

PRESSURE SENSITIVE ADHESIVE SHEET AND IMAGE DISPLAY DEVICE

TECHNICAL FIELD

5 **[0001]** The present invention relates to a double-sided pressure sensitive adhesive sheet and an image display device.

BACKGROUND ART

10 **[0002]** Liquid crystal displays and organic light emitting diode (OLED) displays are widely used as various kinds of image display devices of mobile phones, car navigation devices, personal computer monitors, televisions and so on. On a viewing-side outermost surface of an image display panel, a front transparent plate (also referred to as a “cover window” etc.) such as a transparent resin plate or a glass plate may be provided, for the purpose of, for example, preventing damage to the image display panel due to impact from the outer surface.

15 **[0003]** A colored layer (decorative printed layer) may be formed on the peripheral edge of a front transparent plate for the purpose of decoration and light shielding. When a pressure sensitive adhesive is bonded to a transparent member having a decorative printed layer, bubbles are easily generated on the periphery of a printing level difference portion. Accordingly, a pressure sensitive adhesive sheet having a large thickness is used to impart a level difference followability, so that a failure such as ingress of bubbles can be suppressed (see Patent Document 1). With an increase in luminance of the display device, the thickness of a decorative printed layer tends to increase for improving a light-shielding property. Accordingly, a thicker and softer pressure sensitive adhesive sheet is used for bonding a front transparent plate.

20 **[0004]** Patent Document 2 suggests that as a pressure sensitive adhesive sheet for bonding a cover window to a polarizing plate of a liquid crystal panel including an in-cell-type or an on-cell-type touch sensor, a base film-equipped pressure sensitive adhesive layer is used in which a pressure sensitive adhesive layer having specific thickness is disposed on each of both surfaces of a base film.

30 **[0005]** Heretofore, the most common image display device has been a liquid crystal display device in which a polarizing plate is disposed on the front and back side of a liquid crystal cell with a liquid crystal layer held between two glass substrates, and is combined with a light source such as a backlight. In recent years, OLED displays have been put into practical use in which an electrode and a light emitting layer are disposed on a resin film

substrate such as a polyimide film. Since the OLED is a light-emitting device, and thus does not require a light source, the screen can be thinned, curved and made flexible.

PRIOR ART DOCUMENTS

- 5 **[0006]** Patent Document 1: WO2013/161666
Patent Document 2: JP 2017-160416 A

SUMMARY OF THE INVENTION

PROBLEMS TO BE SOLVED BY THE INVENTION

- 10 **[0007]** In formation of an image display device, pressure processing such as heat pressing or pressure bonding may be performed during or after bonding an image display panel to a front transparent plate. In an image display panel including a rigid substrate such as a glass substrate, the substrate is not easily deformed, and therefore the image display panel is hardly deformed even if pressure is locally applied. On the other hand, in an
15 image display panel including a flexible substrate, the substrate is locally deformed if high pressure is locally applied to a connection portion of components or the like during pressure processing. If the local deformation does not recover even after release of the pressure and remains as a “press mark”, the local deformation may cause a defect on image display.

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MEANS FOR SOLVING THE PROBLEMS

- [0008]** When a base film-equipped double-sided pressure sensitive adhesive sheet in which a pressure sensitive adhesive layer is arranged on both surfaces of a base film is used for bonding an image display panel to a front transparent plate, it is possible to
25 suppress press marks resulting from deformation of the image display panel due to local pressure application from the back side.

- [0009]** The pressure sensitive adhesive sheet of the present invention is a base film-equipped double-sided pressure sensitive adhesive sheet, which includes a first pressure sensitive adhesive layer on one principal surface of a transparent base film and a second
30 pressure sensitive adhesive layer on the other principal surface. The thickness of the first pressure sensitive adhesive layer is larger than the thickness of the second pressure sensitive adhesive layer.

[0010] The thickness of the first pressure sensitive adhesive layer is preferably 80 μm or more, and the thickness of the second pressure sensitive adhesive layer is preferably 150

μm or less. The thickness of the transparent base film is preferably 15 to 150 μm. The in-plane retardation of the transparent base film is preferably 50 nm or less.

[0011] The base film-equipped double-sided pressure sensitive adhesive sheet can be used for forming an image display device in which a front transparent plate is disposed on the viewing-side of an image display panel. In the image display device, the first pressure sensitive adhesive layer is bonded to the front transparent plate, and the second pressure sensitive adhesive layer is bonded to the image display panel. The image display panel may include a polarizing plate on the viewing-side surface of the image display cell. Here, the polarizing plate is bonded to the second pressure sensitive adhesive layer.

[0012] The image display panel may be an OLED display including an OLED. The OLED cell may include an electrode and an organic light emitting layer on a resin film substrate.

EFFECTS OF THE INVENTION

[0013] When an image display cell is bonded to a front transparent plate with a base film-equipped pressure sensitive adhesive sheet according to the present invention, it is possible to reduce remaining press marks resulting from pressing from the back side.

BRIEF DESCRIPTION OF THE DRAWINGS

[0014] FIG. 1 is a sectional view showing an example of a configuration of a base film-equipped double-sided pressure sensitive adhesive sheet film.

FIG. 2 is a sectional view showing an example of a configuration of an image display device.

FIGS. 3 and 4 are sectional views each showing an example of a stacking configuration of an optical film with a pressure sensitive adhesive sheet.

FIG. 5 is a schematic view showing an arrangement of a sample in an impact resistance test.

DETAILED DESCRIPTION OF PREFERRED EMBODIMENTS

[0015] FIG. 1 is a cross-sectional view of a base film-equipped double-sided pressure sensitive adhesive sheet. A base film-equipped double-sided pressure sensitive adhesive sheet according to the present invention includes a first pressure sensitive adhesive layer 51 on one principal surface of a transparent base film 59 and a second pressure sensitive adhesive layer 53 on the other principal surface of the transparent base film 59.

In a configuration shown in FIG. 1, release films 21 and 23 are temporarily attached to the surfaces of pressure sensitive adhesive layers 51 and 53, respectively. FIG. 2 is a cross-sectional view showing an example of a configuration of an image display device in which a front transparent plate 7 is fixed to a viewing-side surface of an image display panel with a base film-equipped double-sided pressure sensitive adhesive sheet 15.

[0016] [Image display panel]

In an image display device 201 shown in FIG. 2, an image display panel 10 includes an image display cell 6 such as a liquid crystal cell or an OLED cell.

[0017] The image display cell 6 includes a functional layer for displaying an image and a substrate for supporting the functional layer. For example, in a liquid crystal cell, a liquid crystal layer is arranged between two transparent substrates, and the amount of light transmitted through a polarizing plate is adjusted by changing the orientation state of a liquid crystal to change the polarization state of the transmitted light. In the OLED cell, a pair of electrodes are provided on the substrate, and the amount of light emitted from the organic light emitting layer arranged between the electrodes is adjusted.

[0018] The substrate of the image display cell 6 may be a rigid substrate of glass or the like, or a flexible substrate such as a resin film. Use of a resin film substrate enables reduction of thickness and weight. Use of a resin film substrate enables formation of a curved display and a flexible display.

[0019] Examples of the image display cell including a film substrate include top emission type or bottom emission type OLED cells. The top emission type OLED cell includes a metal electrode, an organic light emitting layer and a transparent electrode in this order on a substrate, and emits light from the transparent electrode-side (side opposite to the substrate). The top emission type OLED cell includes a transparent electrode, an organic light emitting layer and a metal electrode in this order on a substrate, and emits light from the substrate-side. The organic light emitting layer may include an electron transport layer, a hole transport layer and the like in addition to the organic layer which itself functions as a light emitting layer. In the bottom emission type OLED cell, a transparent substrate is used. In the top emission type OLED cell, the substrate is not required to be transparent.

[0020] A reinforcing substrate 9 may be arranged on the back side of the image display cell 6 for the purpose of protecting and reinforcing the substrate. As the reinforcing substrate 9, a metal plate, a glass plate, a resin film or the like is used. The thickness of the reinforcing substrate is, for example, about 10 to 200 μm .

[0021] A flexible printed wiring circuit (FPC) 95 is connected to the outer peripheral edge of the image display cell 6. The FPC 95 is bent so as to wrap around the back side of the image display cell 6, and connected to a main substrate 90 disposed on the back side of the image display cell. In FIG. 2, the FPC is connected to the main substrate by inserting a terminal of the FPC 95 into a connector 91 arranged on the main substrate 90. The FPC may be connected to the main substrate by soldering or the like. In addition, the FPC can be connected to the main substrate through a lead wire. At the connection point of FPC, the connector or the soldered portion may locally have a large thickness, leading to formation of a projection.

[0022] An optical film 3 may be arranged on the viewing-side surface of the image display cell 6 with the pressure sensitive adhesive layer 4 interposed therebetween. The optical film 3 arranged on the viewing-side surface of the image display cell 6 may be a polarizing plate. The polarizing plate includes a polarizer and, in general, transparent film as polarizer protective film is laminated on both surfaces of the polarizer. The polarizer protective film on one surface or both surfaces of the polarizer may be omitted.

[0023] The polarizing plate may include an optically functional film laminated on one surface or both surfaces of the polarizer with an appropriate adhesive layer or pressure sensitive adhesive layer interposed therebetween if necessary. Examples of the optically functional film include retarders, wide-viewing films, limited-viewing (peep-preventing) films and brightness enhancement films.

[0024] In the case where the image display cell 6 is an OLED cell, the metal electrode of the OLED cell has light reflectivity, and therefore, when external light is incident to the inside of the OLED cell, the light is reflected at the metal electrode, and the reflected light looks like a mirror surface from the outside. By arranging a circularly polarizing plate as the optical film 3 on a viewing-side surface of the OLED cell, re-emission of reflected light from the metal electrode to the outside can be prevented to improve the visibility and visuality of the screen of the display device.

[0025] The image display panel 10 may be an image display panel with an in-cell-type or on-cell-type touch sensor in which a touch sensor is incorporated. When the image display panel 10 has a touch sensor function, it is not necessary to separately provide a touch sensor on the viewing-side of the image display panel 10. Therefore, in the image display device 201, the front transparent plate 7 is bonded to a viewing-side surface of the image display panel 10 with the base film-equipped double-sided pressure sensitive adhesive sheet 15 being interposed therebetween.

[0026] [Front transparent plate]

In the front transparent plate 7, a printed layer 76 is provided on the peripheral edge of one surface of a transparent flat plate 71. By disposing the front transparent plate on the viewing-side surface of the image display panel, breakage of the image display panel 10 by an impact from the outer surface can be prevented. Since the printed layer 76 is provided, a wiring member such as the FPC 95 is not viewed from the outside, and therefore the design property of the image display device is improved.

[0027] As the transparent plate 71, for example, a transparent resin plate such as that of an acryl-based resin or a polycarbonate-based resin, or a glass plate is used. The transparent plate 71 may have rigidity, or may be flexible. From the viewpoint of enhancing protectiveness for the image display panel 10, the transparent plate 71 is may be a rigid substrate, and the thickness of the transparent plate 71 is preferably 200 μm or more, more preferably 300 μm or more. The thickness of the printed layer 76 is about 10 to 100 μm .

[0028] [Base film-equipped double-sided pressure sensitive adhesive sheet]

In the base film-equipped double-sided pressure sensitive adhesive sheet 15, as shown in FIG. 2, the first pressure sensitive adhesive layer 51 disposed on one principal surface of the transparent base film 59 is bonded to the front transparent plate 7, and the second pressure sensitive adhesive layer 53 disposed on the other principal surface of the transparent base film 59 is bonded to the image display panel 10.

[0029] In the pressure sensitive adhesive sheet 15, the adhesive strength of the first pressure sensitive adhesive layer 51 to glass is preferably 2 N/10 mm or more, more preferably 4 N/10 mm or more, further preferably 5 N/10 mm or more. When the adhesive strength of the photocured pressure sensitive adhesive sheet is within the above-mentioned range, peeling of the pressure sensitive adhesive sheet from the adherend can be prevented even in case of occurrence of stress by strain or an impact of falling or the like. Preferably, the second pressure sensitive adhesive layer 53 has a high adhesive strength, like the first pressure sensitive adhesive layer. The adhesive strength is determined by a peeling test conducted at a tension speed of 300 mm/minute and a peeling angle of 180° with a glass plate used as an adherend. Unless otherwise specified, the adhesive strength is a value measured at 25°C.

[0030] The total light transmittance of the pressure sensitive adhesive sheet 15 is preferably 85% or more, more preferably 90% or more. The haze of the pressure sensitive

adhesive sheet 15 is preferably 1% or less. The thickness of the pressure sensitive adhesive sheet 15 (total thickness of the transparent base film 59 and the pressure sensitive adhesive layers 51 and 53) is preferably 120 to 1000 μm , more preferably 150 to 500 μm , further preferably 180 to 400 μm .

