-6-(2H-benzotriazole-2-yl)phenol], 2-(2-hydroxy-3,5-di-tert-butylphenyl)benzotriazole, 2-(2-hydroxy-3,5-di-tert-butylphenyl)-5-chlorobenzotriazole, 2-(2-hydroxy-3,5-di-tert-amylphenyl)benzotriazole, 2-(2-hydroxy-5-tert-octylphenyl)benzotriazole, 2-(2-hydroxy-5-tert-

butylphenyl)benzotriazole, 2-(2-hydroxy-4-octoxyphenyl)benzotriazole, 2,2'-methylenebis(4-cumyl-6-benzotriazolephenyl), 2,2'-p-phenylenebis(1,3-benzoxazine-4-one), and 2-[2-hydroxy-3-(3,4,5,6-tetrahydrophthalimidomethyl)-5-methylphenyl]benzotriazole.

[0108]

Examples of the triazine-based ultraviolet absorbers include 2-(2-hydroxy-4-methoxyphenyl)-4,6-diphenyl-1,3,5-triazine, 2-(2-hydroxy-4-ethoxyphenyl)-4,6-diphenyl-1,3,5-triazine, 2-(2-hydroxy-4-propoxyphenyl)-4,6-diphenyl-1,3,5-triazine, 2-(2-hydroxy-4-butoxyphenyl)-4,6-diphenyl-1,3,5-triazine, 2-(2-hydroxy-4-hexyloxyphenyl)-4,6-diphenyl-1,3,5-triazine, 2-(2-hydroxy-4-octyloxyphenyl)-4,6-diphenyl-1,3,5-triazine, 2-(2-hydroxy-4-dodecyloxyphenyl)-4,6-diphenyl-1,3,5-triazine, 2-(2-hydroxy-4-benzyloxyphenyl)-4,6-diphenyl-1,3,5-triazine, 2,4-bis(2-hydroxy-4-butoxyphenyl)-6-(2,4-dibutoxyphenyl)-1,3,5-triazine, 2,4,6-tris(2-hydroxy-4-hexyloxy-3-methylphenyl)-1,3,5-triazine, 2-(2-hydroxy-4-[1-octyloxycarbonylethoxy]phenyl)-4,6-bis(4-phenylphenyl)-1,3,5-triazine, 2-[4-[(2-hydroxy-3-dodecyloxypropyl)oxy]-2-hydroxyphenyl]-4,6-bis(2,4-dimethylphenyl)-1,3,5-triazine, 2-[4-[(2-hydroxy-3-tridecyloxypropyl)oxy]-2-hydroxyphenyl]-4,6-bis(2,4-dimethylphenyl)-1,3,5-triazine, 2-[4-[(2-hydroxy-3-(2'-ethyl)hexyl)oxy]-2-hydroxyphenyl]-4,6-bis(2,4-dimethylphenyl)-1,3,5-triazine, 2,4-bis(2,4-dimethylphenyl)-6-[2-hydroxy-4-(3-octyloxy-2-hydroxypropyloxy)-5-α-cumylphenyl]-s-triazine, 2,4-bis(2,4-dimethylphenyl)-6-[2-hydroxy-4-(3-nonyloxy-2-hydroxypropyloxy)-5-α-cumylphenyl]-s-triazine, 2,4-bis(2,4-dimethylphenyl)-6-[2-hydroxy-4-(3-decyloxy-2-hydroxypropyloxy)-

5-α-cumylphenyl]-s-triazine, and 2-(2-hydroxy-4-acryloyloxyethoxyphenyl)-4,6-bis(2,4-dimethylphenyl)-1,3,5-triazine.

[0109]

Examples of the salicylic acid-based ultraviolet absorber include phenyl salicylate, p-tert-butylphenyl salicylate, and p-octylphenyl salicylate.

[0110]

Examples of the cyanoacrylate-based ultraviolet absorbers include 2-ethylhexyl-2-cyano-3,3'-diphenyl acrylate and ethyl-2-cyano-3,3'-diphenyl acrylate.

[0111]

Among these, from the viewpoint of effectively suppressing ultraviolet deterioration of the adhesive sheet itself or the adherend, a benzophenone-based ultraviolet absorber, a benzotriazole-based ultraviolet absorber, and a triazine-based ultraviolet absorber are preferred. Among these, from the viewpoint of excellent heat resistance, a triazine-based ultraviolet absorber having a triazine structure is more preferred.

[0112]

The content of the ultraviolet absorber (D) is preferably usually from 0.1 to 15 parts by mass, preferably from 0.3 to 12 parts by mass, more preferably from 0.5 to 10 parts by mass, particularly preferably from 1 to 8 parts by mass, and most preferably from 3 to 7 parts by mass, with respect to 100 parts by mass of the (meth)acrylic copolymer (A).

When the content of the ultraviolet absorber (D) is at least the above lower limit, light resistance reliability tends to be improved.

When the content of the ultraviolet absorber (D) is at most the above upper limit, there is a tendency that bleed-out is suppressed and that yellowing resistance is improved.

[0113]

The content of the ultraviolet absorber (D) in the pressure-sensitive adhesive composition is usually from 0.1 to 15 mass%, preferably from 0.3 to 12 mass%, more preferably from 0.5 to 10 mass%, particularly preferably from 1 to 8 mass%, and most preferably from 2.5 to 7 mass%, based on the total mass of the pressure-sensitive adhesive composition.

When the content of the ultraviolet absorber (D) is at least the above lower limit, light resistance reliability tends to be improved.

When the content of the ultraviolet absorber (D) is at most the above upper limit, there is a tendency that bleed-out is suppressed and that yellowing resistance is improved.

[0114]

In a case where the present adhesive sheet has a laminate pressure-sensitive adhesive layer described later, the ultraviolet absorber (D) may be contained in at least one layer, and the ultraviolet absorber (D) is preferably contained in the pressure-sensitive adhesive composition forming the second pressure-sensitive adhesive layer, from the viewpoint of ease of progress of a photocuring reaction and suppression of bleed-out of the ultraviolet absorber (D). The content of the ultraviolet absorber (D) at this time is based on the total mass of the (meth)acrylic copolymer (A) contained in all the pressure-sensitive adhesive layers constituting the present adhesive sheet or the total

mass of all the pressure-sensitive adhesive compositions constituting the adhesive sheet.

