

OPTICAL LAMINATE, METHOD FOR PRODUCING SAME, AND DISPLAY DEVICE

TECHNICAL FIELD

[0001] The present invention relates to an optical laminate including an optical film and a pressure sensitive adhesive, and a method for producing the laminate. The present invention also relates to a display device including an image display element and an optical element.

BACKGROUND ART

[0002] Display devices such as mobile phones, smartphones, car navigation devices, monitors for personal computers and televisions includes liquid crystal display, organic EL display or the like as an image display element. In a liquid crystal display, under its display principle, a polarizing plate is disposed on a viewing-side of an image display cell. In an organic EL display, a circularly polarizing plate (laminate of a polarizing plate and a quarter wave plate) may be arranged on a viewing-side surface of the image display cell for suppressing a situation in which external light is reflected by a metal electrode (cathode) to appear as a mirror surface.

[0003] A front transparent plate (also referred to as a "cover window") such as a transparent resin plate or a glass plate may be disposed on the viewing-side of the image display cell for the purpose of, for example, preventing damage to the image display cell due to an impact from the outer surface. In a display device with a cover window disposed in front of an image display cell, the image display cell and the cover window are bonded to each other with a pressure sensitive adhesive sheet interposed therebetween.

[0004] It is suggested in Patent Document 1 that an both sides pressure sensitive adhesive-equipped optical film for formation of a display device in which an optical film such as a polarizing plate is bonded to a surface of an image display cell, and a cover window is disposed on a viewing-side surface thereof. In both sides pressure sensitive adhesive-equipped optical film, one surface of the optical film is provided with a pressure sensitive adhesive layer for bonding the film to an image display cell, and the other surface of the optical film is provided with a pressure sensitive adhesive layer for bonding the film to a cover window or the like.

PRIOR ART DOCUMENT

[0005] Patent Document 1: JP 2016-157077 A

SUMMARY OF THE INVENTION

5 PROBLEMS TO BE SLVED BY THE INVENTION

[0006] In display devices of smartphones, tablet terminals and notebook personal computers, in general, light receiving elements such as a camera and an optical sensor, and light emitting elements such as a LED are arranged in a bezel region on the outer periphery of a display region. In recent years, popularization of bezel-less (full-display) display devices
10 has progressed mainly in mobile devices such as smartphones.

[0007] With popularization of bezel-less display devices, it is necessary to change the arrangement of optical elements (light receiving elements and/or light emitting elements) arranged in a bezel region in a conventional display device. A method has been proposed in which an opening is provided in a display region of a display device and optical elements such
15 as a camera are stored under or in the opening. The opening provided in the display region is viewed from the outside, and therefore it is desirable that the opening be uniform in shape. For this reason, studies have been conducted on a method in which an opening is formed by performing processing with an ultraviolet laser which causes little heat damage and has high processing accuracy.

[0008] When an opening is formed in optical members such as a polarizing plate and a pressure sensitive adhesive sheet by laser processing, followed by bonding the members, it is not easy to accurately adjust the positions of the opening among a plurality of optical members. When a pressure sensitive adhesive layer is laminated to the optical member, followed by forming an opening by applying an ultraviolet laser, it may be possible to improve
25 productivity and the yield because position adjustment among the members is not required.

[0009] However, formation of an opening by applying an ultraviolet laser to a laminate including a pressure sensitive adhesive layer may cause poor processing of the pressure sensitive adhesive layer, ingress of bubbles into the pressure sensitive adhesive layer, delamination at a bonding interface of the pressure sensitive adhesive layer, and ingress of
30 bubbles into the bonding interface. In view of such problems, an object of the present invention is to provide an optical laminate for display devices which is excellent in

processability with an ultraviolet laser or the like, and an optical laminate having an opening extending through a plurality of optical members.

MEANS FOR SOLVING THE PROBLEM

5 [0010] An optical laminate of the present invention includes an optical film including a polarizer; a first pressure sensitive adhesive layer disposed on one principal surface of the optical film; a first adherend bonded to the first pressure sensitive adhesive layer; a second pressure sensitive adhesive layer disposed on the other principal surface of the optical film; and a second adherend bonded to the second pressure sensitive adhesive layer. The adherend
10 bonded to the pressure sensitive adhesive layer may be firmly adhered to the pressure sensitive adhesive layer, or temporarily attached on the pressure sensitive adhesive layer.

[0011] The first pressure sensitive adhesive layer and the second pressure sensitive adhesive layer are transparent pressure sensitive adhesive layers having a light transmittance of 85% or more at a wavelength of 420 nm. The first pressure sensitive
15 adhesive layer has ultraviolet absorbability, and has a light transmittance of 80% or less at a wavelength of 355 nm. The first pressure sensitive adhesive layer may have a light transmittance of 20% or more at a wavelength of 355 nm.

[0012] The thickness of the first pressure sensitive adhesive layer is, for example, 30 μm or more. The storage elastic modulus of the first pressure sensitive adhesive layer at 25°C is
20 preferably 0.35 MPa or less. The first pressure sensitive adhesive layer may be a photocurable pressure sensitive adhesive containing a photocurable compound and a photopolymerization initiator.

[0013] The second pressure sensitive adhesive layer may have ultraviolet absorbability, or may have no ultraviolet absorbability. The thickness of the second pressure sensitive
25 adhesive layer may be smaller than the thickness of the first pressure sensitive adhesive layer. When the thickness of the second pressure sensitive adhesive layer is larger than 30 μm , it is preferable that the second pressure sensitive adhesive layer has ultraviolet absorbability, and the light transmittance at a wavelength of 355 nm is 80% or less. The light transmittance of the second pressure sensitive adhesive layer at a wavelength of 355 nm may
30 be larger than the light transmittance of the first pressure sensitive adhesive layer at a wavelength of 355 nm. The storage elastic modulus of the second pressure sensitive adhesive

layer at 25°C may be larger than the storage elastic modulus of the first pressure sensitive adhesive layer at 25°C.

[0014] The optical film may include a resin film on one surface or both surfaces of the polarizer. The resin film bonded to the polarizer may have a light transmittance of 10% or less at a wavelength of 355 nm.

[0015] Examples of the adherend temporarily attached on the pressure sensitive adhesive layer include release films. The adherend firmly adhered to the first pressure sensitive adhesive layer is, for example, a cover window. The adherend firmly adhered to the second pressure sensitive adhesive layer is, for example, an image display cell. The image display cell is, for example, an organic EL cell. The organic EL cell may include a polyimide film.

[0016] A principal surface of the optical laminate on the first adherend-side or a principal surface of the optical laminate on the second adherend-side is irradiated with an ultraviolet laser to form an opening (through-hole) extending through the first adherend, the first pressure sensitive adhesive layer, the optical film, the second pressure sensitive adhesive layer and the second adherend. It is preferable that the adherend disposed on the surface irradiated with an ultraviolet laser has ultraviolet absorbability, and the light transmittance at a wavelength of 355 nm is 70% or less.