5 [0031] Preferably, the pressure sensitive adhesive sheet 15 has an ultraviolet shielding property. When the pressure sensitive adhesive sheet 15 has an ultraviolet shielding property, an organic layer (*e.g.*, an organic light emitting layer) contained in the polarizing plate 3 and the image display cell 6 of the image display panel 10 can be prevented from being degraded by an ultraviolet ray. The transmittance of the pressure sensitive adhesive sheet 15 at a wavelength of 380 nm is preferably 20% or less, more preferably 15% or less, further preferably 10% or less. For the pressure sensitive adhesive sheet 15 to have an ultraviolet shielding property, an ultraviolet shielding property may be imparted to one or more of the first pressure sensitive adhesive layer 51, the transparent base film 59 and the second pressure sensitive adhesive layer 53. An ultraviolet shielding property 15 can be imparted by, for example, using a resin material having an ultraviolet shielding property, such as transparent polyimide or polyethylene naphthalate, for the transparent base film 59. One or more of the transparent base film 59 and the pressure sensitive adhesive layers 51 and 53 may contain an ultraviolet absorber.

[0032] <Transparent base film>

20 A transparent resin film is used for the transparent base film 59. The total light transmittance of the transparent base film 59 is preferably 85% or more, more preferably 90% or more. The resin material constituting the transparent base film 59 is not particularly limited as long as it has transparency. Examples of the resin include polyesters such as polyethylene terephthalate and polyethylene naphthalate; polyolefins 25 such as polyethylene and polypropylene; cyclic polyolefins such as norbornene-based polymers; cellulose-based polymers such as diacetyl cellulose and triacetyl cellulose; acryl-based polymers; styrene-based polymers; polycarbonate, polyamide, polyimide, and polyether ether ketone.

[0033] The transparent base film 59 may have functional layers such as an adhesion 30 enhancing layer or an antistatic layer on a surface of the film. The transparent base film 59 may have a function as a touch sensor. When the transparent base film 59 has a function as a touch sensor, an electrode for position detection is arranged on a surface of the film. On the other hand, when the image display panel 10 has a touch sensor function, it is not necessary to provide a touch sensor on the viewing-side of the image display panel

10. Therefore, the transparent base film 59 is not required to include an electrode for position detection.

[0034] Since a transparent base film is disposed between two pressure sensitive adhesive layers 51 and 53, elasticity of the pressure sensitive adhesive sheet 15 as a whole is enhanced, so that restoring force against deformation increases. Thus, even if the image display panel is deformed by pressing from the back side of the image display panel 10, the pressure sensitive adhesive sheet 15 is less plastically deformed, so that remaining press marks can be reduced by restoring force of the base film. The thickness of the transparent base film 59 is preferably 15 to 150 μm , more preferably 25 to 120 μm , further preferably 35 to 100 μm .

[0035] From the viewpoint of suppressing rainbow-like coloring (iris phenomenon) at the time of viewing the screen of the image display device, it is preferable that the transparent base film 59 has optical isotropy. The in-plane retardation of the transparent base film 59 at a wavelength of 590 nm is preferably 50 nm or less, more preferably 30 nm or less, further preferably 10 nm or less, especially preferably 5 nm or less.

[0036] <Pressure sensitive adhesive layer>

The thickness of the first pressure sensitive adhesive layer 51 is larger than the thickness of the second pressure sensitive adhesive layer 53. The thickness of the second pressure sensitive adhesive layer 53 is preferably 0.2 to 0.85 times, more preferably 0.3 to 0.8 times, further preferably 0.4 to 0.75 times the thickness of the first pressure sensitive adhesive layer 51.

[0037] Since the thickness of the first pressure sensitive adhesive layer 51 is relatively large, the level difference followability of the front transparent plate 7 to the printed layer 76 tends to be enhanced. The thickness of the first pressure sensitive adhesive layer 51 is preferably 80 μm or more from the viewpoint of securing level difference followability and impact resistance. The thickness of the first pressure sensitive adhesive layer 51 may be 100 μm or, more or 120 μm or more. When the first pressure sensitive adhesive layer 51 is bonded to a front transparent plate having the printed layer 76, the thickness of the first pressure sensitive adhesive layer 51 is preferably larger than the thickness of the printed layer 76.

[0038] The upper limit of the thickness of the first pressure sensitive adhesive layer 51 is not particularly limited, and is preferably 500 μm or less, more preferably 300 μm or less, further preferably 250 μm or less, from the viewpoint of, for example, productivity and processing dimension stability.

[0039] Since the thickness of the second pressure sensitive adhesive layer 53 is relatively small, plastic deformation by pressing from the image display panel 10-side is reduced. Even if the image display panel 10 is deformed by pressing from the back side, the pressure sensitive adhesive sheet 15 is less plastically deformed, so that remaining of press marks can be reduced.

[0040] From the viewpoint of reducing plastic deformation to reduce print marks, the thickness of the second pressure sensitive adhesive layer 53 is preferably 150 μm or less, more preferably 120 μm or less. The thickness of the second pressure sensitive adhesive layer 53 may be 100 μm or less, or 80 μm or less. From the viewpoint of imparting impact resistance, the thickness of the second pressure sensitive adhesive layer 53 is preferably 30 μm or more, more preferably 50 μm or more.

[0041] When the image display panel is bonded to the front transparent plate with a base film-less single-layer pressure sensitive adhesive sheet interposed therebetween, small thickness of the pressure sensitive adhesive sheet may result in insufficient followability to the printing level difference of the front transparent plate, and large thickness of the pressure sensitive adhesive sheet may result in remaining of press marks caused by pressing from the panel-side due to considerable plastic deformation of the pressure sensitive adhesive sheet. In a base film-equipped pressure sensitive adhesive sheet, which includes the transparent base film 59 between the two pressure sensitive adhesive layers 51 and 53, level difference followability can be secured with the first pressure sensitive adhesive layer 51 having a relatively large thickness. The second pressure sensitive adhesive layer 53 having a relatively small thickness is less plastically deformed, and thus deformation of the second pressure sensitive adhesive layer 53 due to pressing from the back side is easily restored by elastic restoring force of the transparent base film 59, so that remaining of press marks can be suppressed.

[0042] From the viewpoint of enhancing adhesion retaining force in bonding of the pressure sensitive adhesive sheet 15 to an adherend and securing processing dimensional stability, the shear storage elastic modulus at 25°C ($G'_{25^\circ\text{C}}$) of the first pressure sensitive adhesive layer 51 is preferably 0.16 MPa or more, more preferably 0.18 MPa or more, further preferably 0.20 MPa or more, especially preferably 0.21 MPa or more.

[0043] On the other hand, from the viewpoint of imparting moderate viscosity to secure wettability, and imparting level difference followability and a cushion property against impacts from falling etc., the storage elastic modulus $G'_{25^\circ\text{C}}$ of the first pressure sensitive adhesive layer 51 is preferably 0.5 MPa or less, more preferably 0.4 MPa or less, further

preferably 0.3 MPa or less, especially preferably 0.28 MPa or less.

[0044] From the viewpoint of imparting level difference followability to the pressure sensitive adhesive sheet 15, the loss tangent at 70°C ($\tan\delta_{70^\circ\text{C}}$) of the first pressure sensitive adhesive layer 51 is preferably 0.25 or more, more preferably 0.30 or more, further preferably 0.35 or more. The loss tangent $\tan\delta_{70^\circ\text{C}}$ may be 0.40 or more, 0.45 or more, 0.50 or more, or 0.55 or more. From the viewpoint of adhesion retaining force, the loss tangent $\tan\delta_{70^\circ\text{C}}$ is preferably 1.0 or less, more preferably 0.9 or less, further preferably 0.85 or less. The loss tangent $\tan\delta_{70^\circ\text{C}}$ may be 0.80 or less, 0.75 or less, or 0.70 or less.

[0045] The $\tan\delta$ peak-top value of the first pressure sensitive adhesive layer 51 is preferably 1.5 or more, more preferably 1.6 or more, further preferably 1.7 or more. A pressure sensitive adhesive having a large $\tan\delta$ peak-top value tends to have a high viscous behavior, leading to excellent impact resistance. The upper limit of the $\tan\delta$ peak-top value of the first pressure sensitive adhesive layer 51 is not particularly limited, and is typically 3.0 or less. From the viewpoint of adhesion retaining force, the $\tan\delta$ peak-top value is preferably 2.7 or less, more preferably 2.5 or less.

[0046] The glass transition temperature of the first pressure sensitive adhesive layer 51 is preferably -3°C or lower, more preferably -4°C or lower. The glass transition temperature of the first pressure sensitive adhesive layer 51 is preferably -20°C or higher, more preferably -15°C or higher, further preferably -13°C or higher. When the glass transition temperature is within the above-described range, the pressure sensitive adhesive has an appropriate viscosity even in a low temperature region, and peeling of the adherend due to impacts from falling etc. tends to be suppressed.

[0047] The shear storage elastic modulus G' , loss tangent $\tan\delta$ and glass transition temperature are determined by viscoelasticity measurement at 1 Hz. The $\tan\delta$ is a ratio G''/G' between the storage elastic modulus G' and the loss elastic modulus G'' , and the glass transition temperature is a temperature at which $\tan\delta$ is maximum (peak-top temperature). The storage elastic modulus G' corresponds to a part stored as elastic energy in deformation of a material, and is an index indicating a degree of hardness. As the storage elastic modulus increases, the adhesion retaining force tends to become higher, leading to suppression of peeling caused by strain. The loss elastic modulus G'' corresponds to a loss energy part scattered and lost by internal friction etc. in deformation of a material, and indicates the degree of viscosity. As the loss tangent ($\tan\delta$) increases,

the pressure sensitive adhesive sheet tends to become more viscous, and exhibit a deformation behavior closer to that of liquid, leading to a decrease in rebound elastic energy.

5 [0048] From the viewpoint of imparting moderate flexibility for imparting a level difference followability while securing processing dimensional stability by setting the storage elastic modulus $G'_{25^{\circ}\text{C}}$ to 0.16 MPa or more, the gel fraction of the pressure sensitive adhesive is preferably 30 to 80%, more preferably 35 to 70%. The gel fraction may be 40% or more, 45% or more and may be 65% or less, or 60% or less.

10 [0049] The gel fraction of the pressure sensitive adhesive can be determined as a content of components insoluble in a solvent such as ethyl acetate, and specifically, the gel fraction is determined as a weight fraction (unit: % by weight) of insoluble components after immersion of the pressure sensitive adhesive layer in ethyl acetate at 23°C for 7 days to the sample before immersion. Generally, the gel fraction of the polymer is equal to a crosslinked degree, and the gel fraction becomes higher as the number of crosslinked
15 moieties in the polymer increases. The gel fraction (introduction amount of crosslinked structure) can be adjusted within a desired range by a method for introducing a crosslinked structure, the type and the amount of a crosslinker, and the like.

[0050] The second pressure sensitive adhesive layer 53 is not particularly limited as long as it has a thickness as described above. The pressure sensitive adhesive of the first
20 pressure sensitive adhesive layer 51 may be identical to or different from the pressure sensitive adhesive of the second pressure sensitive adhesive layer 53. From the viewpoint of enhancing adhesion retaining force, dimensional stability and impact resistance, the shear storage elastic modulus at 25°C ($G'_{25^{\circ}\text{C}}$), the loss tangent at 70°C ($\tan\delta_{70^{\circ}\text{C}}$), the $\tan\delta$ peak-top value, the glass transition temperature and the gel fraction of the second
25 pressure sensitive adhesive layer 53 are preferably within the ranges described above for the first pressure sensitive adhesive layer 51.

[0051] [Compositions of Pressure Sensitive Adhesive]

Composition of the pressure sensitive adhesive constituting the first pressure sensitive adhesive layer 51 and the second pressure sensitive adhesive layer 53 is not
30 particularly limited, and pressure sensitive adhesives containing a base polymer such as an acryl-based polymer, a silicone-based polymer, a polyester, a polyurethane, a polyamide, a polyvinyl ether, a vinyl acetate/vinyl chloride copolymer, a modified polyolefin, an epoxy-based polymer, a fluorine-based polymer, or a polymer based on a rubber such as a natural rubber or a synthetic rubber can be appropriately selected. Particularly, an acryl-based

pressure sensitive adhesive including an acryl-based base polymer having a crosslinked structure is preferably used because it is excellent in optical transparency, exhibits moderate wettability, cohesive strength and pressure sensitive adhesive properties such as adhesiveness, and is also excellent in weather resistance, heat resistance and the like.

5 **[0052]** The acryl-based base polymer contains a (meth)acrylic acid alkyl ester as a main constituent monomer component. In this specification, the “(meth)acryl” means acryl and/or methacryl.