[0115]

Monofunctional (Meth)acrylate

The pressure-sensitive adhesive 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 excellent stress relaxation properties is easily obtained, which is preferable.

[0116]

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, 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-hydroxy-o-phenylphenol propyl acrylate, 2-(meth)acryloyloxyethylsuccinic acid, 2-(meth)acryloyloxyethyltetrahydrophthalic acid, 2-(meth)acryloyloxyethylhexahydrophthalic acid, 2-(meth)acryloyloxypropylphthalic acid, 2-(meth)acryloyloxypropylhydrophthalic acid, and 2-(meth)acryloyloxypropylhexahydrophthalic acid, benzyl (meth)acrylate, phenoxyethyl (meth)acrylate, phenoxyethylene glycol (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 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.

[0117]

In a case where the monofunctional (meth)acrylate component is contained, the content thereof is preferably 2 parts by mass or more, more preferably 4 parts by mass or more, and particularly preferably 6 parts by mass or more, with respect to 100 parts by mass of the (meth)acrylic copolymer (A), from the viewpoint of imparting moderate flexibility to the cured product by adjusting a crosslinking density. The upper limit value is preferably 20 parts by mass or less, more preferably 18 parts by mass or less, and particularly preferably 15 parts by mass or less.

The range of the content of the monofunctional (meth)acrylate component is, for example, from 2 to 20 parts by mass.

[0118]

Additional Component

The pressure-sensitive adhesive composition may appropriately contain, as an "additional component", various additives such as a silane coupling agent, 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 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-

based compound may be appropriately contained. These may be used alone, or two or more thereof may be used in combination. Among these, the pressure-sensitive adhesive composition preferably contains a silane coupling agent.

[0119]

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.

[0120]

The alkoxy group attached to a silicon atom is preferably an alkoxy group with from 1 to 8 carbon atoms 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.

[0121]

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 obtained 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 obtained 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-isocyanatopropyltriethoxysilane; and vinyl group-containing silane coupling agents such as vinyltrimethoxysilane and vinyltriethoxysilane.

These may be used alone, or two or more thereof may be used in combination.

[0122]

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.

[0123]

In a case where the pressure-sensitive adhesive composition contains a silane coupling agent, the content thereof is usually from 0.005 to 10 parts by mass, preferably from 0.01 to 5 parts by mass, and particularly preferably from 0.05 to 1 part by mass, with respect to 100 parts by mass of the (meth)acrylic copolymer (A). When the content is within the above range, the adhesive force and durability tend to be improved.

[0124]

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.

[0125]

In a case where the pressure-sensitive adhesive composition contains the plasticizer, the content thereof is not particularly limited, and is usually from 0.1 to 20 parts by mass, and preferably from 0.5 to 15 parts by mass, with respect to 100 parts by mass of the (meth)acrylic copolymer (A).

[0126]

Tackifier

The pressure-sensitive adhesive composition may include a tackifier to improve the adhesive force of the adhesive sheet.

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.

[0127]

In a case where the pressure-sensitive adhesive composition contains the tackifier, the content thereof is not particularly limited, and is usually from 0.1 to 20 parts by mass, and preferably from 0.5 to 15 parts by mass, with respect to 100 parts by mass of the (meth)acrylic copolymer (A).

[0128]

Rust Inhibitor

The pressure-sensitive adhesive composition may contain a rust inhibitor to prevent corrosion in a case where an adherend includes a corrosive part such as a metal wiring.

Examples of the rust inhibitor include triazoles and benzotriazoles.

[0129]

In a case where the pressure-sensitive adhesive composition contains the rust inhibitor, the content thereof is usually from 0.01 to 5 parts by mass, and preferably from 0.1 to 3 parts by mass, with respect to 100 parts by mass of the (meth)acrylic copolymer (A).

[0130]

Method for Producing Present Adhesive Sheet

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

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

[0131]

The present adhesive sheet can be produced by preparing a pressure-sensitive adhesive composition containing the (meth)acrylic copolymer (A), preferably the crosslinking agent (B), the photoinitiator (C), the ultraviolet absorber (D), additional components, and the like, as necessary, forming the pressure-sensitive adhesive composition into a sheet shape, and crosslinking,

that is, polymerizing and curing the pressure-sensitive adhesive composition, followed by appropriate processing as necessary.

[0132]

The pressure-sensitive adhesive composition is 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 produce a master batch and then supplied.

[0133]

As a method for forming the pressure-sensitive adhesive composition into a sheet 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 a sheet, a wet lamination method, an extrusion casting method, and an extrusion lamination method are suitable.

[0134]

Curing of the pressure-sensitive adhesive composition can be performed by irradiation with an active energy ray, and the present adhesive sheet can be produced by irradiating a molded body of the pressure-sensitive

adhesive composition, for example, a sheet body, with an active energy ray. Note that in addition to the irradiation with an active energy ray, the pressure-sensitive adhesive composition can be further cured by heating.

[0135]

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 photoinitiator (C) can be activated to polymerize the photoreactive component such as a (meth)acrylic acid ester compound.

In a case where a hydrogen abstraction type photoinitiator is used as the photoinitiator (C), a hydrogen abstraction reaction also occurs from the (meth)acrylic copolymer (A), and the (meth)acrylic copolymer (A) is incorporated into a crosslinked structure, whereby a crosslinked structure having many crosslinking points can be formed.

Accordingly, the present adhesive sheet is preferably obtained by being cured using the hydrogen abstraction type photoinitiator.

[0136]

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.

[0137]

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 from 150 to 450 nm. Among these, a high-pressure mercury lamp, a metal halide lamp, and an LED lamp are preferably used.

[0138]

The irradiation amount of the active energy ray (cumulative light quantity) is preferably from 100 to 10000 mJ/cm^2, more preferably from 200 to 5000 mJ/cm^2, further preferably from 300 to 4000 mJ/cm^2, particularly preferably from 400 to 3000 mJ/cm^2, and further particularly preferably from 500 to 2000 mJ/cm^2, from the viewpoint of curing.

[0139]

The present adhesive sheet can also be provided as an adhesive sheet with a release film having a configuration in which a release film is laminated on one surface or both surfaces of the adhesive sheet. 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 sheet with a release film.

[0140]

In a case of providing the release film on both surfaces of the present adhesive sheet, it is preferable to have a laminate structure in which a light

release film having a relatively low peeling force and a heavy release film having a relatively high peeling force are laminated.