[0017] For example, when an optical laminate with a release film temporarily attached on each of the first pressure sensitive adhesive layer and the second pressure sensitive adhesive layer is irradiated with an ultraviolet laser to form a through-hole, the light transmittance of the release film on any one of the surfaces at a wavelength of 355 nm is preferably 70% or less. The release film on the ultraviolet-irradiated surface may have a light transmittance of 15% or more at a wavelength of 355 nm.

[0018] An optical laminate with a release film temporarily attached on the first pressure sensitive adhesive layer and an image display cell firmly adhered to the second pressure sensitive adhesive layer may be irradiated with an ultraviolet laser to form a through-hole. When an ultraviolet laser is applied from the image display cell-side, it is preferable that the image display cell has ultraviolet absorbability. For example, when the image display cell includes a polyimide film, the polyimide film has ultraviolet absorbability. When an ultraviolet laser is applied from the release film-side, it is preferable that the release film has ultraviolet absorbability. In this case, the light transmittance of the release film at a

wavelength of 355 nm is preferably from 15 to 70%.

[0019] The adherend on the pressure sensitive adhesive layer may be replaced by another adherend. For example, the release film temporarily attached on the second pressure sensitive adhesive layer may be peeled off, followed by bonding an image display cell, or the release film temporarily attached on the first pressure sensitive adhesive layer may be peeled off, followed by bonding a cover window. The release film temporarily attached on the pressure sensitive adhesive layer may be replaced by another release film.

[0020] The adherend may be replaced after a through-hole is formed. For example, after formation of a through-hole in an optical laminate with a release film attached on the first pressure sensitive adhesive layer and an image display cell firmly adhered to the second pressure sensitive adhesive layer, the release film may be peeled off from the first pressure sensitive adhesive layer, followed by bonding a cover window to the first pressure sensitive adhesive layer.

[0021] The optical element is arranged in the through-hole or under the through-hole to form a display device including an image display element and an optical element. Examples of the optical element arranged in the through-hole or under the through-hole include light receiving elements such as cameras and optical sensors, and light emitting elements such as LEDs.

EFFECTS OF THE INVENTION

[0022] The optical laminate of the present invention is excellent in processability with an ultraviolet laser because in addition to an adherend on a laser-irradiated surface, a pressure sensitive adhesive layer has ultraviolet absorbability. The optical laminate of the present invention is applicable for formation of a display device in which an optical element such as a camera is arranged in a display region of the device.

BRIEF DESCRIPTION OF THE DRAWINGS

[0023] FIG. 1A is a perspective view of an optical laminate of one embodiment, and FIG. 1B is a sectional view thereof.

FIG. 2 is a sectional view of an optical laminate of one embodiment.

FIG. 3 is a sectional view of an optical laminate of one embodiment.

FIG. 4 is a sectional view of an image display device of one embodiment.

FIG. 5 is a sectional view of an optical laminate of one embodiment.

FIG. 6 is a sectional view of an optical laminate of one embodiment.

FIG. 7 is a sectional diagram showing a stage in the middle of a step of cutting out a
5 sheet-like optical laminate from a mother substrate.

FIG. 8 is a sectional diagram showing a stage in the middle of a step of cutting out a
sheet-like optical laminate from a mother substrate.

FIG. 9 is a sectional view of an optical laminate of one embodiment.

FIG. 10 is a sectional view of an optical laminate of one embodiment.

FIG. 11 is a sectional view of an optical laminate of one embodiment.

FIG. 12 is a sectional view of an optical laminate of one embodiment.

FIG. 13 is a sectional diagram showing a stage in the middle of a step of cutting out
a sheet-like optical laminate from a mother substrate.

FIG. 14 is a micrograph of a release film in which bubbles are generated on the
15 periphery of a through-hole.

DETAILED DESCRIPTION OF PREFERRED EMBODIMENTS

[0024] The optical laminate of the present invention includes an optical film including a
polarizer, and pressure sensitive adhesive layers disposed on both surfaces of the optical film.

20 An adherend is bonded to each of the pressure sensitive adhesive layers on both surfaces of
the optical film. The adherend may be firmly adhered or releasably attached (temporarily
attached) to the pressure sensitive adhesive layer. At least one of the pressure sensitive
adhesive layers disposed on both surfaces of the optical film has ultraviolet absorbability.

[0025] One embodiment of the optical laminate has a through-hole extending through the
25 optical film and the pressure sensitive adhesive layers disposed on both surfaces of the optical
film. The through-hole may extend through an adherend bonded to the surface of the
pressure sensitive adhesive layer. Another embodiment of the optical laminate is a laminate
before formation of a through-hole, and is suitable for processing with an ultraviolet laser
because at least one of the pressure sensitive adhesive layers disposed on both surfaces of the
30 optical film has ultraviolet absorbability.

[0026] FIG. 1A is a perspective view of an optical laminate 101 having a through-hole. The

optical laminate 101 includes a first pressure sensitive adhesive layer 21 (viewing-side pressure sensitive adhesive layer) on one surface of the optical film 10, and a second pressure sensitive adhesive layer 22 (cell-side pressure sensitive adhesive layer) on the other surface of the optical film 10. A release film 41 as a first adherend is temporarily attached on the first
5 pressure sensitive adhesive layer 21, and an image display cell 70 as a second adherend is firmly adhered on the second pressure sensitive adhesive layer 22. The optical laminate 101 has a through-hole 5 that extends through the image display cell 70, the second pressure sensitive adhesive layer 22, the optical film 10, the first pressure sensitive adhesive layer 21 and the first release film 41.

10 **[0027]** FIG. 1B is a sectional view of the optical laminate 101. FIG. 1B corresponds to a cross-section taken along line B-B in FIG. 1A. FIG. 2 is a cross-sectional view of the optical laminate 102 with release films 41 and 42 temporarily attached on both principal surfaces of both sides pressure sensitive adhesive-equipped optical film 25. The both sides pressure sensitive adhesive-equipped optical film 25 includes a first pressure sensitive adhesive layer
15 21 on one principal surface of the optical film 10 and a second pressure sensitive adhesive layer 22 on the other principal surface of the optical film 10. Release films 41 and 42 as adherends are temporarily attached on the surfaces of the pressure sensitive adhesive layers 21 and 22. As shown in FIG. 5, the release films 41 and 42 may protrude outside the lateral surface of the both sides pressure sensitive adhesive-equipped optical film 25.