10 **[0053]** As the (meth)acrylic acid alkyl ester, a (meth)acrylic acid alkyl ester with the alkyl group having 1 to 20 carbon atoms is preferably used. The alkyl group of the (meth)acrylic acid alkyl ester may have a branch or may have a cyclic alkyl group.

15 **[0054]** Specific examples of the (meth)acrylic acid alkyl ester having a linear or branched alkyl group include methyl (meth)acrylate, ethyl (meth)acrylate, butyl (meth)acrylate, isobutyl (meth)acrylate, s-butyl (meth)acrylate, t-butyl (meth)acrylate, pentyl (meth)acrylate, isopentyl (meth)acrylate, neopentyl (meth)acrylate, hexyl (meth)acrylate, heptyl (meth)acrylate, 2-ethylhexyl (meth)acrylate, octyl (meth)acrylate, isooctyl (meth)acrylate, nonyl (meth)acrylate, isononyl (meth)acrylate, decyl (meth)acrylate, isodecyl (meth)acrylate, undecyl (meth)acrylate, dodecyl (meth)acrylate, isotridodecyl (meth)acrylate, tetradecyl (meth)acrylate, isotetradecyl (meth)acrylate, pentadecyl (meth)acrylate, cetyl (meth)acrylate, heptadecyl (meth)acrylate, octadecyl (meth)acrylate, isooctadecyl (meth)acrylate, nonadecyl (meth)acrylate and aralkyl (meth)acrylate.

20 **[0055]** Specific examples of the (meth)acrylic acid alkyl ester having a cycloaliphatic alkyl group include (meth)acrylic acid cycloalkyl esters such as cyclopentyl (meth)acrylate, cyclohexyl (meth)acrylate, cycloheptyl (meth)acrylate and cyclooctyl (meth)acrylate; (meth)acrylic acid esters having a dicyclic aliphatic hydrocarbon ring, such as isobornyl (meth)acrylate; and (meth)acrylic acid esters having a tri-or-more-cyclic aliphatic hydrocarbon ring, such as dicyclopentanyl (meth)acrylate, dicyclopentanyloxyethyl (meth)acrylate, tricyclopentanyl (meth)acrylate, 1-adamantyl (meth)acrylate, 2-methyl-2-adamantyl (meth)acrylate and 2-ethyl-2-adamantyl (meth)acrylate.

30 **[0056]** The amount of the (meth)acrylic acid alkyl ester based on the total amount of monomer components for forming an acryl-based base polymer is preferably 50% by weight or more, more preferably 55% by weight or more, further preferably 60% by weight or more. From the viewpoint of ensuring that the glass transition temperature (T_g) of the base polymer is within an appropriate range, the amount of the (meth)acrylic acid alkyl ester having a linear or branched alkyl group having 4 to 10 carbon atoms based on the

total amount of constituent monomer components of the acryl-based base polymer is preferably 40% by weight or more, more preferably 50% by weight or more, further preferably 55% by weight or more. The monomer components of the acryl-based base polymer are the monomer components of the polymer but crosslinker and monomers for forming a crosslinked structure (*e.g.*, polyfunctional (meth)acrylates and urethane (meth)acrylates as described later) are excluded.

[0057] The acryl-based base polymer may contain a hydroxy group-containing monomer and a carboxy group-containing monomer as constituent monomer components. When a crosslinked structure is introduced by an isocyanate crosslinker, the hydroxy group forms a reaction point with an isocyanate group, and when the crosslinked structure is introduced by an epoxy-based crosslinker, the carboxy group forms a reaction point with an epoxy group.

[0058] Examples of the hydroxy group-containing monomer include (meth)acrylic acid esters such as 2-hydroxyethyl (meth)acrylate, 2-hydroxypropyl (meth)acrylate, 4-hydroxybutyl (meth)acrylate, 6-hydroxyhexyl (meth)acrylate, 8-hydroxyoctyl (meth)acrylate, 10-hydroxydecyl (meth)acrylate, 12-hydroxylauryl (meth)acrylate and (4-hydroxymethylcyclohexyl)-methyl (meth)acrylate. When a crosslinked structure is introduced into the acryl-based base polymer chain by a urethane-based segment, it is preferable that the acryl-based base polymer contains as a constituent monomer component a (meth)acrylic acid ester having a hydroxyalkyl group having 4 to 8 carbon atoms, from the viewpoint of high compatibility with the urethane-based segment and improvement of the transparency of the pressure sensitive adhesive.

[0059] When the acryl-based base polymer contains a hydroxyalkyl group containing monomer as a constituent monomer component, the transparency of the pressure sensitive adhesive tends to be improved, and cloudiness under a high-temperature and high-humidity environment tends to be suppressed. The hydroxy group of the hydroxy group-containing monomer can form a physical crosslinkage with an acryl-based polymer or a crosslink segment by hydrogen bonding. Thus, by increasing the ratio of hydroxy group-containing monomers in monomer components of the acryl-based base polymer, cohesive force tends to be enhanced, leading to an increase in $G'_{25^{\circ}\text{C}}$. The amount of the hydroxy group-containing monomer based on the total amount of monomer components of the acryl-based base polymer is preferably 5 to 30 wt%, more preferably 8 to 25 wt%, further preferably 10 to 20 wt%.

[0060] Examples of the carboxy group-containing monomer include acryl-based

monomers such as (meth)acrylic acid, carboxyethyl (meth)acrylate and carboxypentyl (meth)acrylate, and unsaturated fatty acids such as itaconic acid, maleic acid, fumaric acid and crotonic acid.

[0061] The acryl-based base polymer may contain a nitrogen-containing monomer as the constituent monomer component. Examples of the nitrogen-containing monomer include vinyl-based monomer such as N-vinylpyrrolidone, methylvinylpyrrolidone, vinylpyridine, vinylpiperidone, vinylpyrimidine, vinylpiperazine, vinylpyrazine, vinylpyrrole, vinylimidazole, vinyloxazole, vinylmorpholine, (meth)acryloylmorpholine, N-vinylcarboxylic acid amides and N-vinylcaprolactam; and cyano group-containing acryl-based monomers such as acrylonitrile and methacrylonitrile. Among them, N-vinylpyrrolidone is preferable because it considerably contribute to enhancement of adhesive strength by improvement of cohesive force.

[0062] When the acryl-based base polymer contains high-polarity monomers such as a hydroxy group-containing monomer, a carboxy group-containing monomer and a nitrogen-containing monomer as constituent monomer components, the cohesive force of the pressure sensitive adhesive tends to be enhanced and $G'_{25^{\circ}\text{C}}$ is increased, leading to improvement of adhesion retainability. On the other hand, when the content of the high-polarity monomer is too large, glass transition temperature becomes high, leading to leading to deterioration of impact resistance. Therefore, the amount of high-polarity monomers (total of a hydroxy group-containing monomer, a carboxy group-containing monomer and a nitrogen-containing monomer) based on the total amount of monomer components for forming the acryl-based base polymer is preferably 15 to 45% by weight, more preferably 20 to 40% by weight, further preferably 25 to 37% by weight. Specifically, it is preferable the total of the hydroxy group-containing monomer and the nitrogen-containing monomer is within the above range. The amount of the nitrogen-containing monomer based on the total amount of monomer components for forming the acryl-based base polymer is preferably 7 to 30% by weight, more preferably 10 to 25% by weight, further preferably 12 to 22% by weight.

[0063] Besides the above-described monomer components, the acryl-based base polymer may contain other monomer components. Examples of the monomer components include: vinyl-based monomers such as acid anhydride group-containing monomers, caprolactone adducts of acrylic acids, sulfonic acid group-containing monomers, phosphoric acid group-containing monomers, styrene and α -methylstyrene; cyano group-containing acryl-based

monomers such as acrylonitrile and methacrylonitrile; epoxy group-containing monomers such as glycidyl (meth)acrylate; glycol-based acryl ester monomers such as polyethylene glycol (meth)acrylate, polypropylene glycol (meth)acrylate, methoxyethylene glycol (meth)acrylate and methoxypolypropylene glycol (meth)acrylate; and acrylic acid ester-based monomers such as tetrahydrofurfuryl (meth)acrylate, fluorine (meth)acrylate, silicone (meth)acrylate and 2-methoxyethyl (meth)acrylate.

[0064] Preferably, the acryl-based base polymer contains a (meth)acrylic acid alkyl ester in the largest amount among the above-mentioned monomer components. The properties of the pressure sensitive adhesive are apt to depend on the type of a monomer contained in the largest amount among the constituent monomers of the base polymer (main monomer). For example, when the main monomer is a (meth)acrylic acid alkyl ester having a linear or branched alkyl group having 6 or less carbon atoms, the $\tan\delta_{70^{\circ}\text{C}}$ tends to increase, leading to improvement of level difference followability. Particularly, when the main monomer is an acrylic acid C_4 -alkyl ester such as butyl acrylate, the $\tan\delta_{70^{\circ}\text{C}}$ tends to increase. The amount of the (meth)acrylic acid alkyl ester having a linear or branched alkyl group having 6 or less carbon atoms is preferably 40 to 85% by weight, more preferably 45 to 80% by weight, further preferably 50 to 75% by weight based on the total amount of monomer components for forming the acryl-based base polymer. Particularly, the content of butyl acrylate as a constituent monomer component is preferably within the above-mentioned range.

[0065] The theoretical T_g of the acryl-based base polymer is preferably -50°C or higher. The theoretical T_g of the acryl-based base polymer is preferably -10°C or lower, more preferably -20°C or lower, further preferably -25°C or lower. The theoretical T_g is calculated from the glass transition temperature T_{gi} of a homopolymer of a constituent monomer component of the acryl-based base polymer and the weight fraction (W_i) of each monomer component of accordance with the following Fox equation:

$$1/T_g = \Sigma(W_i/T_{gi}).$$

[0066] T_g represents a glass transition temperature (unit: K) of the polymer, W_i represents a weight fraction (copolymerization ratio on a weight basis) of a monomer component i forming the polymer, and T_{gi} represents a glass transition temperature (unit: K) of a homopolymer of the monomer component i . As the glass transition temperature of the homopolymer, the value described in Polymer Handbook, 3rd edition (John Wiley & Sons, Inc., 1989) can be referred. As the T_g of a homopolymer of a monomer which is not

described in the document, a loss tangent ($\tan\delta$) peak-top temperature obtained by dynamic viscoelasticity measurement may be employed.

[0067] A polymer having crosslinked structure may be obtained by, for example, (1) a method in which a base polymer having a functional group capable of reacting with a crosslinker is prepared, and the crosslinker is then added to react the base polymer with the crosslinker; and (2) a method in which a photopolymerizable polyfunctional compound is incorporated in polymerization components of a base polymer to introduce a branched structure (crosslinked structure) into the polymer chain. These methods may be adopted in combination to introduce multiple kinds of crosslinked structure into the base polymer.

[0068] Specific examples of the crosslinker in the method (1) above in which base polymer and crosslinker are reacted include isocyanate-based crosslinkers, epoxy-based crosslinkers, oxazoline-based crosslinkers, aziridine-based crosslinkers, carbodiimide-based crosslinkers and metal chelate-based crosslinkers. In particular, isocyanate-based crosslinkers and epoxy-based crosslinkers are preferable because they have high reactivity with the hydroxy group and the carboxy group of the base polymer, so that introduction of a crosslinked structure is facilitated. Such a crosslinker forms a crosslinked structure by reacting with functional groups such as a hydroxy group and a carboxy group which are introduced into the base polymer. In an acid-free pressure sensitive adhesive in which the base polymer does not contain a carboxy group, it is preferable to form a crosslinked structure by use of an isocyanate-based crosslinker, *i.e.*, by reaction of a hydroxy group in the base polymer with the isocyanate crosslinker.

[0069] As an isocyanate-based crosslinker, a polyisocyanate having two or more isocyanate groups per molecule is used. Examples of the isocyanate-based crosslinker include lower aliphatic polyisocyanates such as butylene diisocyanate and hexamethylene diisocyanate; cycloaliphatic isocyanates such as cyclopentylene diisocyanate, cyclohexylene diisocyanate and isophorone diisocyanate; aromatic isocyanates such as 2,4-tolylene diisocyanate, 4,4'-diphenylmethane diisocyanate and xylylene diisocyanate; isocyanate adducts such as trimethylolpropane/tolylene diisocyanate trimer adducts (*e.g.* "CORONATE L" manufactured by Tosoh Corporation), trimethylolpropane/hexamethylene diisocyanate trimer adducts (*e.g.* "CORONATE HL" manufactured by Tosoh Corporation), trimethylolpropane adducts of xylylene diisocyanate (*e.g.* "TAKENATE D110N" manufactured by Mitsui Chemicals, Incorporated) and isocyanurate forms of hexamethylene diisocyanate (*e.g.* "CORONATE HX" manufactured by Tosoh Corporation). By using a urethane prepolymer having an isocyanate group at

the terminal as the isocyanate-based crosslinker, crosslinked structure by urethane-based segment can be introduced.