It is sufficient that when the adhesive sheet 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 sheet, 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 sheet, and an image display device constituent member (referred to as a second member) is bonded to the other surface.

[0141]

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

As the base material of the release film, for example, 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, which is subjected to a release treatment by applying a release agent such as a silicone resin, or release paper 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 can be used.

[0142]

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 from 10 to 250 μm, more preferably from 25 to 200 μm, and particularly preferably from 35 to 190 μm.

[0143]

In another embodiment of the method for producing the present adhesive sheet, the pressure-sensitive adhesive 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 sheet can be obtained 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 sheet can be adjusted by the coating thickness and the solid content concentration of a coating liquid.

[0144]

The coating method may be a known method such as roll coating, die coating, gravure coating, comma coating, screen printing, or bar coating.

[0145]

To produce the present adhesive sheet using the coating method, for example, the present adhesive sheet can be formed by dissolving the pressure-sensitive adhesive composition in a solvent, coating the release film with the dissolved adhesive composition, drying the coated adhesive composition, and curing the dried adhesive composition by irradiation with an active energy ray. Further, a release film may be laminated as necessary. In this case, the dissolved adhesive 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 adhesive 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 sheet.

[0146]

The solvent is not particularly limited as long as it dissolves the pressure-sensitive adhesive 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. These can be used alone, or two or more thereof can 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.

[0147]

The content of the solvent is usually from 1 to 600 parts by mass, preferably from 50 to 500 parts by mass, more preferably from 100 to 400 parts by mass, and particularly preferably from 150 to 300 parts by mass, with respect to 100 parts by mass of the (meth)acrylic copolymer (A), from the viewpoint of the drying property.

[0148]

The solvent content in the pressure-sensitive adhesive 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%.

[0149]

The drying temperature is usually from 40 to 150°C, more preferably from 45 to 140°C, further preferably from 50 to 130°C, and particularly preferably from 55 to 120°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.

[0150]

The drying time is usually from 1 to 30 minutes, more preferably from 3 to 25 minutes, and further preferably from 5 to 20 minutes. When the drying time is within the above range, the solvent can be efficiently and sufficiently removed.

[0151]

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. These can be used alone, or two or more thereof can be used in combination.

[0152]

In still another embodiment of the method for producing the present adhesive sheet, the present adhesive sheet may be produced by preparing a pressure-sensitive adhesive composition, coating the pressure-sensitive adhesive composition on an image display device constituent member

described below, and curing the pressure-sensitive adhesive composition. However, the method is not limited to this method.

[0153]

The present adhesive sheet may be a monolayer adhesive sheet consisting of only a pressure-sensitive adhesive layer obtained by curing a pressure-sensitive adhesive composition, or may be a multilayer adhesive sheet in which the pressure-sensitive adhesive layer or another pressure-sensitive adhesive layer formed from a pressure-sensitive adhesive composition other than the pressure-sensitive adhesive composition is laminated in a plurality of layers.

Among these, the present adhesive sheet preferably has a laminate pressure-sensitive adhesive layer in which two or more pressure-sensitive adhesive layers are laminated adjacent to each other, more preferably has at least three layers of an outermost layer, a backmost layer and an intermediate layer, and particularly preferably has a pressure-sensitive adhesive layer obtained by curing a pressure-sensitive adhesive composition in which an outermost layer and a backmost layer contain the (meth)acrylic copolymer (A). Such a layer configuration tends to provide an adhesive sheet that is excellent in impact resistance and is less likely to be indented or dented even when a local pressure is applied.

[0154]

When the present adhesive sheet has a laminate pressure-sensitive adhesive layer in which two or more pressure-sensitive adhesive layers are laminated adjacent to each other, the laminate pressure-sensitive adhesive layer is preferably a laminate pressure-sensitive adhesive layer in which two

or more pressure-sensitive adhesive layers having different shear storage moduli of elasticity (G') at 25°C are laminated adjacent to each other.

The laminate pressure-sensitive adhesive layer preferably includes a first pressure-sensitive adhesive layer having a lower shear storage modulus of elasticity at 25°C (G') than that of an adjacent pressure-sensitive adhesive layer, and a second pressure-sensitive adhesive layer having a greater shear storage modulus of elasticity at 25°C (G') than that of an adjacent pressure-sensitive adhesive layer.

[0155]

The first pressure-sensitive adhesive layer and the second pressure-sensitive adhesive layer may be formed by curing pressure-sensitive adhesive compositions containing (meth)acrylic copolymers (A) having the same composition, or may be formed by curing pressure-sensitive adhesive compositions containing (meth)acrylic copolymers (A) having different compositions, particularly containing (meth)acrylic copolymers (A) having different compositions as main components. Among them, from the viewpoint of easy adjustment of the modulus of elasticity ratio (E'/G') and functional separation of inverse properties such as stress relaxation properties and shape retention properties for each layer, the first pressure-sensitive adhesive layer and the second pressure-sensitive adhesive layer are preferably formed by curing pressure-sensitive adhesive compositions containing (meth)acrylic copolymers (A) having different compositions, particularly containing (meth)acrylic copolymers (A) having different compositions as main components.

On the other hand, from the viewpoint of easy production, the first pressure-sensitive adhesive layer and the second pressure-sensitive adhesive layer are preferably formed by curing pressure-sensitive adhesive compositions containing (meth)acrylic copolymers (A) having the same composition as main components.

[0156]

When the first pressure-sensitive adhesive layer and the second pressure-sensitive adhesive layer are formed by curing pressure-sensitive adhesive compositions containing (meth)acrylic copolymers (A) having different compositions as main components, a theoretical Tg (Tg1) of the (meth)acrylic copolymer (A) contained in the pressure-sensitive adhesive composition forming the first pressure-sensitive adhesive layer and a theoretical Tg (Tg2) of the (meth)acrylic copolymer (A) contained in the pressure-sensitive adhesive composition forming the second pressure-sensitive adhesive layer preferably satisfy the relationship Tg2 > Tg1.

[0157]

The difference (Tg2 - Tg1) between the theoretical Tg (Tg1) of the (meth)acrylic copolymer (A) contained in the pressure-sensitive adhesive composition forming the first pressure-sensitive adhesive layer and the theoretical Tg (Tg2) of the (meth)acrylic copolymer (A) contained in the pressure-sensitive adhesive composition forming the second pressure-sensitive adhesive layer is usually from 10 to 80°C, preferably from 15 to 75°C, more preferably from 20 to 70°C, particularly preferably from 30 to 65°C, and most preferably from 40 to 60°C.