20 **[0028]** The release film 42 temporarily attached on the second pressure sensitive adhesive layer 22 is peeled off, and an image display cell 70 is bonded onto the second pressure sensitive adhesive layer 22 to obtain an optical laminate 103 shown in FIG. 3. Although, in FIG 3, the respective optical members that constitute the optical laminate 103 have lateral surfaces aligned with one another, the lateral surfaces of the optical members do not have to
25 be aligned. For example, the release film 41 may protrude outside the lateral surface of the first pressure sensitive adhesive layer 21, and the image display cell 70 may protrude outside the lateral surface of the second pressure sensitive adhesive layer 22.

[0029] The optical laminate 103 is provided with the through-hole 5 to form the optical laminate 101. When the laminate including the both sides pressure sensitive adhesive-
30 equipped optical film 25 is subjected to perforation processing, a through-hole extending through the optical film 10 and the pressure sensitive adhesive layers 21 and 22 disposed on

both surfaces of the optical film 10, so that the perforation process can be simplified, and the yield may be improved.

[0030] The first release film 41 temporarily attached on the first pressure sensitive adhesive layer 21 of the optical laminate 101 shown in FIG.1B is peeled off, and a cover window 80 is bonded onto the first pressure sensitive adhesive layer 21 to obtain a display device 204 shown in FIG. 4. An optical element 91 is arranged under the through-hole 5. The optical element 91 is, for example, a light receiving element such as a camera or an optical sensor. By arranging the through-hole 5 extending through the optical laminate from the image display cell 70 to the first pressure sensitive adhesive layer 21, external light is transmitted through the cover window 80 to reach the optical element 91. When the optical element 91 is a light emitting element, light from the optical element 91 is transmitted through the cover window 80 by way of the through-hole 5, and emitted to the outside. The optical element 91 may be disposed in the through-hole 5.

[0031] The through-hole 5 of the optical laminate 101 is formed by, for example, performing perforation processing with an ultraviolet laser applied from the image display cell 70-side (the lower side in FIG. 3) of the laminate 103 shown in FIG. 3. When the optical film 10 and the image display cell 70 are laminated beforehand, and perforation processing is performed so as to pierce the laminate 103, there is no need to align the hole during lamination, so that the device preparation process can be simplified, and improvement of the yield is expected.

[0032] When the laminate 103 is irradiated with an ultraviolet laser to subject the laminate to perforation processing, it is preferable that the adherend on the laser-irradiated surface has ultraviolet absorbability. For example, when an ultraviolet laser is applied from the image display cell 70-side of the laminate 103, it is preferable that the image display cell 70 has ultraviolet absorbability. When an ultraviolet laser is applied from the first release film 41-side of the laminate 103, it is preferable that the first release film 41 has ultraviolet absorbability.

[0033] Since the adherend on the laser-irradiated surface has ultraviolet absorbability, the adherend absorbs an ultraviolet laser, generates heat and vaporizes, and the pressure sensitive adhesive layer, the optical film and the like arranged on the adherend are blown off with the vapor, so that a through-hole is formed.

[0034] In order to efficiently absorb the ultraviolet laser, the light transmittance of the

adherend on the laser-irradiated surface at a wavelength of 355 nm is preferably 70% or less, more preferably 60% or less, further preferably 50% or less. The light transmittance of the adherend on the laser-irradiated surface at a wavelength of 355 nm may be 40% or less, 30% or less, 20% or less, 10% or less, 5% or less, or 1% or less.

5 [0035] When the image display cell 70 includes a polyimide film as a substrate 71, application of an ultraviolet laser from the image display cell 70-side ensures excellent perforation processability because the polyimide film has high ultraviolet absorbability.

[0036] In the display device 204, the first pressure sensitive adhesive layer 21 disposed on the viewing-side of the optical film 10 may be required to have level difference followability, so
10 that a thick and soft pressure sensitive adhesive layer is used. It is preferable that the first pressure sensitive adhesive layer 21 has a thickness of, for example, 30 μm or more, and a storage elastic modulus of 0.35 MPa or less at 25°C.

[0037] As described above, when the member disposed on the laser-irradiated surface has ultraviolet absorbability, a member arranged thereon is also processed by the laser. Thus,
15 when merely perforation is performed, the pressure sensitive adhesive layer and the optical film disposed on the adherend are not necessarily required to have ultraviolet absorbability. However, since the pressure sensitive adhesive layer is soft, and has lower processability as compared with a film material or the like, formation of a through-hole may be insufficient, or bubbles may be generated on the periphery of a laser-processed portion.

20 [0038] In particular, the first pressure sensitive adhesive layer 21 may be required to have level difference followability, and is thick and soft, so that processing failure easily occurs during processing with a laser. Further, in the optical laminate 103 shown in FIG. 3, the first pressure sensitive adhesive layer 21 and the release film 41 are temporarily attached to each other, and thus have small adhesive strength at the interface, and therefore a problem may
25 arise such that the release film is peeled off from the pressure sensitive adhesive layer on the periphery of a laser-irradiated region.

[0039] When the first pressure sensitive adhesive layer 21 has ultraviolet absorbability, the first pressure sensitive adhesive layer 21 absorbs an ultraviolet laser, and therefore processability is improved, so that problems such as processing failure and peeling of the
30 release film can be suppressed. The light transmittance of the first pressure sensitive adhesive layer 21 at a wavelength of 355 nm is preferably 80% or less, more preferably 75%

or less.

[0040] The second pressure sensitive adhesive layer 22 may also have ultraviolet absorbability. When ultraviolet absorbability is imparted to the second pressure sensitive adhesive layer, the light transmittance of the second pressure sensitive adhesive layer at a wavelength of 355 nm is preferably 80% or less, more preferably 75% or less. In general, the second pressure sensitive adhesive layer 22 for bonding the optical film 10 and the image display cell 70 is not required to have level difference followability. As compared to the first pressure sensitive adhesive layer 21, the second pressure sensitive adhesive layer 22 is thinner and harder, and therefore processing failure hardly occurs even when the second pressure sensitive adhesive layer 22 does not have ultraviolet absorbability. In particular, when the thickness of the second pressure sensitive adhesive layer 22 is 30 μm or less, there is little processing failure even when the second pressure sensitive adhesive layer 22 does not have ultraviolet absorbability.

[0041] [Components of optical laminate]

Hereinafter, preferred embodiments of the optical elements that constitute the optical laminate will be described.

[0042] <Image display cell>

In the optical laminate shown in FIGS. 1B, 3 and 4, the image display cell 70 is a top emission type organic EL cell, which includes a metal electrode 73, an organic light emitting layer 75 and a transparent electrode 77 in this order on the substrate 71. On the transparent electrode 77, a sealing material 79 is stacked. Preferably, the sealing material 79 is disposed so as to cover the electrodes 73 and 77 and the lateral surfaces of the organic light emitting layer 75 although this is not shown in the drawings.