5 [0070] In the method (2) in which a polyfunctional monomer is added to the polymerization component for the base polymer, the total amount of a monomer component for forming the acryl-based base polymer and the polyfunctional compound for introducing a crosslinked structure may be reacted at once, or polymerization may be performed in a multiple stages. For performing polymerization in multiple stages, a method is preferable in which a monofunctional monomer for forming a base polymer are polymerized (prepolymerization) to form a partially polymerized product (prepolymer composition), and a polyfunctional compound such as a polyfunctional (meth)acrylate is added in the prepolymer composition to polymerize the prepolymer composition and the polyfunctional monomer (main polymerization). The prepolymer composition is a partially polymerized product containing a polymerized product with a low polymerization ratio and an unreacted monomer.

15 [0071] By performing prepolymerization of a constituent component of the acryl-based base polymer, branch points (crosslinked points) with a polyfunctional compound can be uniformly introduced into the base polymer. In addition, the pressure sensitive adhesive layer can also be formed by applying a mixture of a low-molecular-weight polymer or a partially polymerized product and an unpolymerized monomer component (pressure sensitive adhesive composition) onto a substrate, and then performing main polymerization on the substrate. A low-polymerization composition such as a prepolymer composition has a low viscosity, and is thus excellent in application property, and therefore by using a method in which a pressure sensitive adhesive composition that is a mixture of a prepolymer composition and a polyfunctional compound is applied, and then main polymerization is performed on a substrate, productivity of the pressure sensitive adhesive sheet can be improved, and the thickness of the pressure sensitive adhesive layer can be made uniform.

25 [0072] Examples of the polyfunctional compound to be used for introducing a crosslinked structure include compounds having two or more polymerizable functional groups having an unsaturated double bond (ethylenically unsaturated group) in one molecule. The polyfunctional compound is preferably a polyfunctional (meth)acrylate because it is easily copolymerized with the monomer component of the acryl-based base polymer. When a branched (crosslinked) structure is introduced by active energy ray polymerization (photopolymerization), a polyfunctional acrylate is preferable as the polyfunctional

compound.

[0073] Examples of the polyfunctional compound include polyethylene glycol di(meth)acrylate, polypropylene glycol di(meth)acrylate, polytetramethylene glycol di(meth)acrylate, bisphenol A ethylene oxide-modified di(meth)acrylate, bisphenol A propylene oxide-modified (meth)acrylate, alkanediol di(meth)acrylate, tricyclodecane dimethanol di(meth)acrylate, ethoxylated isocyanuric acid triacrylate, pentaerythritol tri(meth)acrylate, pentaerythritol di(meth)acrylate, trimethylolpropane tri(meth)acrylate, ditrimethylolpropane tetra(meth)acrylate, ethoxylated pentaerythritol tetra(meth)acrylate, pentaerythritol tetra(meth)acrylate, dipentaerythritol poly(meth)acrylate, dipentaerythritol hexa(meth)acrylate, neopentyl glycol di(meth)acrylate, glycerin di(meth)acrylate, epoxy (meth)acrylate, butadiene (meth)acrylate and isoprene (meth)acrylate.

[0074] A crosslinked structure by a urethane-based segment can be introduced by using a urethane (meth)acrylate having a (meth)acryloyl group at a terminal of a polyurethane chain as the poly functional (meth)acrylate. When the acryl-based base polymer is crosslinked with a urethane-based segment, a pressure sensitive adhesive in which low glass transition temperature and high adhesion retaining force are compatible can be attained easily. The urethane-based segment is a molecular chain having a urethane bond, and both terminals of the urethane-based segment are covalently bonded to the acryl-based polymer, so that a crosslinked structure is introduced into the acryl-based polymer chain. The urethane-based segment typically includes a polyurethane chain obtained by reacting diol and diisocyanate.

[0075] The molecular weight of the polyurethane chain in the urethane-based segment is preferably 5000 to 30000, more preferably 6000 to 23000, further preferably 7000 to 20000. The larger the molecular weight of the polyurethane chain in the urethane-based segment increases, the longer the distance between crosslinked points of the acryl-based polymer chain. When the molecular weight of the polyurethane chain is within the above-described range, the polymer having crosslinked structure has appropriate cohesiveness and fluidity, so that it is possible to achieve all of adhesive strength, level difference followability and impact resistance.

[0076] When the molecular weight of the polyurethane chain is excessively small, and thus the distance between the crosslinked points is short, an increase in cohesive force tends to decrease $\tan\delta$, leading to deterioration of level difference followability and impact resistance. On the other hand, when the molecular weight of the polyurethane chain is

excessively large, and thus the distance between crosslinked points is long, the storage elastic modulus may be low, leading to an insufficient adhesion retaining force. Even if the polyurethane chain has a large molecular weight, the storage elastic modulus can be increased by increasing the amount of urethane-based segments to enhance the gel fraction. However, a polyurethane chain having a large molecular weight has low compatibility with an acryl-based polymer, and an increase in the amount of urethane-based segments may increase the haze of a pressure sensitive adhesive, leading to deterioration of transparency.

[0077] When the amount of the urethane-based segment is excessively large, the viscosity of the pressure sensitive adhesive may be reduced due to an increase in gel fraction, leading to deterioration of the level difference followability and impact resistance.

In addition, when the amount of the urethane-based segment is excessively large, the transparency of the pressure sensitive adhesive may be deteriorated, leading to an increase in haze. Thus, the amount of the urethane-based segment in the base polymer is

preferably 10 parts by weight or less, more preferably 7 parts by weight or less, further preferably 5 parts by weight or less, based on 100 parts by weight of the acryl-based polymer. On the other hand, from the viewpoint of the gel fraction and imparting adhesion retaining force, the amount of the urethane-based segment in the base polymer is preferably 0.3 parts by weight or more, more preferably 0.4 parts by weight or more, further preferably 0.5 parts by weight or more, based on 100 parts by weight of the acryl-based polymer. The amount of urethane-based segments in the base polymer may be 4 parts by weight or less, or 3 parts by weight or less, and may be 0.7 parts by weight or more, or 1 part by weight or more, based on 100 parts by weight of the acryl-based polymer.

[0078] Examples of the diol to be used for formation of the polyurethane chain include low-molecular-weight diols such as ethylene glycol, diethylene glycol, propylene glycol, butylene glycol and hexamethylene glycol; and high-molecular-weight polyols such as polyester polyol, polyether polyol, polycarbonate polyol, acryl polyol, epoxy polyol and caprolactone polyol.

[0079] The diisocyanate to be used for formation of the polyurethane chain may be either an aromatic or aliphatic diisocyanate. A derivative of an isocyanate compound may also be used as the diisocyanate. Examples of the derivative of an isocyanate compound include dimers of polyisocyanate, trimers of isocyanate (isocyanurates), polymeric MDI, adducts with trimethylolpropane, biuret modified products, allophanate modified products and urea modified products. As the diisocyanate component, a urethane prepolymer having an

isocyanate group at the terminal may be used.

[0080] Among the exemplified polyurethane chains, those including a polyether urethane having a polyether polyol as a diol component and/or a polyester urethane having polyester polyol as a diol component are preferable because these components have high compatibility with an acryl-based polymer. In particular, when a crosslinked structure is introduced with polyester urethane, the storage elastic modulus at room temperature tends to increase, leading to improvement of adhesion retaining force and processability. One reason is that polyester has a more rigid molecular structure as compared to polyether etc. It is considered that when the crosslinked structure is introduced with rigid segments, the storage elastic modulus is increased because movement of the polymer is restricted, while impact resistance and level difference followability are exhibited because the distance between crosslinked points in the polymer is retained.

[0081] When a compound having at the terminal of a polyurethane chain a polyfunctional group copolymerizable with a monomer component for forming an acryl-based polymer chain, or a compound having at the terminal of a polyurethane chain a functional group capable of reacting with a carboxy group, a hydroxy group or the like contained in an acryl-based polymer chain is used, a crosslinked structure can be introduced into the acryl-based polymer chain by a urethane-based segment. It is preferable that a crosslinked structure is introduced by a urethane-based segment using a urethane di(meth)acrylate having a (meth)acryloyl group at both terminals of a polyurethane chain because crosslinked points are easily introduced uniformly into the acryl-based polymer chain, and excellent compatibility between the acryl-based polymer chain and the urethane-based segment is exhibited.

[0082] The urethane di(meth)acrylate having a (meth)acryloyl group at both terminals is obtained by, for example, using a (meth)acrylic compound having a hydroxy group, in addition to a diol component, in polymerization of polyurethane. From the viewpoint of controlling the chain length (molecular weight) of the urethane-based segment, it is preferable that an isocyanate-terminated polyurethane is synthesized by reacting a diol with a diisocyanate in such a manner that the isocyanate is in surplus, and a (meth)acrylic compound having a hydroxy group is then added to react the isocyanate group at the terminal of the polyurethane with a hydroxy group of the (meth)acrylic compound.

[0083] By reacting a polyhydric alcohol with a polyisocyanate compound in such a manner that the polyisocyanate compound is in surplus, a polyurethane chain having an isocyanate group at the terminal is obtained. For obtaining an isocyanate-terminated

polyurethane, a diol component and a diisocyanate component may be used in such a manner that the NCO/OH ratio (equivalent ratio) is preferably 1.1 to 2.0, more preferably 1.15 to 1.5. A diol component and a diisocyanate component may be mixed in substantially equal amounts and reacted, followed by adding a diisocyanate component.

5 **[0084]** Examples of the (meth)acrylic compound having a hydroxy group include hydroxyethyl (meth)acrylate, hydroxypropyl (meth)acrylate, hydroxybutyl (meth)acrylate, hydroxyhexyl (meth)acrylate, hydroxymethyl acrylamide and hydroxyethyl acrylamide.

10 **[0085]** As the urethane (meth)acrylate, a commercially available product from a company such as Arakawa Chemical Industries, Ltd., Shin-Nakamura Chemical Co., Ltd., Toagosei Co., Ltd., Kyoisha Chemical Co., Ltd., Nippon Kayaku Co., Ltd., The Nippon Synthetic Chemical Industry Co., Ltd., Negami Chemical Industrial Co., Ltd., Daicel-Allnex Ltd may be used. The weight average molecular weight of the urethane (meth)acrylate is preferably 5000 to 30000, more preferably 6000 to 23000, further preferably 7000 to 20000.

15 **[0086]** The glass transition temperature of the urethane (meth)acrylate is preferably 0°C or lower, more preferably -10°C or lower, further preferably -20°C or lower. By using a urethane (meth)acrylate having a low glass transition temperature (T_g), a pressure sensitive adhesive excellent in adhesive strength at a low temperature even when a crosslinked structure is introduced by a urethane-based segment to enhance the cohesive
20 force of the base polymer. The lower limit of the glass transition temperature of the urethane (meth)acrylate is not particularly limited, but is preferably -100°C or higher, more preferably -90°C or higher, further preferably -80°C or higher from the viewpoint of obtaining a pressure sensitive adhesive excellent in retaining force at a high temperature.

25 **[0087]** When a crosslinked structure is introduced into the acryl-based polymer chain by a urethane-based segment using a urethane (meth)acrylate, the glass transition temperature of the urethane-based segment of the base polymer is substantially equal to the glass transition temperature of the urethane (meth)acrylate.

[0088] <Pressure sensitive adhesive composition>

30 A pressure sensitive adhesive composition containing a base polymer is applied onto a substrate and, if necessary, the solvent is removed by drying and the base polymer is crosslinked and cured to form a pressure sensitive adhesive layer.

[0089] The base polymer can be prepared by a known polymerization method such as solution polymerization, photopolymerization (UV polymerization), bulk polymerization or

emulsion polymerization. A solution polymerization method or a photopolymerization method is preferable from the viewpoint of the transparency, water resistance, cost, etc. of the pressure sensitive adhesive. In photopolymerization, a polymer can be prepared without using a solvent, so that it is not necessary to dry and remove the solvent during formation of the pressure sensitive adhesive layer, and a pressure sensitive adhesive layer having a large thickness and thickness uniformity can be formed.

[0090] In preparation of the base polymer, a polymerization initiator such as a photopolymerization initiator or a thermopolymerization initiator may be used depending on the type of polymerization reaction. Examples of the photopolymerization initiator include benzoin ether-based photopolymerization initiators, acetophenone-based photopolymerization initiators, α -ketol-based photopolymerization initiators, aromatic sulfonyl chloride-based photopolymerization initiators, photoactive oxime-based photopolymerization initiators, benzoin-based photopolymerization initiators, benzyl-based photopolymerization initiators, benzophenone-based photopolymerization initiators, ketal-based photopolymerization initiators, thioxanthone-based photopolymerization initiators and acylphosphine oxide-based photopolymerization initiators. Examples of the thermopolymerization initiator include: an azo-based initiator, a peroxide-based initiator, a redox-based initiator obtained by combining a peroxide and a reducing agent (*e.g.*, combination of a persulfate and sodium hydrogen sulfite, combination of a peroxide and sodium ascorbate).