[0158]

The theoretical Tg of the (meth)acrylic copolymer (A) contained in the pressure-sensitive adhesive composition forming the first pressure-sensitive adhesive layer or the second pressure-sensitive adhesive layer is a value calculated by applying the glass transition temperature (Tg) and the mass fraction of each homopolymer when the homopolymer is formed from each monomer constituting the (meth)acrylic copolymer (A) to the Fox equation shown below.

$$\frac{1}{Tg} = \frac{Wa}{Tga} + \frac{Wb}{Tgb} + \cdots + \frac{Wn}{Tgn}$$

Tg: theoretical tg (K) of acrylic resin (A)
Tga: glass transition temperature (K) of homopolymer of monomer a
Wa: mass fraction of monomer a
Tgb: glass transition temperature (K) of homopolymer of monomer b
Wb: mass fraction of monomer b
Tgn: glass transition temperature (K) of homopolymer of monomer n
Wn: mass fraction of monomer n (Wa + Wb + ... + Wn = 1)

[0159]

As the glass transition temperatures (Tg) of the homopolymers formed from the monomers constituting the (meth)acrylic copolymers (A), a value as measured by a differential scanning calorimeter (DSC) by a method in accordance with JIS K7121-1987 or JIS K6240, and a value described in a catalog are usually used.

[0160]

Further, in the first pressure-sensitive adhesive layer, the glass transition temperature (Tg) defined by the maximum value of the loss tangent (Tanδ) as obtained by the dynamic viscoelasticity measurement in the shear mode described above is preferably lower than the glass transition temperature of the second pressure-sensitive adhesive layer. The glass

transition temperature (Tg1) defined by the maximum value of the loss tangent (Tanδ) of the first pressure-sensitive adhesive layer is usually from -80 to -10°C, preferably from -70 to -15°C, more preferably from -50 to -17°C, and further preferably from -40 to -20°C.

[0161]

In the second pressure-sensitive adhesive layer, the glass transition temperature (Tg2) defined by the maximum value of the loss tangent (Tanδ) as obtained by the dynamic viscoelasticity measurement in the shear mode described above is usually from -25 to 60°C, preferably from -15 to 40°C, more preferably from -10 to 30°C, and further preferably from 0 to 20°C.

[0162]

When the present adhesive sheet has at least three layers of an outermost layer, a backmost layer and an intermediate layer, it is preferable that at least one of the outermost layer or the backmost layeris formed of the first pressure-sensitive adhesive layer, and that the intermediate layer is formed of the second pressure-sensitive adhesive layer, and it is more preferred that the pressure-sensitive adhesive layer has a three-layer configuration in which the first pressure-sensitive adhesive layer, the second pressure-sensitive adhesive layer and the first pressure-sensitive adhesive layer are laminated in this order.

[0163]

In addition, in a case where the present adhesive sheet has a laminated configuration including the first pressure-sensitive adhesive layer and the second pressure-sensitive adhesive layer, a ratio (t2/t1) of the thickness (t2) of the second pressure-sensitive adhesive layer to the

thickness (t1) of the first pressure-sensitive adhesive layer is preferably 0.2 or more, more preferably from 0.5 to 10, and particularly preferably from 1.0 to 5. When the ratio (t2/t1) of the thickness (t2) of the second pressure-sensitive adhesive layer to the thickness (t1) of the first pressure-sensitive adhesive layer is within the above range, there is a tendency that an adhesive sheet more excellent in foaming resistance during bonding, proper bonding such as level difference absorbability, and impact resistance can be obtained.

In a case where the present adhesive sheet has a three-layer configuration in which the first pressure-sensitive adhesive layer, the second pressure-sensitive adhesive layer and the first pressure-sensitive adhesive layer are laminated in this order, the thickness (t1) of the first pressure-sensitive adhesive layer represents the total thickness of the two first pressure-sensitive adhesive layers.

[0164]

The present adhesive sheet thus obtained is an optically transparent adhesive sheet. Here, the phrase "optically transparent" means that the total light transmittance is 80% or more, preferably 85% or more, and more preferably 90% or more.

The haze value of the adhesive sheet is preferably 10% or less, more preferably 5% or less, and particularly preferably 3% or less.

[0165]

The thickness of the present adhesive sheet is preferably from 50 to 1000 μm, more preferably from 60 to 500 μm, and particularly preferably from 75 to 300 μm.

[0166]

In addition, the present adhesive sheet may be embossed or formed with various irregularities (such as a conical shape, a pyramidal shape, or a hemispherical shape) as necessary. In addition, for the purpose of improving adhesiveness to various members, the surface may be subjected to various surface treatments such as a corona treatment, a plasma treatment, and a primer treatment.

[0167]

Preferred Use of Present Adhesive Sheet

The present adhesive sheet is suitably used for bonding an optical member. Specifically, the adhesive sheet is suitably used for bonding members constituting a display, particularly members used for producing a display, and is suitably used as an adhesive sheet 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.

[0168]

Laminate for Image Display Device

A laminate for an image display device according to an example of an embodiment of the present disclosure (hereinafter sometimes referred to as "the present laminate for an image display device") is a laminate for an image display device having a configuration in which two image display device constituent members are laminated via the present adhesive sheet.

[0169]

Among constituent elements of the present laminate for an image display device, the present adhesive sheet is as described above, and elements other than the adhesive sheet will be described below.

[0170]

Image Display Device Constituent Member

Examples of the image display device constituent member constituting the present laminate for an image display device include a flat panel image display device constituent member, an image display device constituent member having a curved portion, and a flexible image display device constituent member. Examples of such an image display device constituent member include an image display panel such as a liquid crystal display or an organic electroluminescence (EL) display, a surface protection panel (surface protection film), a polarizing plate, a polarizing element, a retardation film, a color filter, 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 may be used, or any two of these may be used in combination. For example, a combination of a surface protection panel and another image display device constituent member, or a combination of a surface protection panel and other image display device constituent members can be mentioned.

[0171]

It is preferable that 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, and it is more preferable that the surface protection panel has a frame-shaped concealing portion in a peripheral edge thereof, and has a portion where a width of the frame is 3 mm or less. With the above configuration, the effects of the present disclosure can be particularly exhibited. From such a viewpoint, the width of the frame is particularly preferably 2 mm or less, and especially preferably 1.5 mm or less.