[0043] As the substrate 71, a glass substrate or a plastic substrate is used. In the top emission type organic EL cell, the substrate 71 is not required to be transparent, and a high heat-resistance film such as a polyimide film may be used as the substrate 71. The organic light emitting layer 75 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. The transparent electrode 77 is a metal oxide layer or a metal thin film, and transmits light from the organic light emitting layer 75. A back sheet (not shown) may be disposed on the back side of the substrate 71 for the purpose of protecting and reinforcing the substrate.

[0044] The organic EL cell may be a bottom emission type organic EL cell in which a transparent electrode, an organic light emitting layer and a metal electrode are stacked in this order on a substrate. In the bottom emission type organic EL cell, a transparent substrate is used, and the substrate is arranged on the viewing-side (the second pressure sensitive adhesive layer 22-side). The image display cell is not limited to the organic EL cell, and may be a liquid crystal cell or an electrophoretic display cell (electronic paper). A touch panel sensor (not shown) may be disposed on a viewing-side surface of the image display cell 70.

[0045] <Optical film>

The optical film 10 is bonded onto the organic EL cell 70 with the second pressure sensitive adhesive layer 22 interposed therebetween. The optical film 10 includes a polarizer 11. On both surfaces of the polarizer 11, transparent films 13 and 15 are laminated as polarizer protective films. The pressure sensitive adhesive layer may be disposed directly on the polarizer 11 in place of the polarizer protective films on one surface or both surfaces of the polarizer.

[0046] Examples of the polarizer 11 include films obtained by uniaxially stretching a hydrophilic polymer film such as a polyvinyl alcohol-based film, a partially formalated polyvinyl alcohol-based film or an ethylene-vinyl acetate copolymer-based partially saponified film with a dichroic substance such as iodine or a dichroic dye adsorbed to the film, and polyene-based oriented films such as dehydrated products of polyvinyl alcohol and dehydrochlorinated products of polyvinyl chloride.

[0047] As the polarizer 11, a thin polarizer having a thickness of 10 μm or less can also be used. Examples of the thin polarizer include thin polarizers as described in JP 51-069644 A, JP 2000-338329 A, WO 2010/100917, JP 4691205 B, JP 4751481 B, and so on. These thin polarizers can be prepared by, for example, a method including the steps of: stretching a laminate of polyvinyl alcohol -based resin layer and a stretchable resin base film; and performing iodine dying to the polyvinyl alcohol -based resin layer.

[0048] As the transparent films 13 and 15, a transparent resin film such as a cellulose-based resin, a cyclic polyolefin-based resin, an acryl-based resin, a phenylmaleimide-based resin or a polycarbonate-based resin is preferably used. The light transmittance of the transparent films 13 and 15 at a wavelength of 420 nm is preferably 85% or more. When the

transparent films 13 and 15 are disposed on both surfaces of the polarizer 11, the transparent films 13 and 15 may be films composed of the same resin material, or films composed of different resin materials.

[0049] The transparent films 13 and 15 disposed on one surface or both surfaces of the polarizer 11 may have ultraviolet absorbability. Since the transparent films 13 and 15 have ultraviolet absorbability, processability of the pressure sensitive adhesive layers 21 and 22 disposed adjacent to the optical film 10 with an ultraviolet laser tends to be improved. The light transmittance at a wavelength of 355 nm of the transparent film disposed on one surface or both surfaces of the polarizer 11 may be 10% or less, or 5% or less.

[0050] When the transparent film 13 disposed on the viewing-side of the polarizer 11 has ultraviolet absorbability, an ultraviolet ray in external light is absorbed by the transparent film 13, and therefore deterioration of the polarizer 11 by the ultraviolet ray can be suppressed. The light transmittance of the transparent film 13 at a wavelength of 355 nm may be 10% or less, or 5% or less.

[0051] By applying an ultraviolet absorbing coating to the film surface, or incorporating an ultraviolet absorber in the film, ultraviolet absorbability can be imparted to the transparent film. 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. A resin material having ultraviolet absorbability, such as polyethylene naphthalate (PEN), may be used as a material of the transparent film,.

[0052] The optical film 10 may include an optically functional film laminated on one surface or both surfaces of the polarizer 11 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. The optical film 10 may include a touch panel sensor as the optically functional film. The transparent films 13 and 15 contacting the polarizer may have functions of both a polarizer protective film and an optically functional film. The transparent films 13 and 15 may have a function of an electrode substrate film of a touch panel sensor.

[0053] The metal electrode 73 of the organic EL cell 70 has light reflectivity. Thus, when

external light is incident to the inside of the organic EL cell, light is reflected at the metal electrode 73, and reflected light appears as a mirror surface when viewed from the outside. By arranging a circularly polarizing plate as the optical film 10 on a viewing-side surface of the organic EL cell 70, re-emission of reflected light from the metal electrode 73 to the outside
5 can be prevented to improve the visibility and visuality of the screen of the display device.

[0054] The circularly polarizing plate includes a retardation film on a surface of the polarizer 11 on the organic EL cell 70-side. The transparent film 15 disposed adjacent to the polarizer 11 may be a retardation film. When the retardation film has a retardation of $\lambda/4$, and the angle between the slow axis direction of the retardation film and the absorption axis
10 direction of the polarizer 11 is 45° , the laminate of the polarizer and the retardation film functions as a circularly polarizing plate for suppressing re-emission of reflected light from the metal electrode 73. The retardation film of the circularly polarizing plate may be a laminate of two or more films. For example, by laminating a polarizer, a $\lambda/2$ plate, and a $\lambda/4$ plate in such a manner that their optical axes form a predetermined angle, a broadband
15 circularly polarizing plate that functions as a circularly polarizing plate over a wide wavelength range of visible light is obtained.

[0055] <First pressure sensitive adhesive layer>

The first pressure sensitive adhesive layer 21 is disposed on the viewing-side of the optical film 10 in the display device 204, and is used for bonding the optical film 10 to a
20 transparent member such as the cover window 80. It is preferable that the first pressure sensitive adhesive layer 21 is a transparent pressure sensitive adhesive sheet, and has a high visible light transmittance. The light transmittance of the first pressure sensitive adhesive layer 21 at a wavelength of 420 nm is 85% or more, preferably 88% or more, more preferably 90% or more. The haze of the first pressure sensitive adhesive layer 21 is preferably 2% or
25 less, more preferably 1% or less.

[0056] The first pressure sensitive adhesive layer 21 may be a laminate of two or more pressure sensitive adhesive sheets. The second pressure sensitive adhesive layer 22 described later may be a laminate of two or more pressure sensitive adhesive sheets. When the pressure sensitive adhesive layer is a laminated pressure sensitive adhesive sheet, the
30 light transmittance and haze of the laminate are preferably within the above-described ranges.