[0091] For adjusting the molecular weight of the base polymer, a chain-transfer agent may be used. Examples of the chain-transfer agent include thiols such as α -thioglycerol, lauryl mercaptan, glycidyl mercaptan, mercaptoacetic acid, 2-mercaptoethanol, thioglycolic acid, 2-ethylhexyl thioglycolate and 2,3-dimercapto-1-propanol, and α -methylstyrene dimers.

[0092] When a polyfunctional monomer, in addition to a monofunctional monomer, is used as a monomer component that forms the base polymer, the monofunctional monomer may be first polymerized to form a prepolymer composition with a low polymerization ratio (prepolymerization), followed by polymerizing the prepolymer with the polyfunctional monomer by adding the polyfunctional monomer to a syrup of the prepolymer composition (main polymerization). By performing prepolymerization followed by main polymerization of the prepolymer as described above, a diverging point derived from a polyfunctional monomer component can be uniformly introduced into a

base polymer. A mixture of a prepolymer composition and a non-polymerized monomer component (pressure sensitive adhesive composition) may be applied onto a base member, and then subjected to main polymerization on the base member to form a pressure sensitive adhesive layer. The prepolymer composition has a low viscosity and is thus excellent in coatability, and therefore by using a method in which a pressure sensitive adhesive composition as a mixture of a prepolymer composition and a non-polymerized monomer is applied, and then subjected main polymerization on a base member, the productivity of a pressure sensitive adhesive layer is improved, and the thickness of the pressure sensitive adhesive layer can be made uniform.

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10 **[0093]** The prepolymer composition can be prepared by, for example, partially polymerizing (prepolymerizing) a composition (referred to as a “prepolymer forming composition”) obtained by mixing a monomer component that forms an acryl-based base polymer, and a polymerization initiator. Among the aforementioned monomer components that form the acryl-based polymer, the monomer component in the prepolymer forming composition is preferably a monofunctional monomer component such as a (meth)acrylic acid alkyl ester or a polar group-containing monomer. The prepolymer forming composition may contain a polyfunctional monomer. For example, after a part of a polyfunctional monomer component as a raw material of a base polymer is included in a prepolymer forming composition, and a prepolymer is polymerized, the remaining part of

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20 the polyfunctional monomer component may be added and subjected to main polymerization.

[0094] In addition to the monomer and polymerization initiator, the prepolymer forming composition may contain a chain-transfer agent etc. as necessary. Although the method for polymerizing a prepolymer is not particularly limited, polymerization by irradiation of an active ray such as UV light is preferable for adjusting the reaction time to ensure that the molecular weight (polymerization ratio) of the prepolymer falls within a desired range. The polymerization initiator and the chain-transfer agent to be used for prepolymerization are not particularly limited, and for example, the above-mentioned photopolymerization initiators and chain-transfer agents may be used.

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30 **[0095]** Although the polymerization ratio of the prepolymer is not particularly limited, it is preferably 3 to 50% by weight, more preferably 5 to 40% by weight for adjusting a viscosity of the prepolymer syrup suitable for application onto a base member. The polymerization ratio of the prepolymer can be adjusted to fall within a desired range by adjusting the type and used amount of a photopolymerization initiator, the irradiation

intensity/irradiation time of an active ray such as UV light, and so on. The polymerization ratio of the prepolymer is calculated in accordance with the following expression from weights before and after heating at 130°C for 3 hours. The polymerization ratio of the pressure sensitive adhesive is calculated by the same method.

5 polymerization ratio (%) = weight after drying / weight before drying × 100

[0096] The prepolymer composition is mixed with remnants of monomer components (post-addition monomers) for forming the acryl-based base polymer, and if necessary, a polymerization initiator, a chain-transfer agent, a silane coupling agent, a crosslinker and the like are mixed to form a pressure sensitive adhesive composition. Preferably, the post-addition monomer contains a polyfunctional monomer. When a crosslinked structure from urethane-based segments is introduced using urethane di(meth)acrylate, it is preferable to add urethane di(meth)acrylate as a post-addition monomer.

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[0097] The polymerization initiator and the chain-transfer agent to be used for main polymerization are not particularly limited, and for example, the above-mentioned photopolymerization initiators and chain-transfer agents may be used. When the polymerization initiator in prepolymerization is not deactivated and remains in the prepolymer composition, addition of the polymerization initiator for main polymerization may be omitted.

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[0098] In main polymerization, it is preferable to adjust the molecular weight by incorporating a chain-transfer agent in a pressure sensitive adhesive composition. The chain-transfer agent used in main polymerization is not particularly limited, and for example, the above-described chain-transfer agents can be used. The amount of the chain-transfer agent in the pressure sensitive adhesive composition is preferably 0.001 to 2 parts by weight, more preferably 0.005 to 1 part by weight, further preferably 0.01 to 0.5 parts by weight, based on 100 parts by weight of the constituent components of the base polymer. When the chain-transfer agent used in the prepolymerization is not deactivated and remains in the prepolymer composition, addition of the chain-transfer agent in the pressure sensitive adhesive composition may be omitted.

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[0099] The chain-transfer agent receives radicals from a growing polymer chain to stop extension of the polymer, and the chain-transfer agent having received the radicals attacks the monomer to start polymerization again. By using a chain-transfer agent, an increase in molecular weight of the polymer is suppressed without reducing the concentration of radicals in the reaction system.

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[0100] When the ratio between the monofunctional monomer and the polyfunctional monomer is constant, an increase in molecular weight tends to raise the probability that one polymer chain contains a crosslinked point (branching point) from a polyfunctional monomer, resulting in an increase in gel fraction. By suppressing elongation of the polymer using a chain-transfer agent, the molecular weight of the polymer tends to decrease, leading to suppression of increase in gel fraction. Thus, when the pressure sensitive adhesive composition contains a chain-transfer agent, a pressure sensitive adhesive having a large $\tan\delta$ and excellent level difference followability is easily formed.

[0101] (Ultraviolet Absorber)

An ultraviolet absorber may be used to impart ultraviolet absorption into the pressure sensitive adhesive layers 51 and 53. Examples of the ultraviolet absorber include benzotriazole-based ultraviolet absorbers, benzophenone-based ultraviolet absorbers, salicylate-based ultraviolet absorbers, triazine ultraviolet absorbers and cyanoacrylate-based ultraviolet absorbers. Triazine-based ultraviolet absorbers and benzotriazole-based ultraviolet absorbers are preferable because they have high ultraviolet absorbability and have excellent compatibility with acryl-based polymers so that highly transparent acryl-based pressure sensitive adhesive can be easily obtained. Among them, triazine-based ultraviolet absorbers containing a hydroxy group, and benzotriazole-based ultraviolet absorbers containing one benzotriazole backbone per molecule are preferable.

[0102] As the ultraviolet absorber, a commercially available product may be used. Examples of the commercially available triazine-based ultraviolet absorber include reaction products of 2-(4,6-bis (2,4-dimethylphenyl)-1,3,5-triazin-2-yl)-5-hydroxyphenyl with [(alkyloxy)methyl]oxirane ("TINUVIN 400" manufactured by BASF SE), reaction products of 2-(2,4-dihydroxyphenyl)-4,6-bis-(2,4-dimethylphenyl)-1,3,5-triazine with (2-ethylhexyl)-glycidic acid ester ("TINUVIN 405" manufactured by BASF SE), (2,4-bis[2-hydroxy-4-butoxyphenyl]-6-(2,4-dibutoxyphenyl)-1,3,5-triazine ("TINUVIN 460" manufactured by BASF SE), 2-(4,6-diphenyl-1,3,5-triazin-2-yl)-5-[(hexyl)oxy]-phenol ("TINUVIN 577" manufactured by BASF SE), 2-(2-hydroxy-4-[1-octyloxycarbonylethoxy]phenyl)-4,6-bis(4-phenylphenyl)-1,3,5-triazine ("TINUVIN 479" manufactured by BASF SE), bis(ethylhexyl) oxyphenolmethoxyphenyl triazine ("Tinosorb S" manufactured by BASF SE), and 2-(4,6-diphenyl-1,3,5-triazine-2-yl)-5-[2-(2-ethylhexanoyloxy)ethoxy]-phenol ("ADK STAB LA-46" manufactured by ADEKA Corporation).

[0103] Examples of the commercially available benzotriazole ultraviolet absorber include

2-(2H-benzotriazol-2-yl)-6-(1-methyl-1-phenylethyl)-4-(1,1,3,3-tetramethylbutyl)phenol
 ("TINUVIN 928" manufactured by BASF SE), 2-(2-hydroxy-5-tert-butylphenyl)-2H-
 benzotriazole ("TINUVIN PS" manufactured by BASF SE), 2-(2H-benzotriazole-2-yl)-4,6-
 bis(1-methyl-1-phenylethyl)phenol ("TINUVIN 900" manufactured by BASF SE), 2-(2H-
 5 benzotriazol-2-yl) -6-(1-methyl-1-phenylethyl)-4-(1,1,3,3-tetramethylbutyl)phenol
 ("TINUVIN 928" manufactured by BASF SE), 2-(2H-benzotriazol-2-yl)-6-dodecyl-4-
 methylphenol ("TINUVIN 571" manufactured by BASF SE), 2-(2H-benzotriazol-2-yl)-p-
 cresol ("TINUVIN P" manufactured by BASF SE), 2-(2H-benzotriazol-2-yl)-4-6-bis(1-
 methyl-1-phenylethyl)phenol ("TINUVIN 234" manufactured by BASF SE), 2-(5-chloro
 10 (2H)-benzotriazol-2-yl)-4-methyl-6-(tert-butyl)phenol ("TINUVIN 326" manufactured by
 BASF SE), 2-(2H-benzotriazol-2-yl)-4,6-di-tert-pentylphenol ("TINUVIN 328"
 manufactured by BASF SE), 2-(2H-benzotriazol-2-yl)-4-(1,1,3,3-tetramethylbutyl)phenol
 ("TINUVIN 329" manufactured by BASF SE), ester compounds of benzenepropanoic acid
 with 3-(2H-benzotriazol-2-yl)-5-(1,1-dimethylethyl)-4-hydroxy (C7-9 side chain and linear
 15 alkyl) ("TINUVIN 384-2" manufactured by BASF SE), reaction products of methyl-3-(3-
 (2H-benzotriazol-2-yl)-5-t-butyl-4-hydroxyphenyl)propionate with polyethylene glycol
 ("TINUVIN1 130" manufactured by BASF SE), reaction products of methyl 3-(3-(2H-
 benzotriazol-2-yl)-5-tert-butyl-4-hydroxyphenyl) propionate with polyethylene glycol 300
 ("TINUVIN 213" manufactured by BASF SE), and 2-[2-hydroxy-3-(3,4,5,6-
 20 tetrahydrophthalimido-methyl)-5-methylphenyl]benzotriazole ("Sumisorb 250"
 manufactured by Sumitomo Chemical Company, Limited).

[0104] When the ultraviolet absorber is added in the pressure sensitive adhesive
 composition, the content thereof is generally about 0.05 to 10 parts by weight, preferably
 0.1 to 5 parts by weight, based on 100 parts by weight of the base polymer. When the
 25 content of the ultraviolet absorber is within the above range, ultraviolet shielding property
 of the pressure sensitive adhesive layer can be improved, while deterioration of the
 transparency due to bleed out, etc. can be suppressed.

[0105] (Oligomer)

The pressure sensitive adhesive composition may contain oligomers for the
 30 purpose of, for example, adjusting the adhesive strength and the viscosity of the pressure
 sensitive adhesive. As the oligomer, one having a weight average molecular weight of, for
 example, about 1000 to 30000 is used. The oligomer is preferably an acryl-based oligomer
 because it is excellent in compatibility with the acryl-based base polymer.

[0106] The acryl-based oligomer contains a (meth)acrylic acid alkyl ester as a main

constituent monomer component. In particular, the acryl-based oligomer is preferably one containing as a constituent monomer component a (meth)acrylic acid alkyl ester having a linear or branched alkyl group (linear or branched alkyl (meth)acrylate) and a (meth)acrylic acid alkyl ester having a cycloaliphatic alkyl group (cycloaliphatic alkyl (meth)acrylate). Specific examples of the linear or branched alkyl (meth)acrylate and the cycloaliphatic alkyl (meth)acrylate are as shown above as constituent monomers of the acryl-based polymer.