[0172]

Method for Producing Present Laminate for Image Display Device

The method for producing the present laminate for an image display device is not particularly limited, and as described above, for example, the pressure-sensitive adhesive composition may be applied onto the image display device constituent member to form the adhesive sheet, or an adhesive sheet with a release film may be formed in advance and then bonded to the image display device constituent member.

[0173]

Image Display Device

An image display device according to an example of an embodiment of the present disclosure (hereinafter sometimes referred to as "the present image display device") is an image display device in which a laminate for an image display device having a configuration in which two image display device constituent members are bonded to each other via the present adhesive sheet is incorporated. For example, there can be exemplified an image display device having a structure obtained by combining a laminate for

an image display device having a configuration in which two image display device constituent members are bonded to each other via the present adhesive sheet, 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.

Examples

[0174]

The present disclosure will be described more specifically with reference to Examples below. However, the present disclosure is not limited to Examples below unless the gist of the present disclosure is exceeded.

[0175]

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

[0176]

(Meth)acrylic Copolymer (A)

(Meth)acrylic copolymers (A-1) to (A-3) having copolymerization component compositions as shown in Table 1 below were prepared.

[0177]

[Table 1]

		Constituent Unit [mass%]						Theoretical Tg (°C)	Weight-average molecular weight
		2EHA	MA	NVP	HEA	DMAA	MMA		
(Meth)acrylic copolymer (A)	A-1	46	45	9	-	-	-	-30	230000
	A-2	64	19	-	17	-	-	-50	460000
	A-3	45	15	-	-	25	15	-5	200000

2EHA: 2-ethylhexyl acrylate, MA: methyl acrylate, NVP: N-vinylpyrrolidone, HEA: hydroxyethyl acrylate, DMAA: N,N-dimethylacrylamide, MMA: methyl methacrylate

[0178]

Crosslinking Agent (B)

· (B-1): Polypropylene glycol #400 diacrylate ("NK Ester APG-400" available from SHIN-NAKAMURA CHEMICAL Co., Ltd.)

· (B-2): Pentaerythritol tri- and tetraacrylate ("NK Ester A-TMM-3L" available from SHIN-NAKAMURA CHEMICAL Co., Ltd.)

[0179]

Photoinitiator (C)

· (C-1): Mixture of 2,4,6-trimethylbenzophenone and 4-methylbenzophenone ("Esacure TZT" available from IGM Resins B.V.)

· (C-2): Methyl benzoyl formate ("Omnirad MBF" available from IGM Resins B.V.)

· (C-3): 4-Methacryloyloxybenzophenone ("MBP" available from Shinryo Corporation)

· (C-4): Ethyl (2,4,6-trimethylbenzoyl)-phenylphosphinate ("Omnirad TPO-L" available from IGM Resins B.V.)

[0180]

Ultraviolet Absorber (D)

· (D-1): 5,5'-Bis(2-ethylhexyloxy)-2,2'-[6-(4-methoxyphenyl)-1,3,5-triazine-2,4-diyl]diphenol ("Tinosorb S" available from BASF)

[0181]

Silane Coupling Agent

· (E-1): 3-Glycidyloxypropyltrimethoxysilane ("KBM-403" available from Shin-Etsu Chemical Co., Ltd.)

[0182]

Example 1

Prepared and uniformly mixed were 100 parts by mass of the (meth)acrylic copolymer (A-2), 1.5 parts by mass of the crosslinking agent (B-1), 0.83 parts by mass of the photoinitiator (C-1), 1.67 parts by mass of the photoinitiator (C-3), and 0.2 parts by mass of the silane coupling agent (E-1), to obtain a pressure-sensitive adhesive composition for a surface layer.

On the other hand, 100 parts by mass of the (meth)acrylic copolymer (A-1), 20 parts by mass of the crosslinking agent (B-2), 1.5 parts by mass of the photoinitiator (C-4), and 2.5 parts by mass of the ultraviolet absorber (D-1) were prepared and uniformly mixed to obtain a pressure-sensitive adhesive composition for an intermediate layer.

The pressure-sensitive adhesive composition for a surface layer and the pressure-sensitive adhesive composition for an intermediate layer were supplied to two extruders, respectively, and were coextruded in a layer configuration of two types and three layers (surface layer/intermediate layer/surface layer, thickness ratio of 1:1:1) and hot-melt molded into a sheet shape having a thickness of 130 μm.

[0183]

Next, the sheet-shaped pressure-sensitive adhesive composition was sandwiched between two polyethylene terephthalate films (available from Mitsubishi Chemical Corporation, thickness: 75 μm) whose surfaces were subjected to a silicone release treatment, that is, two release films, thereby obtaining a laminate composed of release film/pressure-sensitive adhesive composition/release film.

Thereafter, both surfaces of the sheet-shaped pressure-sensitive adhesive composition were irradiated with an active energy ray through the release films using a metal halide lamp in such a manner that the cumulative light quantity at a wavelength of 365 nm was 3000 mJ/cm^2, thereby obtaining a double-sided adhesive sheet with a release film composed of release film/adhesive sheet/release film.

[0184]

Examples 2 to 5 and Comparative Example 3

A double-sided adhesive sheet with a release film was produced in the same manner as in Example 1 except that the formulation, the thickness, the layer configuration, and the cumulative light quantity were changed to those shown in Table 2 below.

[0185]

Comparative Example 1

Uniformly mixed were 100 parts by mass of the (meth)acrylic copolymer (A-2), 1.5 parts by mass of the crosslinking agent (B-1), 0.83 parts by mass of the photoinitiator (C-1), 1.67 parts by mass of the photoinitiator (C-3), and 0.2 parts by mass of the silane coupling agent (E-1) to produce a pressure-sensitive adhesive composition.

[0186]

Next, the pressure-sensitive adhesive composition was spread in a sheet shape on a release film (PET film available from Mitsubishi Chemical Corporation) having a thickness of 75 μm and subjected to a silicone release treatment in such a manner that the thickness of the pressure-sensitive adhesive composition was 130 μm.

Thereafter, 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 sheet-shaped pressure-sensitive adhesive composition.