[0057] As the pressure sensitive adhesive that forms the pressure sensitive adhesive layer 21, one containing as a base polymer 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.

[0058] An acryl-based pressure sensitive adhesive containing an acryl-based polymer as the base polymer is preferably used for forming the first pressure sensitive adhesive layer 21, because it is excellent in optical transparency, exhibits moderate wettability and adhesion characteristics such as cohesiveness and adhesiveness, and is also excellent in weather resistance, heat resistance, etc. As for the first pressure sensitive adhesive layer 21, an acryl-based pressure sensitive adhesive pressure is also preferable for the pressure sensitive adhesive that constitutes the second pressure sensitive adhesive layer 22 described later. The content of the acryl-based base polymer in the acryl-based pressure sensitive adhesive is preferably 50% by weight or more, more preferably 70% by weight or more, and further preferably 80% or more based on a solid content of the pressure sensitive adhesive composition.

[0059] As the acryl-based base polymer, one having a monomer unit of a (meth)acrylic acid alkyl ester as a main skeleton is suitably used. In this specification, the “(meth)acryl” means acryl and/or methacryl.

[0060] As the (meth)acrylic acid alkyl ester, a (meth)acrylic acid alkyl ester with the alkyl group having 1 to 20 carbon atoms is preferable. The (meth)acrylic acid alkyl ester may have a branched alkyl group. The content of the (meth)acrylic acid alkyl ester is preferably 40% by weight or more, more preferably 50% by weight or more, further preferably 60% by weight or more based on the total amount of monomer components that form the base polymer. The acryl-based base polymer may be a copolymer of a plurality of (meth)acrylic acid alkyl esters. The arrangement of constituent monomer units may be random, or blockwise.

[0061] The acryl-based base polymer preferably contains an acryl-based monomer unit having a crosslinkable functional group as a copolymer component. When the base polymer has a crosslinkable functional group, the gel fraction of the pressure sensitive adhesive can be easily increased by thermal crosslinking, photocuring, etc. of the base polymer. Examples of

the acryl-based monomer having a crosslinkable functional group include hydroxy group-containing monomers and carboxyl group-containing monomers. Particularly, it is preferred that a hydroxy group-containing monomer is contained as the copolymer component of the base polymer. When the base polymer has a hydroxy group-containing monomer as a monomer unit, the crosslinkability by the isocyanate-based crosslinker is improved, and cloudiness of the pressure sensitive adhesive under a high-temperature and high-humidity environment tends to be suppressed, so that a pressure sensitive adhesive having high transparency is obtained.

[0062] Examples of the hydroxy group-containing monomer include 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 acrylate.

[0063] The content of the hydroxy group-containing monomer is preferably 0.1 to 50% by weight, more preferably 1 to 40% by weight, further preferably 3 to 30% by weight based on the total amount of monomer components that form the base polymer.

[0064] Preferably, the acryl-based base polymer contains, in addition to a hydroxy group-containing monomer unit, a monomer unit having high polarity, such as a nitrogen-containing monomer. When the acryl-based base polymer contains a high-polarity monomer unit such as a nitrogen-containing monomer unit in addition to a hydroxy group-containing monomer unit, the pressure sensitive adhesive has high adhesiveness and retentive strength, and cloudiness under a high-temperature and high-humidity environment is suppressed.

[0065] 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; cyano group containing monomer such as acrylonitrile and methacrylonitrile. Among them, N-vinylpyrrolidone and (meth)acryloylmorpholine are preferably used.

[0066] The content of the nitrogen-containing monomer is preferably 0.1 to 50% by weight, more preferably 1 to 40% by weight, further preferably 3 to 30% by weight based on the total amount of monomer components that form the base polymer.

[0067] Monomer components that form the acryl-based polymer may include a polyfunctional monomer component. The polyfunctional monomer is a monomer having at least two polymerizable functional groups each having an unsaturated double bond, such as (meth)acryloyl groups or vinyl groups. The polyfunctional monomer may have three or more
5 polymerizable functional groups per molecule.

[0068] The acryl-based base polymer can be prepared by *e.g.*, solution polymerization, UV polymerization, mass polymerization or emulsification polymerization. Solution polymerization methods or UV polymerization is preferable from the viewpoint of transparency, water resistance, costs and so on. As a solvent for solution polymerization,
10 ethyl acetate, toluene or the like is generally used.

[0069] In preparation of the base polymer, a polymerization initiator such as a photopolymerization initiator or a thermopolymerization initiator may be used depending on a type of polymerization reaction. The photopolymerization initiator is not particularly limited as long as it initiates photopolymerization, and examples of the photopolymerization
15 initiator include: a benzoin ether-based photopolymerization initiator, an acetophenone-based photopolymerization initiator, an α -ketol-based photopolymerization initiator, an aromatic sulfonyl chloride-based photopolymerization initiator, a photoactive oxime-based photopolymerization initiator, a benzoin-based photopolymerization initiator, a benzyl-based photopolymerization initiator, a benzophenone-based photopolymerization initiator, a ketal-
20 based photopolymerization initiator, a thioxanthone-based photopolymerization initiator, an acyl phosphine oxide-based photopolymerization initiator. 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
25 sodium ascorbate).

[0070] For adjusting the molecular weight of the base polymer, a chain-transfer agent may be used. The chain-transfer agent can receive radicals from a growing polymer chain to stop extension of the polymer, and the chain-transfer agent having received the radicals can attack the monomer to start polymerization again. As the chain-transfer agent, for example, a thiol
30 such as α -thioglycerol, lauryl mercaptan, glycidyl mercaptan, mercaptoacetic acid, 2-mercaptoethanol, thioglycolic acid, 2-ethylhexyl thioglycollate or 2,3-dimercapto-1-propanol is

suitably used.

[0071] 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 (post-polymerization). By performing prepolymerization followed by post-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 post-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 post-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.

[0072] 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 the polyfunctional monomer component may be added and subjected to post-polymerization.

[0073] 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.

[0074] 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.

[0075] A remain part of the monomer component (post-polymerization monomer) that forms an acryl-based base polymer, and a polymerization initiator, a chain-transfer agent, a silane coupling agent, a crosslinker and additives as necessary are mixed with the prepolymer composition to form a pressure sensitive adhesive composition. Preferably, the post-polymerization monomer contains a polyfunctional monomer. The post-polymerization monomer may contain a monofunctional monomer in addition to a polyfunctional monomer.

[0076] The photopolymerization initiator and the chain-transfer agent to be used for post-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 post-polymerization may be omitted.