[0107] The glass transition temperature of the acryl-based oligomer is preferably 20°C or higher, more preferably 40°C or higher. The glass transition temperature of the acryl-based oligomer may be 60°C or higher, 80°C or higher, 100°C or higher, or 110°C or higher. When an acryl-based base polymer which has a low glass transition temperature (T_g) and in which a crosslinked structure is introduced by a urethane-based segment, and an acryl-based oligomer having a high glass transition temperature (T_g) are used in combination, the adhesion retaining force of the pressure sensitive adhesive tends to be improved. The upper limit of the glass transition temperature of the acryl-based oligomer is not particularly limited, but is generally 200°C or lower, preferably 180°C or lower, more preferably 160°C or lower. The glass transition temperature of the acryl-based oligomer is calculated in accordance with the Fox equation.

[0108] Among the shown (meth)acrylic acid alkyl esters, the linear or branched alkyl (meth)acrylate is preferably methyl methacrylate because it has a high glass transition temperature, and is excellent in compatibility with the base polymer. As the cycloaliphatic alkyl (meth)acrylate, dicyclopentanyl acrylate, dicyclopentanyl methacrylate, cyclohexyl acrylate and cyclohexyl methacrylate are preferable. That is, the acryl-based oligomer is preferably one containing as constituent monomer components at least one selected from the group consisting of dicyclopentanyl acrylate, dicyclopentanyl methacrylate, cyclohexyl acrylate and cyclohexyl methacrylate, and methyl methacrylate.

[0109] The amount of the cycloaliphatic alkyl (meth)acrylate based on the total amount of monomer components for forming the acryl-based oligomer is preferably 10 to 90% by weight, more preferably 20 to 80% by weight, further preferably 30 to 70% by weight. The amount of the linear or branched alkyl (meth)acrylate based on the total amount of monomer components for forming the acryl-based oligomer is preferably 10 to 90% by weight, more preferably 20 to 80% by weight, further preferably 30 to 70% by weight.

[0110] The weight average molecular weight of the acryl-based oligomer is preferably

1000 to 30000, more preferably 1500 to 10000, further preferably 2000 to 8000. When an acryl-based oligomer having a molecular weight falling within the above-mentioned range is used, the adhesive strength and the adhesion retaining force of the pressure sensitive adhesive tend to be improved.

5 [0111] The acryl-based oligomer is obtained by polymerizing the above-mentioned monomer components by various polymerization methods. In polymerization of the acryl-based oligomer, various polymerization initiators may be used. In addition, a chain-transfer agent may be used for the purpose of adjusting the molecular weight.

[0112] When the pressure sensitive adhesive composition contains an oligomer
10 component such as an acryl-based oligomer, the content of the oligomer component is preferably 0.5 to 20 parts by weight, more preferably 1 to 15 parts by weight, further preferably 2 to 10 parts by weight, based on 100 part by weight of the above base polymer. When the content of the oligomer in the pressure sensitive adhesive composition is within the above-described range, adhesiveness and retention strength at high temperature tend
15 to be enhanced.

[0113] (silane coupling agent)

A silane coupling agent can also be added in the pressure sensitive adhesive composition for the purpose of adjusting the adhesive strength. When the pressure sensitive adhesive composition includes a silane coupling agent, the content thereof is
20 normally about 0.01 to 5.0 parts by weight, preferably 0.03 to 2.0 parts by weight based on 100 parts by weight of the base polymer.

[0114] (Other additives)

In addition to the components exemplified above, additives such as a tackifier, a plasticizer, a softener, a degradation inhibitor, a filler, a colorant, an antioxidant, a
25 surfactant and an antistatic agent maybe contained in the pressure sensitive adhesive composition.

[0115] <Formation of Pressure Sensitive Adhesive Layer>

When the pressure sensitive adhesive composition is photocurable, the pressure sensitive adhesive composition applied onto a substrate is irradiated with an active ray
30 (an ultraviolet ray and/or visible light having a short wavelength) to be photocured. At the time of performing photocuring, it is preferable that a cover sheet is disposed over the surface of the coating layer, and the pressure sensitive adhesive composition is irradiated with an active ray while being held between two sheets, so that hindrance of polymerization by oxygen is prevented.

- [0116]** For each of the substrate and cover sheet to be used for formation of the pressure sensitive adhesive layer, any suitable material is used. Each of the substrate and the cover sheet may be a release film having a release layer on a contact surface with the pressure sensitive adhesive layer. The transparent base film 59 of the pressure sensitive adhesive sheet 15 may be used as the substrate or the cover sheet.
- [0117]** For applying the pressure sensitive adhesive composition, various kinds of methods such as roll coating, kiss roll coating, gravure coating, reverse coating, roll brushing, spray coating, dip roll coating, bar coating, knife coating, air knife coating, curtain coating, lip coating, and extrusion coating may be employed.
- [0118]** The pressure sensitive adhesive composition applied in a layer-form onto the substrate is irradiated with an active ray to perform main polymerization. In main polymerization, unreacted monomers and polyfunctional compounds such as urethane di(meth)acrylate in the prepolymer composition react to give a polymer having a crosslinked structure.
- [0119]** The active ray may be selected according to the type of a polymerizable component, the type of a photopolymerization initiator or the like, and in general, an ultraviolet ray and/or visible light having a short wavelength are used. The accumulated amount of irradiation light is preferably about 100 to 5000 mJ/cm². The light source for photoirradiation is not particularly limited as long as it can emit light in a wavelength range over which the photopolymerization initiator contained in the pressure sensitive adhesive composition is sensitive to light, and a LED light source, a high-pressure mercury lamp, an ultra-high mercury lamp, a metal halide lamp, a xenon lamp or the like is preferably used. If the residual amount of unreacted monomers is large, G'_{25°C} of the pressure sensitive adhesive layer may decrease, leading to deterioration of adhesion retaining force. Therefore, the polymerization ratio of the pressure sensitive adhesive after the main polymerization is preferably 95% or more, more preferably 97% or more, further preferably 98% or more, especially preferably 99% or more. For increasing the polymerization ratio, the photocured pressure sensitive adhesive layer may be heated to volatilize residual monomers, unreacted polymerization initiator and so on.
- [0120]** As described above, the gel fraction of the pressure sensitive adhesive is preferably 30 to 80%, more preferably 35 to 70%. When the gel fraction is 30% or more, the adhesion retaining force of the pressure sensitive adhesive is enhanced, glue missing during processing and positional deviation between members are unlikely to occur, and excellent processability and processing dimensional stability are exhibited. When the gel

fraction is 80% or less, excellent level difference followability can be exhibited.

[0121] The weight average molecular weight of the sol component in the pressure sensitive adhesive is preferably 150,000 to 450,000, more preferably 180,000 to 420,000. The sol component is a soluble component obtained by extracting the base polymer with tetrahydrofuran (hereinafter, referred to as THF). Since it is difficult to measure the molecular weight of individual polymer chains of a crosslinked polymer (gel component), the molecular weight of the sol component (non-crosslinked polymer) is an index of the degree of elongation of the polymer chain. If the molecular weight of the sol component is excessively large, the glass transition temperature may increase, leading to decrease in impact resistance. On the other hand, if the molecular weight of the sol component is excessively small, the adhesion retaining force may decrease.

[0122] <Production of base film-equipped double-sided pressure sensitive adhesive sheet>

A base film-equipped double-sided pressure sensitive adhesive sheet can be obtained by disposing the first pressure sensitive adhesive layer 51 and the second pressure sensitive adhesive layer 53, respectively, on the front and back sides of the transparent base film 59. As described above, in formation of a pressure sensitive adhesive layer, a pressure sensitive adhesive composition may be applied onto the transparent base film 59 to form a laminate of the transparent base film and the pressure sensitive adhesive layer.

[0123] Release films 21 and 23 are bonded, respectively, to surfaces of the first pressure sensitive adhesive layer 51 and the second pressure sensitive adhesive layer 53 to obtain a base film-equipped double-sided pressure sensitive adhesive sheet in which a release film is temporarily attached to each of both surfaces as shown in FIG. 1. The release films 21 and 23 may be the substrate and/or the cover sheet used in formation of the pressure sensitive adhesive layer.

[0124] [Formation of image display device]

As described above, the pressure sensitive adhesive sheet 15 is suitably used for bonding the front transparent plate 7 to the viewing-side surface of the image display panel 10 in formation of the image display device. The order of bonding is not particularly limited, and the pressure sensitive adhesive sheet 15 may be bonded to the image display panel 10 first, or the pressure sensitive adhesive sheet 15 may be bonded to the front transparent plate 7 first. It is also possible to bond the pressure sensitive adhesive sheet 15 to the image display panel 10 and to the front transparent plate 7 in parallel. The

second pressure sensitive adhesive layer 53 may be bonded to the polarizing plate 3, followed by bonding the polarizing plate 3 to the image display cell 6 with the pressure sensitive adhesive layer 4 interposed therebetween.

5 [0125] The form of the base film-equipped double-sided pressure sensitive adhesive sheet according to the present invention is not limited to one in which a release film is temporarily attached to each of the pressure sensitive adhesive layers 51 and 53 as shown in FIG. 1. The pressure sensitive adhesive layer 53 may be firmly bonded to an optical film such a polarizing plate. For example, in the configuration shown in FIG. 3, the release film 21 is temporarily attached to the surface of the first pressure sensitive
10 adhesive layer 51, and the optical film 3 is firmly bonded to the second pressure sensitive adhesive layer 53. In the form shown in FIG. 4, a pressure sensitive adhesive sheet 4 is further provided on the polarizing plate 3, and the release film 24 is temporarily attached to the pressure sensitive adhesive layer 4.

[0126] The image display panel 10 is bonded to the front transparent plate 7 with the
15 pressure sensitive adhesive sheet 15 interposed therebetween, followed by performing pressure processing such as heat pressing or pressure bonding. If there exists a projection partially having a large thickness, such as a FPC connection portion, high pressure is locally applied from the back side of the image display panel, so that the image display panel 10 is deformed. Since the image display panel 10 and the front transparent plate 7
20 are bonded to each other with the base film-equipped double-sided pressure sensitive adhesive sheet 15, the pressure sensitive adhesive sheet 15 is less plastically deformed, and restoring force against deformation acts, so that remaining press marks resulting from pressing from the back side may be reduced.

25 EXAMPLES

[0127] The present invention will be described more specifically below by showing examples and comparative examples, but the present invention is not limited to these examples.

[0128] [Preparation of Acrylic Oligomer]

30 60 parts by weight of dicyclopentanyl methacrylate (DCPMA), 40 parts by weight of methyl methacrylate (MMA), 3.5 parts by weight of α -thioglycerol as a chain-transfer agent, and 100 parts by weight of toluene as a polymerization solvent were mixed, and stirred in a nitrogen atmosphere at 70°C for 1 hour. 0.2 parts by weight of 2,2'-

azobisisobutyronitrile (AIBN) is added as a thermopolymerization initiator, and the mixture was reacted at 70°C for 2 hours, then heated to 80°C, and reacted for 2 hours. Thereafter, the reaction liquid was heated to 130°C, and toluene, the chain-transfer agent and unreacted monomers were removed by drying to obtain a solid acrylic oligomer. The weight average molecular weight of the acrylic oligomer was 5100.

[0129] [Preparation of prepolymer composition]

<Prepolymer composition 1>

70 parts by weight of butyl acrylate (BA), 17 parts by weight of N-vinyl-2-pyrrolidone (NVP), and 13 parts by weight of 4-hydroxybutyl acrylate (4HBA) as prepolymer forming monomer components, and photopolymerization initiators (0.05 parts by weight of "IRGACURE 184" manufactured by BASF SE and 0.05 parts by weight of "IRGACURE 651" manufactured by BASF SE) were blended. The mixture was irradiated with an ultraviolet ray to perform polymerization until the viscosity of the composition reaches about 20 Pa·s (BH viscometer No. 5 Rotor, 10 rpm, measurement temperature: 30°C), thereby obtaining prepolymer composition 1 (polymerization ratio: about 9%).

[0130] <Prepolymer composition 2>

The prepolymer forming monomer components were changed to 68 parts by weight of 2-ethylhexyl acrylate (2EHA), 17 parts by weight of NVP and 17 parts by weight of 4-hydroxybutyl acrylate (4HBA), and polymerization was performed in the same manner as described above to obtain a prepolymer composition 2.

[0131] [Preparation of photocurable pressure sensitive adhesive composition]

<Pressure sensitive adhesive composition A>

To 100 parts by weight of the prepolymer composition 1 were added 2 parts by weight of polyester urethane diacrylate having a weight average molecular weight of 12500 ("Art Resin UN-350" manufactured by Negami Chemical Industrial Co., Ltd.); 5 parts by weight of the acrylic oligomer; 0.05 parts by weight of "IRGACURE 184" and 0.55 parts by weight of "IRGACURE 651" as photopolymerization initiators; 0.07 parts by weight of an α -methylstyrene dimer ("NOFMER MSD" manufactured by NOF CORPORATION) as a chain-transfer agent; and 0.3 parts by weight of "KBM 403" manufactured by Shin-Etsu Chemical Co., Ltd. as a silane coupling agent. The mixture was then homogeneously mixed to prepare a pressure sensitive adhesive composition A.