Both surfaces of the sheet-shaped pressure-sensitive adhesive composition were irradiated with an active energy ray through the release films using a metal halide lamp in such a manner that the cumulative light quantity at a wavelength of 365 nm was 1500 mJ/cm^2, thereby obtaining a double-sided adhesive sheet with a release film composed of release film/adhesive sheet/release film.

[0187]

Comparative Example 2

A double-sided adhesive sheet with a release film of Comparative Example 2 was produced in the same manner as in Comparative Example 1 except that the formulation, the thickness, and the cumulative light quantity were changed to those shown in Table 2 below.

[0188]

[Table 2]

			Example 1		Example 2		Example 3		Example 4		Example 5		Comparative Example 1	Comparative Example 2	Comparative Example 3	
			Intermediate layer	Surface layer	Intermediate layer	Surface layer	Intermediate layer	Surface layer	Intermediate layer	Surface layer	Intermediate layer	Surface layer	Monolayer	Monolayer	Intermediate layer	Surface layer
Pressure-sensitive adhesive composition	(Meth)acrylic copolymer (A)	A-1	100	-	100	-	100	-	-	-	-	-	-	100	-	100
		A-2	-	100	-	100	-	100	-	100	-	100	100	-	100	-
		A-3	-	-	-	-	-	-	100	-	100	-	-	-	-	-
	Crosslinking agent (B)	B-1	-	1.5	-	1.5	-	1.5	-	1.5	-	1.5	1.5	1.5	-	1.5
		B-2	20	-	20	-	20	-	20	-	20	-	-	-	15	-
	Photoinitiator (C)	C-1	-	0.83	-	0.83	-	0.83	-	0.83	-	0.83	0.83	-	2	-
		C-2	-	-	-	-	-	-	-	-	-	-	-	2.45	-	2.45
		C-3	-	1.67	-	1.67	-	1.67	-	1.67	-	1.67	1.67	1.05	-	1.05
		C-4	1.5	-	1.5	-	1.5	-	1.5	-	1.5	-	-	-	-	-
	Ultraviolet absorber (D)	D-1	2.5	-	1.7	-	1.4	-	2.8	-	1.4	-	-	-	-	-
	Silane coupling agent (E)	E-1	-	0.2	-	0.2	-	0.2	-	0.2	-	0.2	0.2	-	-	0.2
Double-sided adhesive sheet	Cumulative light quantity at 365 nm	mJ/cm^2	3000		3000		3000		3000		3000		1500	1000	1000	
	Thickness	μm	130		130		130		130		130		130	150	150	
	Layer configuration (surface layer: intermediate layer: surface layer)		1:1:1		1:2:1		1:3:1		1:1:1		1:4:1		Monolayer	Monolayer	1:2:1	

[0189]

Measurement and Evaluation of Physical Properties

The adhesive sheets produced in Examples and Comparative Examples were subjected to the following various measurements and evaluations. The evaluation results are summarized in Table 3 below.

[0190]

Tensile Modulus of Elasticity (E')

The double-sided adhesive sheet with a release film produced in each of Examples and Comparative Examples was cut into a piece of 20 mm wide × 70 mm long. The release film was removed from the double-sided adhesive sheet with a release film, the double-sided adhesive sheet was set in a tensile tester so that the grip distance was 20 mm, and a tensile test was performed at a rate of 300 mm/min using the tensile tester under an environment at 25°C. In the stress-strain curve obtained in the tensile test, the slope in the section of strain of from 10 to 200% was calculated, and the tensile modulus of elasticity (E') was determined.

[0191]

Shear Storage Modulus of Elasticity (G')

The release film on one side was removed from the double-sided adhesive sheet with a release film produced in each of Examples and Comparative Examples, and the double-sided adhesive sheet was repeatedly laminated with a hand roller to adjust the thickness to about 0.8 mm, and was punched out in a circular shape having a diameter of 8 mm to obtain a sample. The obtained sample was placed in a rheometer ("DHR-2" available

from T.A. Instruments), and dynamic viscoelasticity measurement was performed under conditions of a measurement jig: a parallel plate with a diameter of 8 mm, a frequency: 1 Hz, a measurement temperature: from -50 to 150°C, and a temperature rise rate: 5°C/min, and the value of shear storage modulus of elasticity at 25°C (G') was read.

[0192]

Modulus of Elasticity Ratio (E'/G')

The modulus of elasticity ratio (E'/G') was calculated from the tensile modulus of elasticity at 25°C (E') obtained in the tensile test and the shear storage modulus of elasticity (G') obtained in the dynamic viscoelasticity measurement.

[0193]

Stress Relaxation Rate (X)

The release film on one side was removed from the double-sided adhesive sheet with a release film produced in each of Examples and Comparative Examples, and the double-sided adhesive sheet was repeatedly laminated with a hand roller to adjust the thickness to about 0.8 mm, and was punched out in a circular shape having a diameter of 25 mm to obtain a sample.

A strain of 25% was applied to the obtained sample at 70°C using a viscoelasticity measurement apparatus ("DHR2" available from T.A. Instruments) and a measurement jig: a parallel plate with a diameter of 25 mm, and the storage modulus of elasticity after 0.1 seconds had elapsed was read as an initial modulus of elasticity (G'(0)). Further, a strain of 25% was applied at 70°C, and the storage modulus of elasticity after 300 seconds had

elapsed was read as a relaxation modulus of elasticity (G'(300)). The values of the initial modulus of elasticity (G’(0)) and the relaxation modulus of elasticity (G’(300)) were substituted into Equation (I) to determine a stress relaxation rate (X).

Stress relaxation rate (X) = (G'(300)/G'(0)) ··· (I)

[0194]

Gel Fraction

For the double-sided adhesive sheet with a release film produced in each of Examples and Comparative Examples, an adhesive sheet piece of about 0.1 g was collected from the adhesive sheet from which the release film was peeled off. The collected adhesive sheet 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 produce 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. Each of the measured masses was substituted into the following equation to calculate the gel fraction before light irradiation.

Gel fraction (%) = [(Z - X)/(Y - X)] × 100 ··· (II)

[0195]

Glass Transition Temperature (Tg)

The release film on one side was removed from the adhesive sheet with a release film produced in each of Examples and Comparative Examples, and the adhesive sheet was repeatedly laminated with a hand

roller to adjust the thickness to about 0.9 mm, and was punched out in a circular shape having a diameter of 8 mm to obtain a sample. The obtained sample was placed in a rheometer ("DHR-2" available from T.A. Instruments), and dynamic viscoelasticity measurement was performed under conditions of a measurement jig: a parallel plate with a diameter of 8 mm, a frequency: 1 Hz, a measurement temperature: from -50 to 150°C, and a temperature rise rate: 5°C/min.