[0077] The base polymer may have a crosslinked structure as necessary. The crosslinked structure is formed by, for example, adding a crosslinker after polymerization of the base polymer or after prepolymerization. As the crosslinker, a common cross linker can be used, such as an isocyanate-based crosslinker, an epoxy-based crosslinker, an oxazoline-based crosslinker, an aziridine-based crosslinker, a carbodiimide-based crosslinker or a metal chelate-based crosslinker. The content of the crosslinker is normally 0 to 5 parts by weight, preferably 0 to 3 parts by weight based on 100 parts by weight of the acryl-based base polymer.

[0078] When the pressure sensitive adhesive composition includes a crosslinker, it is preferred to perform a heating for crosslinking to form crosslinked structure before bonding to an adherend. The heating temperature and the heating time in the crosslinking treatment are appropriately set according to a type of crosslinker to be used, and crosslinking is normally performed by heating at 20°C to 160°C for 1 minute to about 7 days.

[0079] The pressure sensitive adhesive that constitutes the pressure sensitive adhesive layer 21 may be a photocurable pressure sensitive adhesive that can be cured by light irradiation after being bonded to an adherend such as the cover window 80. For example, when a photocurable pressure sensitive adhesive is used for bonding a cover window having a raised portion such as decorative printing, ingress of bubbles into a region near the raised portion, etc. can be suppressed by imparting level difference followability by bonding the cover window before photocuring when the pressure sensitive adhesive is soft. Bonding reliability can be improved by applying an ultraviolet ray or the like to photocure the pressure sensitive adhesive after bonding.

[0080] The photocurable pressure sensitive adhesive is preferably one containing, for example, a photocurable compound (monomer or oligomer having a photopolymerizable functional group) and a photopolymerization initiator in addition to the polymer. It is preferable that the photocurable pressure sensitive adhesive contains, as a photopolymerizable compound, a polyfunctional compound having two or more polymerizable functional groups per molecule. The amount of the polyfunctional compound used varies depending on the molecular weight, the number of functional groups and the like of the compound, and is preferably 10% by weight or less, more preferably 5% by weight or less, based on the total amount of monomer components of the base polymer.

[0081] A mixture (pressure sensitive adhesive composition) of the prepolymer composition and the unpolymerized monomer component may be used as it is as a photocurable pressure sensitive adhesive. A photocurable pressure sensitive adhesive layer may be formed by applying a pressure sensitive adhesive composition onto a base member, and then adjusting the polymerization ratio during post-polymerization so that part of the monomer remains in an uncured state.

[0082] In addition to the components exemplified above, the pressure sensitive adhesive layer 21 may include additives such as a silane coupling agent, a tackifier, a plasticizer, a

softener, a degradation inhibitor, a filler, a colorant, an antioxidant, a surfactant and an antistatic agent.

[0083] For imparting ultraviolet absorbability to the pressure sensitive adhesive layer 21, an ultraviolet absorber may be used. The content of the ultraviolet absorber in the pressure sensitive adhesive layer 21 is about 0.05 to 10% by weight, and may be adjusted so that the light transmittance of the pressure sensitive adhesive layer 21 at a wavelength of 355 nm is 80% or less. Examples of the ultraviolet absorber include benzotriazole-based ultraviolet absorbers, benzophenone-based ultraviolet absorbers, triazine ultraviolet absorbers, salicylate-based 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 excellent compatibility with acryl-based polymers, and ensures that an acryl-based pressure sensitive adhesive sheet with high transparency is easily obtained. Among them, triazine-based ultraviolet absorbers containing a hydroxyl group, and benzotriazole-based ultraviolet absorbers containing one benzotriazole backbone per molecule are preferable.

[0084] 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), 2,4-bis-[[4-(2-ethylhexyloxy)-2-hydroxy]-phenyl]-6-(4-methoxyphenyl)-1,3,5-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).

[0085] 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-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 (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 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-tetrahydrophthalimido-methyl)-5-methylphenyl]benzotriazole ("Sumisorb 250" manufactured by Sumitomo Chemical Company, Limited).

[0086] The pressure sensitive adhesive layer can be formed by applying the pressure sensitive adhesive composition onto a substrate in a layer form, and performing drying of solvent and crosslinking and/or curing of the base polymer as necessary. When the pressure sensitive adhesive composition is photocurable, the pressure sensitive adhesive composition may be applied onto the supporting substrate, and then irradiated with ultraviolet ray and/or short wavelength visible light to photocure the pressure sensitive adhesive composition. During photocuring, it is preferable to attach a cover sheet to the surface of the applied layer and irradiate the pressure sensitive adhesive composition with light in a state where the pressure sensitive adhesive composition is sandwiched between two sheets, to prevent the inhibition of polymerization due to oxygen.

[0087] The thickness of the first pressure sensitive adhesive layer 21 is not particularly limited, and is generally about 5 to 1000 μm . When an adherend (e.g., cover window 80) that

is firmly adhered to the first pressure sensitive adhesive layer 21 includes a raised portion such as decorative printing and level difference followability is required for the pressure sensitive adhesive, the thickness of the first pressure sensitive adhesive layer 21 is preferably 30 μm or more. The thickness of the first pressure sensitive adhesive layer 21 may be 40 μm or more or 50 μm or more. The thickness of the first pressure sensitive adhesive layer 21 is preferably 500 μm or less, more preferably 300 μm or less, and more preferably 250 μm or less from the viewpoints of reduction in the weight and reduction in the thickness of the image display device, and in consideration of ease of forming the pressure sensitive adhesive layer, handling properties, etc.

[0088] The light transmittance of the first pressure sensitive adhesive layer 21 at a wavelength of 355 nm is 80% or less. Since the first pressure sensitive adhesive layer 21 has ultraviolet absorbability, processability of the first pressure sensitive adhesive layer is improved during processing of the laminate with an ultraviolet laser, and peeling at the bonding interface and ingress of bubbles into the bonding interface can be suppressed.

[0089] From the viewpoint of improving processability with an ultraviolet laser, the light transmittance of the first pressure sensitive adhesive layer 21 at a wavelength of 355 nm is preferably as small as possible. The light transmittance of the first pressure sensitive adhesive layer 21 at a wavelength of 355 nm may be 75% or less, 70% or less, or 65% or less.

[0090] When the first pressure sensitive adhesive layer 21 has ultraviolet absorbability, an ultraviolet ray in external light is absorbed by the first pressure sensitive adhesive layer 21, and therefore deterioration of the polarizer 11 by the ultraviolet ray can be suppressed. On the other hand, when the transparent film 13 disposed on the viewing-side of the polarizer 11 has ultraviolet absorbability, the first pressure sensitive adhesive layer 21 is not required to have high ultraviolet absorbability, and the first pressure sensitive adhesive layer 21 may have ultraviolet absorbability which enables exhibition of processability with an ultraviolet laser.