[0132] <Pressure sensitive adhesive composition B>

0.70 parts by weight of an ultraviolet absorber "Tinosorb S" manufactured by

BASF SE was added, and 0.05 parts by weight of “IRGACURE 184” manufactured by BASF SE, 0.05 parts by weight of by weight of “IRGACURE 651” manufactured by BASF SE and 0.40 parts by weight of “IRGACURE 819” manufactured by BASF SE were used as the photopolymerization initiator. Except that the above-mentioned changes were made, the same procedure as in preparation of the pressure sensitive adhesive composition A was carried out to prepare a pressure sensitive adhesive composition B.

[0133] <Pressure sensitive adhesive composition C>

Except that the amount of the chain-transfer agent was changed to 0.03 parts by weight, the same procedure as in preparation of the pressure sensitive adhesive composition B was carried out to prepare a pressure sensitive adhesive composition C.

[0134] <Pressure sensitive adhesive composition D>

Except that 0.1 parts by weight of hexanediol diacrylate (HDDA), instead of polyester urethane diacrylate, was blended as a polyfunctional monomer, the same procedure as in preparation of the pressure sensitive adhesive composition B was carried out to prepare a pressure sensitive adhesive composition D.

[0135] <Pressure sensitive adhesive composition E>

To 100 parts by weight of the prepolymer composition 2, 0.1 parts by weight of HDDA; 5 parts by weight of the acrylic oligomer; 0.04 parts by weight of “IRGACURE 184”, 0.04 parts by weight of “IRGACURE 651” and 0.12 parts by weight of “IRGACURE 819” as photopolymerization initiators; and 0.3 parts by weight of a silane coupling agent. The mixture was then homogeneously mixed to prepare a pressure sensitive adhesive composition E.

[0136] [Preparation of pressure sensitive adhesive layer]

<Pressure sensitive adhesive layer A1>

A 75 μm -thick polyethylene terephthalate (PET) film having a silicone-based release layer on a surface thereof was provided as a substrate, and the photocurable pressure sensitive adhesive composition was applied in a thickness of 150 μm to form a coating layer on the substrate. To the coating layer, a 75 μm -thick PET film with one surface subjected to silicone release treatment was bonded as a cover sheet. By a black light, which was position-adjusted so that the irradiation intensity at an irradiation surface just below the lamp was 5 mW/cm², the laminate was irradiated with an ultraviolet ray from the cover sheet-side to be photocured, thereby obtaining a pressure sensitive adhesive layer A1 having a thickness of 220 μm and a polymerization ratio of 99%.

[0137] <Pressure sensitive adhesive layers A2 to A4>

Except that the thickness of the pressure sensitive adhesive layer was changed to 150 μm , 100 μm and 70 μm , the same procedure as in preparation of the pressure sensitive adhesive layer A1 was carried out to prepare pressure sensitive adhesive layers A2, A3 and A4.

[0138] <Pressure sensitive adhesive layers B1 to B4, C2, C3, D2, D3 and E1 to E3>

Except that the type and the thickness of the pressure sensitive adhesive composition were changed as shown in Table 1, the same procedure as in preparation of the pressure sensitive adhesive layer A1 was carried out to prepare a pressure sensitive adhesive layer.

[0139] [Evaluation of pressure sensitive adhesive layer]

For each of the above-described pressure sensitive adhesive layers, the glass transition temperature, the storage elastic modulus, the loss tangent, the gel fraction and the molecular weight of the sol component were measured by the following methods.

[0140] <Storage elastic modulus, loss tangent and glass transition temperature>

A plurality of pressure sensitive adhesive layers, from which release films (substrate and cover sheet) on the front and back sides had been peeled and removed, were laminated to a thickness of about 1.5 mm to obtain a measurement sample. Dynamic viscoelasticity was measured under the following conditions using “Advanced Rheometric Expansion System (ARES)” manufactured by Rheometric Scientific, Inc.

(Measurement Conditions)

Deformation mode: torsion

Measurement Frequency: 1 Hz

Temperature elevation rate: 5°C/minute

Shape: parallel plate (7.9 mm ϕ)

[0141] The shear storage elastic modulus $G'_{25^\circ\text{C}}$ at 25°C and the loss tangent $\tan\delta_{70^\circ\text{C}}$ at 70 °C were read from the measurement result. The temperature at which the loss tangent ($\tan\delta$) was maximum (peak-top temperature) was defined as the glass transition temperature of the pressure sensitive adhesive layer.

[0142] <Gel fraction>

About 0.2 g of the pressure sensitive adhesive was scraped off from the pressure sensitive adhesive layer. The sample was wrapped in a porous polytetrafluoroethylene film having pore diameter of 0.2 μm (manufactured by Nitto Denko Corporation; trade

name: “NTF-1122”) cut to a size of 100 mm × 100 mm, and the wrapped opening was tied with a kite string. The total weight (A) of the porous polytetrafluoroethylene film and the kite string measured beforehand was subtracted from the weight of this sample to calculate the weight (B) of the pressure sensitive adhesive sample. The pressure sensitive adhesive sample wrapped in the porous polytetrafluoroethylene film was immersed in approximately 50 mL of ethyl acetate at 23°C for 7 days to elute sol components of the pressure sensitive adhesive to the outside of the polytetrafluoroethylene film. After immersion, the pressure sensitive adhesive wrapped in the porous polytetrafluoroethylene film was taken out, dried at 130°C for 2 hours, and allowed to cool for about 20 minutes, and the dry weight (C) was measured. The gel fraction of the pressure sensitive adhesive was calculated from the following formula.

$$\text{gel fraction (\%)} = 100 \times (C - A) / B$$

[0143] <Weight average molecular weight of sol component>

About 0.2 g of the pressure sensitive adhesive was scraped off from the pressure sensitive adhesive layer, and immersed in a 10 mM tetrahydrofuran phosphate solution for 12 hours to extract a sol component. With consideration given to the gel fraction of the pressure sensitive adhesive, the amount of the tetrahydrofuran phosphate solution was adjusted so that the sol component content of the solution after extraction was 0.1 wt%. A filtrate obtained by filtering solution after extraction with a 0.45 μm membrane filter was provided as a sample. Gel permeation chromatography (GPC) analysis was performed under the following conditions with a GPC apparatus (product name “HLC-8120GPC”) manufactured by TOSOH CORPORATION, and the weight average molecular weight Mw of the sol component was calculated.

(Measurement conditions)

Column: G7000HXL + GMHXL + GMHXL manufactured by TOSOH CORPORATION

Column size: 7.8 mm φ x 30 cm each (total column length: 90 cm)

Column temperature: 40°C and flow rate: 0.8 mL/min

Injection volume: 100 μL

Eluent: tetrahydrofuran

Detector: Differential Refractometer (RI)

Standard sample: polystyrene

[0144] Table 1 shows the composition and the thickness of each pressure sensitive

adhesive layer (pressure sensitive adhesive composition), and the evaluation results.

[0145] [Table 1]

		A1	A2	A3	A4	B1	B2	B3	B4	C2	C3	D2	D3	E1	E2	E3
Composition	Prepolymer composition	2EHA	-				-			-		-			68	
		BA	70				70			70		70			-	
		NVP	17				17			17		17			15	
		4HBA	13				13			13		13			-	
		2HFA	-				-			-		-			17	
	Polyfunctional monomer	UN-350	2				2			2		1			-	
		HDDA	-				-			-		-			0.1	
	Acrylic Oligomer		5				5			5		5			5	
		Irg651	0.55				0.05			0.05		0.05			0.04	
	Photopolymerization Initiator	Irg184	0.05				0.05			0.05		0.05			0.04	
		Irg819	-				0.40			0.40		0.40			0.12	
	UV absorber	Tinosorb S	-				0.7			0.7		0.7			0.7	
	Chain-transfer agent	NOFMER MSD	0.07				0.07			0.03		0.07			-	
	Silane coupling agent	KBM-403														
Evaluation	Thickness (μm)		220	150	100	70	220	150	100	70	150	100	100	300	150	100
	Tg (°C)		-5	-5	-5	-5	-5.3	-5.3	-5.3	-5.3	-4.5	-4.5	-5.3	-7	-7	-7
	G'25°C (kPa)		210	210	210	210	230	210	210	210	200	230	230	120	120	120
	tanδ25°C		0.60	0.60	0.60	0.60	0.35	0.33	0.33	0.33	0.28	0.38	0.38	0.20	0.20	0.20
	Gel fraction (%)		54	54	54	54	65	73	73	73	74	60	60	85	88	85
	Sol component Mw (× 10 ⁴)		36	36	36	36	28	24	24	24	34	29	29	18	18	18

[0146] [Example 1]

A pressure sensitive adhesive layer A2 as a first pressure sensitive adhesive layer was bonded to one principal surface of a 50 μm -thick cyclic olefin polymer (COP) film ("Zeonor Film ZF16" manufactured by Zeon Corporation; in-plane retardation: 3 nm), and
5 a pressure sensitive adhesive layer A3 as a second pressure sensitive adhesive layer was bonded to the other principal surface to prepare a base film-equipped double-sided pressure sensitive adhesive sheet in which a pressure sensitive adhesive layer is disposed on both sides of a base film.

[0147] [Example 2]

10 Except that a 50 μm -thick a biaxially oriented polyethylene terephthalate (PET) film ("Lumirror S10" manufactured by Toray Industries, Inc.; in-plane retardation 920 nm) was used as a base film, the same procedure as in Example 1 was carried out to prepare a base film-equipped double-sided pressure sensitive adhesive sheet.

[0148] [Examples 3 to 9 and Comparative Examples 3 to 5]

15 A base film-equipped double-sided pressure sensitive adhesive sheet was prepared while the type of the base film and the type of the pressure sensitive adhesive layer were changed as shown in Table 2.

[0149] [Comparative Examples 1, 2, 6 and 7]

20 Single-layer pressure sensitive adhesive layer A1, B1, E1 or E3 was used as a base film-less pressure sensitive adhesive sheet.

[0150] [Evaluation]

For the pressure sensitive adhesive sheets of Examples and Comparative Examples, adhesive strength, level difference followability, falling impact durability and press marks were evaluated by the following methods.

25 [0151] <Adhesive strength>

The release film was peeled from the second pressure sensitive adhesive layer, the second pressure sensitive adhesive layer was bonded to a 50 μm -thick PET film, and cut to a width of 10 mm and a length of 100 mm. Thereafter, the release film was peeled from the first pressure sensitive adhesive layer, and the pressure sensitive adhesive sheet was
30 press-bonded to a glass plate with a 5 kg roller to prepare an adhesive strength measuring sample. For preparing samples in Comparative Examples 1, 2, 6 and 7 using a base film-less single-layer pressure sensitive adhesive sheet, the release film on one surface was peeled, a PET film was bonded to the surface, the release film on the other surface was then peeled, and a glass plate was bonded to the surface (the same applies to other

evaluations below).

[0152] The adhesive strength measuring sample was held under an environment at 25°C for 30 minutes, and thereafter, using a tensile tester, a test piece was peeled from the glass plate under the condition of a tension speed of 300 mm/minute and a peeling angle of 180° to measure the peeling strength.

[0153] <Haze>

The release film was peeled from the second pressure sensitive adhesive layer, and the second pressure sensitive adhesive layer was bonded to an alkali-free glass (total light transmittance: 92% and haze: 0.4%) with a thickness of 800 μm, and the release film was then peeled from the first pressure sensitive adhesive layer to obtain a test piece. The haze of the test piece was measured with a haze meter ("HM-150" manufactured by MURAKAMI COLOR RESEARCH LABORATORY). A value obtained by subtracting the haze (0.4%) of the alkali-free glass from the measured value was defined as the haze of the pressure sensitive adhesive sheet.

[0154] <Level difference followability>

The pressure sensitive adhesive sheet was cut to a size of 75 mm × 45 mm, the release film was peeled from the second pressure sensitive adhesive layer. Using a roll laminator (inter-roll pressure: 0.2 MPa and feeding speed: 100 mm/minute), the pressure sensitive adhesive sheet was bonded to the center of a 125 μm-thick PET film cut to a size of 100 mm × 50 mm. Thereafter, the release film was peeled from the first pressure sensitive adhesive layer, and a 500 μm-thick glass plate (100 mm × 50 mm) printed with a black ink (print thickness: 25 μm or 40 μm) in a frame pattern on the peripheral edge portion was bonded to the pressure sensitive adhesive sheet by a roll laminator (inter-roll pressure: 0.2 MPa and feeding speed: 100 mm/minute). The ink-printed region of the glass plate extended over 5 mm from both ends in the short-side direction and 15 mm from the both ends in the long-side direction, and the black ink layer was in contact with the region of 5 mm from the ends of the four sides of the pressure sensitive adhesive sheet. The sample was treated in an autoclave (50°C, 0.5 MPa) for 30 minutes. The vicinity of the boundary of the black ink printed-region was observed with a digital microscope at a magnification of 20 times to examine presence or absence of bubbles. For each of samples with a black ink print thickness of 25 μm and 40 μm, level difference followability was evaluated in accordance with the following criteria.