From the spectrum of Tanδ obtained by the dynamic viscoelasticity measurement, the temperature at which Tanδ was a maximum value was read and taken as the glass transition temperature (Tg).

[0196]

Adhesive Force

The release film on one side was removed from the double-sided adhesive sheet with a release film produced in each of Examples and Comparative Examples, and a PET film (available from TOYOBO Co., Ltd., COSMOSHINE A4300, thickness: 100 μm) was attached as a backing film with a hand roller. The laminate was cut into a strip of 10 mm wide × 150 mm long, and the surface of the adhesive sheet exposed by peeling off the remaining release film was bonded to the surface of soda-lime glass with a hand roller. The obtained laminate was subjected to an autoclaving treatment (60°C, gauge pressure: 0.2 MPa, 20 minutes) for finish bonding, thereby producing a measurement sample for measuring the adhesive force.

The adhesive sheet was peeled off from the soda-lime glass together with the backing film while pulling the obtained measurement sample for measuring the adhesive force at an angle of 180° and a peeling rate of 60

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 force.

[0197]

Light Transmittance

One release film of the double-sided adhesive sheet with a release film produced in each of Examples and Comparative Examples was peeled off, and the exposed adhesive surface was roll-pressed to soda-lime glass (82 mm × 53 mm × 0.5 mm thick). Then, the remaining release film was peeled off, and the exposed adhesive surface was roll-pressed to soda-lime glass (82 mm × 53 mm × 0.5 mm thick). Thereafter, an autoclaving treatment (60°C, gauge pressure: 0.2 MPa, 20 minutes) was performed for finish bonding, thereby producing a laminate for evaluation. The spectral transmittances (%) of the laminate for evaluation at wavelengths of from 300 nm to 800 nm were measured using a spectrophotometer ("UV2000" available from Shimadzu Corporation), and the light transmittance at a wavelength of 380 nm was read.

[0198]

Bonding Appearance

The release film on one side of the adhesive sheet with a release film produced in each of Examples and Comparative Examples was peeled off, and the remaining adhesive sheet with a release film was bonded to a foam sheet having a thickness of 0.18 mm. The adhesive surface of the adhesive sheet exposed by peeling off the remaining release film was roll-pressed onto the entire surface of soda-lime glass (68 mm × 155 mm × 0.55 mm thick) by

moving a hand roller back and forth once to produce a sample for evaluation of bonding appearance.

A maximum height (Sz) of the soda-lime glass-side surface of the sample was measured in accordance with ISO 25178 using a laser microscope ("LEXT OLS4000" available from OLYMPUS CORPORATION). The measurement was performed at three points in total, one point for each of three regions obtained by dividing the sample into three equal parts in the long side direction, using a Gaussian filter with a 5 × objective lens. An average of the values measured at the three points was defined as the maximum height (Sz_1) of the sample.

[0199]

The foam sheet was laminated on the entire surface of soda-lime glass (68 mm × 155 mm × 0.55 mm thick) by moving a hand roller back and forth once to prepare a reference sample. The maximum height (Sz_0) of the reference sample was measured in the same manner as for the sample for evaluation of bonding appearance, and was 660 μm.

The measured value was substituted into the following equation to calculate a reduction rate of the maximum height (Sz).

Maximum height (Sz) reduction rate (%) = $(Sz_0 - Sz_1)/(Sz_0) \times 100$ ··· (III)

A maximum height reduction rate of 65% or more was determined as "S", a maximum height reduction rate of 60% or more and less than 65% was determined as "A", and a maximum height reduction rate of less than 60% was determined as "B".

[0200]

Impact Resistance

The release film on one side of the double-sided adhesive sheet with a release film produced in each of Examples and Comparative Examples was peeled off, and a polyimide film having a thickness of 0.05 mm was roll-pressed to the exposed adhesive surface using a hand roller. The remaining release film was peeled off, and a pressure-sensitive paper ("Prescale MS type" available from FUJIFILM Corporation) was attached to the exposed adhesive surface to prepare a sample for measuring the impact resistance.

The sample was placed on soda-lime glass (thickness: 0.55 mm) such that the polyimide film side was on the upper side, and an iron ball having a weight of 0.5 g was freely dropped from a height of 4 cm above the center of the sample.

The pressure-sensitive paper subjected to falling ball impact through the polyimide film and the double-sided adhesive sheet was observed at a magnification of 100 times using a digital microscope ("DVM 6" available from Leica), and the diameter of a circle surrounding the outer periphery of a portion color-developed by the falling ball impact was measured.

A circle having a diameter of 700 μm or less was determined as "S", a circle having a diameter of more than 700 μm and 750 μm or less was determined as "A", and a circle having a diameter of more than 750 μm was determined as "B".

[0201]

[Table 3]

			Example 1	Example 2	Example 3	Example 4	Example 5	Comparative Example 1	Comparative Example 2	Comparative Example 3
Double-sided adhesive sheet	Tensile modulus of elasticity (E')	MPa	5.4	9.0	11	11.3	9.0	0.37	0.09	1.02
	Shear storage modulus of elasticity (G')	MPa	0.16	0.22	0.28	0.19	0.37	0.06	0.17	0.37
	E'/G'	-	34	41	40	59	24	6.2	0.5	2.7
	Loss tangent (Tanδ)	-	1.8	1.8	1.8	1.8	1.7	2.0	2.5	0.86
	Glass transition temperature (Tg)	°C	-21	-20	-21	-22	-21	-25	-1.6	-21
	Stress relaxation rate (SR)	-	0.43	0.40	0.36	0.49	0.37	0.48	0.05	0.06
	Adhesive force	N/cm	5.5	4	5.3	1.6	3.3	4.4	18	12.5
	Post-UV full layer gel fraction	%	79	81	82	81	82	76	76	82
	Light transmittance	%	3.6	4.1	4.0	3.6	2.9	88	46	84
	Maximum height (Sz_1)	μm	264	261	229	218	211	288	293	266
	Maximum height (Sz) reduction rate	%	60.0%	60.5%	65.3%	66.9%	68.0%	56.4%	55.7%	59.6%
	Bonding appearance	-	A	A	S	S	S	B	B	B
	Diameter of portion subjected to falling ball impact	μm	670	681	741	747	680	604	758	747
	Impact resistance	-	S	S	A	A	S	S	B	A

[0202]

The double-sided adhesive sheets of Examples had a tensile modulus of elasticity at 25°C (E') and a modulus of elasticity ratio (E'/G') within the predetermined ranges, and were excellent in the bonding appearance and the impact resistance.