[0091] When the first pressure sensitive adhesive layer 21 is composed of a photocurable pressure sensitive adhesive, a large amount of an ultraviolet ray absorbed by an ultraviolet absorber or the like may cause hindrance of curing because the amount of the ultraviolet ray absorbed by a photopolymerization initiator is reduced. From the viewpoint of enhancing photocuring efficiency, the light transmittance of the first pressure sensitive adhesive layer 21

at a wavelength of 355 nm may be 20% or more, 25% or more, or 30% or more. Even when the first pressure sensitive adhesive layer 21 does not have a sufficient ultraviolet ray shielding property, degradation of the polarizer 11 by an ultraviolet ray can be suppressed as long as the transparent film 13 has ultraviolet absorbability.

5 [0092] When the first pressure sensitive adhesive layer 21 is required to have level difference followability, the storage elastic modulus G' of the first pressure sensitive adhesive layer 21 at 25°C is preferably 0.35 MPa or less, more preferably 0.30 MPa or less. On the other hand, when the first pressure sensitive adhesive layer 21 is excessively soft, transfer of the pressure sensitive adhesive to a cutting blade etc. may occur at the time of cutting a
10 pressure sensitive adhesive-equipped optical film to a sheet-like shape, or protrusion of the pressure sensitive adhesive layer from the lateral surface of the pressure sensitive adhesive-equipped optical film may occur. In addition, when the first pressure sensitive adhesive layer 21 is excessively soft, processing failure may occur during processing with a laser. Thus, the storage elastic modulus G' of the first pressure sensitive adhesive layer 21 at 25°C is
15 preferably 0.01 MPa or more, more preferably 0.02 MPa or more. The storage elastic modulus G' of the first pressure sensitive adhesive layer 21 at 25°C may be 0.03 MPa or more, 0.05 MPa or more, or 0.1 MPa or more.

[0093] <Second pressure sensitive adhesive layer>

The second pressure sensitive adhesive layer 22 is used for bonding the optical film
20 10 to the image display cell 70 in the display device 204. It is preferable that the second pressure sensitive adhesive layer 22 is a transparent pressure sensitive adhesive sheet, and has a high visible light transmittance. The light transmittance of the second pressure sensitive adhesive layer 22 at a wavelength of 420 nm is 85% or more, preferably 88% or more, more preferably 90% or more. The haze of the second pressure sensitive adhesive layer
25 22 is preferably 2% or less, more preferably 1% or less.

[0094] The pressure sensitive adhesive that constitutes the pressure sensitive adhesive layer 22 is not particularly limited, and can be appropriately selected from those having various polymers as base polymers. As described above, the pressure sensitive adhesive that constitutes the second pressure sensitive adhesive layer 22 is preferably an acryl-based
30 pressure sensitive adhesive having an acryl-based polymer as a base polymer.

[0095] The thickness of the second pressure sensitive adhesive layer 22 is not particularly

limited. Since the second pressure sensitive adhesive layer 22 is not required to have level difference followability, the thickness of the second pressure sensitive adhesive layer 22 may be smaller than the thickness of the first pressure sensitive adhesive layer 21. The thickness of the second pressure sensitive adhesive layer 22 is preferably 3 to 30 μm , more preferably 5 to 27 μm , further preferably 10 to 25 μm .

[0096] The storage elastic modulus G' of the second pressure sensitive adhesive layer 22 at 25°C is, for example, about 0.02 to 5 MPa. Since the second pressure sensitive adhesive layer 22 is not required to have level difference followability, the storage elastic modulus G' of the second pressure sensitive adhesive layer at 25°C may be larger than the storage elastic modulus G' of the first pressure sensitive adhesive layer 21.

[0097] The second pressure sensitive adhesive layer 22 may have ultraviolet absorbability, or may have no ultraviolet absorbability. When the thickness of the second pressure sensitive adhesive layer 22 is 30 μm or less, a through-hole can be formed in the second pressure sensitive adhesive layer 22 by irradiating the laminate with an ultraviolet laser even when the second pressure sensitive adhesive layer does not have ultraviolet absorbability. Thus, the light transmittance of the second pressure sensitive adhesive layer at a wavelength of 355 nm may be 80% or more, 83% or more, or 85% or more. When the thickness of the second pressure sensitive adhesive layer 22 is larger than 30 μm , the light transmittance of the second pressure sensitive adhesive layer 22 at a wavelength of 355 nm is preferably 80% or less, more preferably 75% or less, from the viewpoint of improving processability with an ultraviolet laser. The light transmittance of the second pressure sensitive adhesive layer 22 at a wavelength of 355 nm may be larger than the light transmittance of the first pressure sensitive adhesive layer 21 at a wavelength of 355 nm.

[0098] <Both sides pressure sensitive adhesive-equipped optical film>

The both sides pressure sensitive adhesive-equipped optical film 25 is obtained by disposing the first pressure sensitive adhesive layer 21 on the viewing-side principal surface of the optical film 10 and disposing the second pressure sensitive adhesive layer 22 on the other principal surface of the optical film 10. Examples of the method for forming the first pressure sensitive adhesive layer 21 and the second pressure sensitive adhesive layer 22 on the optical film 10 include a method in which a pressure sensitive adhesive composition is applied onto a release film, a solvent and the like are removed by drying, and crosslinking

treatment is performed if necessary to form a pressure sensitive adhesive layer, followed by transferring the pressure sensitive adhesive layer onto the optical film 10; and a method in which a pressure sensitive adhesive composition is applied to the optical film 10, and a solvent and the like are removed by drying to form a pressure sensitive adhesive layer on the optical film. In the method including a pressure sensitive adhesive layer onto an optical film, a release film used for forming the pressure sensitive adhesive layer may be used as it is as the release films 41 and 42 of the both sides pressure sensitive adhesive-equipped optical film. When a pressure sensitive adhesive composition is applied onto the optical film 10 to form a pressure sensitive adhesive layer, a release film is disposed on the pressure sensitive adhesive layer after a solvent is removed by drying.

[0099] <Release Film>

As the release films 41 and 42 temporarily adhered to the pressure sensitive adhesive layer 21 and 22, release film having a release layer on a surfaces of film substrate is preferable. Examples of the material of the release layer include a silicone-based release agent, a fluorine-based release agent, a long chain alkyl-based release agent, and a fatty acid amide-based release agent. A silicone release agent is preferred because it can achieve both adhesion and peel properties with respect to the acryl-based pressure sensitive adhesive.