A: There were no bubbles at any position on the entire circumference.

B: There were bubbles at one of the four corners, and there were no bubbles on any of the four sides.

X: There were bubbles at two of four corners, or on one or more of the four sides.

[0155] <Impact Resistance>

5 The pressure sensitive adhesive sheet was cut to a size of 75 mm × 45 mm, the release film was peeled from the second pressure sensitive adhesive layer, and by a roll laminator (inter-roll pressure: 0.2 MPa and feeding speed: 100 mm/minute), the second pressure sensitive adhesive layer was bonded to the center of a 500 μm-thick glass plate (100 mm × 70 mm). Thereafter, the release film was peeled from the first pressure
10 sensitive adhesive layer, and a 500 μm-thick glass plate (50 mm × 100 mm) printed with a 30 μm-thick black ink in a frame pattern on the peripheral edge portion was bonded to the first pressure sensitive adhesive layer by vacuum pressure-bonding (surface pressure: 0.3 MPa, pressure: 100 Pa). The ink-printed region of the glass plate extended over 5 mm from both ends in the short-side direction and 15 mm from the both ends in the long-side
15 direction, and the black ink layer was in contact with the region of 5 mm from the ends of the four sides of the pressure sensitive adhesive sheet. The sample was treated in an autoclave (50°C, 0.5 MPa) for 30 minutes.

[0156] As shown in FIG. 5, both ends of the test sample 85 in the short-side direction were placed on tables 83 arranged with a distance of 60 mm therebetween in such a
20 manner that the ink-printed layer 76-formed glass plate 7 was situated on the lower side, and the upper surface of the end portion of the ink-printed layer-free glass plate 8 was fixed on a table 83 with a pressure sensitive adhesive tape (not shown). The test sample 85 fixed on the tables 83 with the pressure sensitive adhesive tape was held under an environment at -5°C for 24 hours, and then taken out into an environment at room
25 temperature, and after 40 seconds or less, a metal ball 87 having a mass of 11 g was dropped from a height of 300 mm to the glass plate 7 to conduct an impact resistance test.

[0157] In the impact resistance test, a cylindrical guide 89 was used for maintaining consistency of the drop position of the metal ball, and the metal ball 87 was dropped to a position at a distance of 10 mm in each of the short-side direction and the long-side
30 direction from the inner edge corners of the frame of the printed region of the printed layer 76. Two tests were conducted. A sample in which the glass plate was not peeled in any of the tests was rated “OK”, and a sample in which the glass plate was peeled in one or both of the two tests was rated “NG”.

[0158] <Press mark test>

The release film was peeled from the second pressure sensitive adhesive layer, and the second pressure sensitive adhesive sheet was bonded to a 50 μm -thick PET film with a roll laminator (inter-roll pressure: 0.2 MPa and delivery speed: 100 mm/min).

- 5 Thereafter, the release film was peeled from the first pressure sensitive adhesive layer, and the first pressure sensitive adhesive sheet was bonded to a 500 μm -thick glass plate with a roll laminator (inter-roll pressure: 0.2 MPa and delivery speed: 100 mm/min). This sample was treated in an autoclave (50°C and 0.5 MPa) for 30 minutes.

- [0159]** With SAICAS manufactured by DAIPLA WINTES, a steel ball indenter with a
10 diameter of 1 mm was pressed against the PET film-side surface of the sample at a pressing speed of 5 $\mu\text{m/s}$ until the vertical load was 1 N, the sample was held for 180 seconds, and the indenter was withdrawn at a speed of 5 $\mu\text{m/s}$. Six hours after the test, the surface shape of the PET film was measured with a noncontact interference microscope (WYKO), the depth of the press mark of the sample was determined, and
15 evaluation was performed in accordance with the following criteria.

A: The depth of the press mark is 3 μm or less.

B: The depth of the press mark is more than 3 μm and less than 4 μm .

X: The depth of the press mark is more than 4 μm .

[0160] [Evaluation Results]

- 20 Table 2 show the stacking configurations and evaluation results of the pressure sensitive adhesive sheets. The numerical values in parentheses for the first pressure sensitive adhesive layers, the base films and the second pressure sensitive adhesive layers in Table 2 each show the thickness (unit: μm) of each layer.

[0161] [Table 2]

Configuration	Example 1	Example 2	Example 3	Example 4	Comparative Example 1	Example 5	Example 6	Comparative Example 2	Comparative Example 3	Comparative Example 4	Comparative Example 5	Example 7	Example 8	Example 9	Comparative Example 6	Comparative Example 7	
	First pressure sensitive adhesive layer	A2 (150)	A2 (150)	A3 (100)	A3 (100)	A1 (220)	B2 (150)	B3 (100)	B1 (220)	B2 (150)	B3 (100)	B4 (70)	C2 (150)	D3 (150)	E2 (150)	E1 (300)	E3 (100)
	Base film	COP (50)	PET (50)	COP (50)	PET (50)	-	COP (50)	COP (50)	COP (50)	COP (50)	COP (50)	COP (50)	COP (50)	COP (50)	COP (50)	-	-
	Second pressure sensitive adhesive layer	A3 (100)	A3 (100)	A4 (70)	A4 (70)		B3 (100)	B4 (70)	B1 (220)	B1 (220)	B1 (220)	B1 (220)	C3 (100)	D4 (100)	E3 (100)		
Evaluation Results	Adhesive strength (N/10mm)	11.4	11.4	11.4	11.4	11.4	12.0	12.0	12.1	14.1	14.1	14.1	10.8	12.5	6.0	9.0	6.0
	Haze (%)	0.2	0.2	0.2	0.2	0.2	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3
	Level Difference	A	A	A	A	A	A	A	A	A	A	A	B	A	B	A	B
	Followability	A	A	A	A	A	A	A	A	A	A	A	B	A	B	A	X
Evaluation Results	Falling impact durability	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK	OK
	Press mark test	A	A	A	A	X	A	A	X	X	X	A	B	A	X	X	A

[0162] Each of the base film-equipped double-sided pressure sensitive adhesive sheets in Examples 1 to 4, in which a pressure sensitive adhesive layer having a relatively large thickness is disposed on the viewing-side of a transparent base film and a pressure sensitive adhesive layer having a relatively small thickness is disposed on the image display panel-side of the transparent base film, exhibited good properties, *i.e.*, exhibited excellent level difference followability, and had a small amount of remaining press marks resulting from deformation caused by pressing an indenter from the second pressure sensitive adhesive layer-side. On the other hand, for the base film-less double-sided pressure sensitive adhesive sheet of Comparative Example 1, which includes a 220 μm -thick pressure sensitive adhesive layer A1, good level difference followability was exhibited, but press marks resulting from deformation caused by pressing the indenter to the pressure sensitive adhesive layer were likely to remain, leading to generation of press mark defects.

[0163] Comparison between Examples 5 and 6 and Comparative Example 2 with different compositions of the pressure sensitive adhesive and comparison between Example 9 and Comparative Example 6 show the same tendency as mentioned above. In Examples 7 and 8 with different compositions of the pressure sensitive adhesive, excellent level difference followability is exhibited, press marks are unlikely to remain and good properties are exhibited as in other examples.

[0164] As in the case with the base film-less pressure sensitive adhesive sheet of Comparative Example 2 consisting of the pressure sensitive adhesive layer B2, the base film-equipped double-sided pressure sensitive adhesive sheets had press marks in Comparative Examples 3 to 5, in which a 220 μm -thick pressure sensitive adhesive layer B1 as the second pressure sensitive adhesive layer is disposed on one principal surface of a base film and a pressure sensitive adhesive layer B2, B3 or B4 as the first pressure sensitive adhesive layer having a relatively small thickness is arranged on the other principal surface of the base film.

[0165] The base film-less pressure sensitive adhesive sheet of Comparative Example 7, which includes a 100 μm -thick pressure sensitive adhesive layer E3 had good results in the press mark test, but was poor in level difference followability because of the small thickness of the pressure sensitive adhesive sheet.

[0166] The above results show that excellent level difference followability to a printing level difference of a front transparent plate can be exhibited, and defects resulting from press marks caused by pressing from the image display panel-side can be suppressed, by

using a base film-equipped double-sided pressure sensitive adhesive sheet in which a first pressure sensitive adhesive layer having a relatively large thickness and a second pressure sensitive adhesive layer having a relatively small thickness are disposed on the viewing-side and the image display panel-side, respectively, of a transparent base film.

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DESCRIPTION OF REFERENCE CHARACTERS

10	[0167]	51, 53	pressure sensitive adhesive layer
		21, 23	release film
		59	transparent base film
		15	base film-equipped double-sided pressure sensitive adhesive sheet
		3	optical film (polarizing plate)
15		4	pressure sensitive adhesive layer
		6	image display cell
		10	image display panel
		7	front transparent plate
		9	reinforcing substrate
20		95	FPC
		91	main substrate
		92	connector
		201	image display device

CLAIMS

1. A pressure sensitive adhesive sheet configured for forming an image display device,
the pressure sensitive adhesive sheet comprising: a transparent base film; a first
5 pressure sensitive adhesive layer firmly laminated on a first surface of the transparent
base film; and a second pressure sensitive adhesive layer firmly laminated on a second
principal surface of the transparent base film, wherein
the first pressure sensitive adhesive layer has a thickness larger than that of the
second pressure sensitive adhesive layer,
10 wherein in formation of the image display device, the pressure sensitive adhesive
sheet is used for bonding an image display panel and a front transparent plate arranged
on a viewing-side of the image display panel, the first pressure sensitive adhesive layer
being arranged in contact with the front transparent plate.
- 15 2. The pressure sensitive adhesive sheet according to claim 1, wherein the first pressure
sensitive adhesive layer has a thickness of 80 μm or more.
3. The pressure sensitive adhesive sheet according to claim 1 or 2, wherein the second
pressure sensitive adhesive layer has a thickness of 150 μm or less.
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4. The pressure sensitive adhesive sheet according to any one of claims 1 to 3, wherein the
transparent base film has a thickness of 15 to 150 μm .
5. The pressure sensitive adhesive sheet according to any one of claims 1 to 4, wherein the
25 transparent base film has an in-plane retardation of 50 nm or less.
6. The pressure sensitive adhesive sheet according to any one of claims 1 to 5, wherein the
first pressure sensitive adhesive layer has a shear storage elastic modulus of 0.16 MPa or
more at 25°C.
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7. The pressure sensitive adhesive sheet according to any one of claims 1 to 6, wherein the
first pressure sensitive adhesive layer has a loss tangent of 0.25 or more at 70°C.
8. The pressure sensitive adhesive sheet according to any one of claims 1 to 7, wherein the

first pressure sensitive adhesive layer has a glass transition temperature of -3°C or lower.

9. The pressure sensitive adhesive sheet according to any one of claims 1 to 8, wherein the first pressure sensitive adhesive layer includes an acryl-based polymer having a crosslinked structure.

10. The pressure sensitive adhesive sheet according to claim 9, wherein the first pressure sensitive adhesive layer has a gel fraction of 30 to 80%.

11. The pressure sensitive adhesive sheet according to claim 9 or 10, wherein the first pressure sensitive adhesive layer has a polymerization ratio of 95% or more.

12. The pressure sensitive adhesive sheet according to any one of claims 9 to 11, wherein the acryl-based polymer has a crosslinked structure introduced by a urethane-based segment.

13. An image display device comprising: an image display panel; and a front transparent plate arranged on a viewing-side of the image display panel, wherein the image display panel and the front transparent plate are firmly bonded with the pressure sensitive adhesive sheet set forth in any one of claims 1 to 12 interposed therebetween,

the first pressure sensitive adhesive layer is bonded to the front transparent plate, and the second pressure sensitive adhesive layer is bonded to the image display panel.

14. The image display device according to claim 13, wherein the image display panel comprises a polarizing plate arranged on a viewing-side of the image display cell, and the polarizing plate is bonded to the second pressure sensitive adhesive layer.

15. The image display device according to claim 13 or 14, wherein the image display panel comprises an OLED cell.

16. The image display device according to claim 15, wherein the OLED cell includes a

resin film substate, and an electrode and an organic light emitting layer disposed on the resin film substate.