On the other hand, the double-sided adhesive sheet of Comparative Example 1 had a low tensile modulus of elasticity at 25°C (E'), and therefore, the effect of reducing the irregularities of the bonding member was poor, and the bonding appearance was poor. The double-sided adhesive sheet of Comparative Example 2 was insufficient in both the bonding appearance and the impact resistance because the values of the tensile modulus of elasticity at 25°C (E') and the modulus of elasticity ratio (E'/G') were not within the predetermined ranges. In Comparative Example 3, the value of the modulus of elasticity ratio (E'/G') was not within the predetermined range, and it was not possible to achieve the bonding appearance and the impact resistance at the same time.

[0203]

Specific embodiments of the present disclosure were described in Examples, but 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

[0204]

The double-sided adhesive sheet of the present disclosure is suitably used for bonding an optical member. Specifically, the double-sided adhesive sheet is suitably used for bonding a member constituting a display, in particular, a member used for producing a display.

Claims

[Claim 1]

A double-sided adhesive sheet comprising a pressure-sensitive adhesive layer formed by curing a pressure-sensitive adhesive composition comprising a (meth)acrylic copolymer (A),

wherein

a tensile modulus of elasticity at 25°C (E') is from 1.0 to 20 MPa, as calculated as a slope in a section of strain of from 10 to 200% in a stress-strain curve obtained by a tensile test performed at a tensile speed of 300 mm/min and a grip distance of 20 mm for a test piece of 20 mm × 70 mm, and

a modulus of elasticity ratio (E'/G') of the tensile modulus of elasticity at 25°C (E') to a shear storage modulus of elasticity at 25°C (G') as obtained by dynamic viscoelasticity measurement in a shear mode at a frequency of 1 Hz is from 15 to 100.

[Claim 2]

The double-sided adhesive sheet according to claim 1, wherein a stress relaxation rate (X) as calculated by Equation (I) is 0.50 or less, where an initial modulus of elasticity (G'(0)) is a value of a modulus of elasticity after 0.1 seconds have elapsed from application of a strain of 25% to the pressure-sensitive adhesive layer at 70°C and a relaxation modulus of elasticity (G'(300)) is a value of a modulus of elasticity after 300 seconds have elapsed from application of a strain of 25% to the pressure-sensitive adhesive layer at 70°C,

Stress relaxation rate (X) = (G'(300)/G'(0)) ··· (I).

[Claim 3]

The double-sided adhesive sheet according to claim 1 or 2, wherein the pressure-sensitive adhesive composition includes a crosslinking agent (B) and a photoinitiator (C).

[Claim 4]

The double-sided adhesive sheet according to claim 1 or 2, wherein the pressure-sensitive adhesive composition includes an ultraviolet absorber (D).

[Claim 5]

The double-sided adhesive sheet according to claim 1 or 2, wherein the double-sided adhesive sheet has a gel fraction of from 30 to 90%.

[Claim 6]

The double-sided adhesive sheet according to claim 1 or 2, wherein a glass transition temperature (Tg) defined by a maximum value of Tanδ as obtained by dynamic viscoelasticity measurement in a shear mode at a frequency of 1 Hz is -10°C or lower.

[Claim 7]

The double-sided adhesive sheet according to claim 1 or 2, wherein the (meth)acrylic copolymer (A) contains a constituent unit derived from at least

one selected from the group consisting of a hydroxy group-containing monomer (a2) and a nitrogen-containing monomer (a3).

[Claim 8]

The double-sided adhesive sheet according to claim 3, wherein the photoinitiator (C) is a hydrogen abstraction type photoinitiator.

[Claim 9]

The double-sided adhesive sheet according to claim 1 or 2, wherein the double-sided adhesive sheet comprises a laminate pressure-sensitive adhesive layer in which two or more pressure-sensitive adhesive layers having different shear storage moduli of elasticity at 25°C (G') are laminated adjacent to each other.

[Claim 10]

The double-sided adhesive sheet according to claim 9, wherein the laminate pressure-sensitive adhesive layer includes a first pressure-sensitive adhesive layer having a lower shear storage modulus of elasticity at 25°C (G') than that of an adjacent pressure-sensitive adhesive layer, and a second pressure-sensitive adhesive layer having a greater shear storage modulus of elasticity at 25°C (G') than that of an adjacent pressure-sensitive adhesive layer.

[Claim 11]

The double-sided adhesive sheet according to claim 10, wherein the laminate pressure-sensitive adhesive layer has a three-layer configuration in which the

first pressure-sensitive adhesive layer, the second pressure-sensitive adhesive layer, and the first pressure-sensitive adhesive layer are laminated in this order.

[Claim 12]

The double-sided adhesive sheet according to claim 10, wherein a pressure-sensitive adhesive composition forming the second pressure-sensitive adhesive layer includes an ultraviolet absorber (D).

[Claim 13]

The double-sided adhesive sheet according to claim 10, wherein a content of a crosslinking agent (B) contained in a pressure-sensitive adhesive composition forming the second pressure-sensitive adhesive layer is larger than a content of a crosslinking agent (B) contained in a pressure-sensitive adhesive composition forming the first pressure-sensitive adhesive layer.

[Claim 14]

The double-sided adhesive sheet according to claim 10, wherein a ratio (t2/t1) of a thickness (t2) of the second pressure-sensitive adhesive layer to a thickness (t1) of the first pressure-sensitive adhesive layer is 0.2 or more.

[Claim 15]

A double-sided adhesive sheet with a release film comprising:

the double-sided adhesive sheet according to claim 1 or 2; and

a release film laminated on the double-sided adhesive sheet.

[Claim 16]

A laminate for an image display device, the laminate comprising:

two image display device constituent members; and

the double-sided adhesive sheet according to claim 1 or 2 interposed between the two image display device constituent members.

[Claim 17]

An image display device comprising the laminate for an image display device according to claim 16.