[0100] The film substrate of the release film is preferably a transparent resin film. Examples of the resin material include polyester-based resins such as polyethylene terephthalate and polyethylene naphthalate, acetate-based resins, polyethersulfone-based resins, polycarbonate-based resins, polyamide-based resins, polyimide-based resins, polyolefin-based resins, (meth)acryl-based resins, polyvinyl chloride-based resins, polyvinylidene chloride-based resins, polystyrene-based resins, polyvinyl alcohol-based resins, polyarylate-based resins, and polyphenylene sulfide-based resins. Among them, polyester-based resins such as polyethylene terephthalate (PET) are particularly preferable.

[0101] The thickness of each of the release films 41 and 42 is preferably from 10 to 200 μm , and more preferably from 25 to 150 μm . The thickness of the release film 41 and the thickness of the release film 42 may be the same or different.

[0102] When a laminate obtained by bonding the image display cell 70 to the second pressure sensitive adhesive layer 22 is processed by applying an ultraviolet laser, the optical properties of the release film 42 do not have a particular influence on laser processability

because the release film 42 has been peeled off. When an ultraviolet laser is applied from the image display cell 70-side, the release film 41 may have ultraviolet absorbability, or may have no ultraviolet absorbability. Thus, the light transmittance of each of the release films 41 and 42 at a wavelength of 355 nm may be 80% or more, 85% or more, or 90% or more. As will be described later in detail, when an ultraviolet laser is applied from a surface of the laminate on the release film-side, it is preferable that the release film on the laser-irradiated surface has ultraviolet absorbability, and the light transmittance of the release film at a wavelength of 355 nm is 15 to 70%.

[0103] [Cutting of optical film]

The laminate 102 in which the release films 41 and 42 are temporarily attached on the surfaces of the pressure sensitive adhesive layers 21 and 22 of the both sides pressure sensitive adhesive-equipped optical film 25 is cut to a predetermined size if necessary, the release films temporarily attached on the surfaces of the pressure sensitive adhesive layers are then peeled off, and the laminate is bonded to an adherend such as the image display cell 70 or the cover window 80.

[0104] A large-area sheet (mother substrate) is prepared by a roll-to-roll method, and the sheet is then cut to a predetermined size in conformity to the size of the adherend to obtain a sheet-like both sides pressure sensitive adhesive-equipped optical film. In this method, a large number of sheet-like products are obtained from the mother substrate, and therefore productivity can be improved. Generally, the mother substrate is cut to a sheet-like product size that matches the size (screen size) of the image display cell 70. Examples of the cutting method include a method in which the laminate is punched with a Thomson blade or the like; and a method using a cutter having a round blade or a flat blade, laser light, or hydraulic pressure.

[0105] In the laminate 102 shown in FIG. 2, the release films 41 and 42 are temporarily attached on the surfaces of the adhesive layers 21 and 22, and therefore the principal surfaces of the pressure sensitive adhesive layers are protected. On the other hand, the lateral surfaces of the pressure sensitive adhesive layers are exposed, glue missing and glue contamination may occur due to protrusion of the pressure sensitive adhesive from the lateral surfaces. In the sheet-like pressure sensitive adhesive-equipped optical film, the lateral surfaces of the pressure sensitive adhesive layers may be positioned inside the lateral surface

of the optical film 10 or the lateral surfaces of the release films 41 and 42 for preventing glue missing and glue contamination.

[0106] For example, as in the laminate 105 shown in FIG. 5, the lateral surfaces of the pressure sensitive adhesive layers 21 and 22 may be positioned inside the lateral surfaces of the release films 41 and 42 with the release films 41 and 42 placed so as to protrude outside the lateral surfaces of the optical film 10 and the pressure sensitive adhesive layers 21 and 22. The cross section of the laminate may have a shape as in the laminate 106 shown in FIG. 6. In FIG. 6, near the central part of the pressure sensitive adhesive layers 21 and 22 in the thickness direction, the lateral surfaces of the pressure sensitive adhesive layers 21 and 22 may be positioned inside the lateral surfaces of the release films 41 and 42; while, near the interface between the pressure sensitive adhesive layers 21 and 22 and the release films 41 and 42, the lateral surfaces of the pressure sensitive adhesive layers 21 and 22 substantially coincide with the lateral surfaces of the release films 41 and 42.

[0107] The both sides pressure sensitive adhesive-equipped optical film 25 in which the release films 41 and 42 are temporarily attached on both surfaces is cut with a pressure applied from a principal surface (surface provided with a release film) so that the end portions of the pressure sensitive adhesive layers 21 and 22 protrude from the end portion of the optical film 10. Thereafter, by releasing the pressure, the lateral surfaces of the pressure sensitive adhesive layers 21 and 22 can be positioned inside the of the optical film 10 and the lateral surfaces of the release films 41 and 42, as in the laminate 106 shown in FIG. 6. When this method is employed, it is preferable that a mother substrate prepared by a roll-to-roll method is punched with a Thomson blade or the like, a plurality of laminates after the punching are piled, and pressurized in a pilling direction to protrude the pressure sensitive adhesive layer from the lateral surface. In this state, the laminate is cut at the inside of a cut surface formed by the punching, so that the laminate is finished to a product size.

[0108] In the sheet-like laminate 105 shown in FIG. 5, the release films 41 and 42 protrude outside the lateral surfaces of the pressure sensitive adhesive layers 21 and 22. The laminate 105 may be formed by a method in which the area where the pressure sensitive adhesive layers 21 and 22 are disposed on the optical film 10 is controlled, or a method in which only the pressure sensitive adhesive layer portion is removed after disposing the pressure sensitive adhesive layers 21 and 22 on the optical film 10.

[0109] From the viewpoint of productivity, a method is preferable in which a mother substrate is prepared by a roll-to-roll method, and a pressure sensitive adhesive-equipped optical film and release films are subjected to cutting processing. For example, a mother substrate of a pressure sensitive adhesive-equipped optical film is subjected to cutting
5 processing in the following procedure to form the sheet-like laminate 105 in which the release films 41 and 42 protrude outside the lateral surfaces of the pressure sensitive adhesive layers 21 and 22.

[0110] First, a laminate in which the release films 41 and 42 are arranged on both surfaces is subjected to half-cutting from a surface on the release film 42-side to cut the release film 42
10 and the both sides pressure sensitive adhesive-equipped optical film 25. Thereafter, the both sides pressure sensitive adhesive-equipped optical film in a region surrounded by a cutting line, and the release film 42 over the entire surface is peeled off from the surface of the release film 41. Another release film 43 is bonded onto the second pressure sensitive adhesive layer 22 of the both sides pressure sensitive adhesive-equipped optical film 25 to form a laminate
15 307 in which a plurality of sheet-like both sides pressure sensitive adhesive-equipped optical films 25 are disposed between two release films 41 and 43 as shown in FIG. 7.

[0111] The laminate 307 is cut to obtain a sheet-like laminate in which the release films 41 and 43 protrude outside the lateral surface of the both sides pressure sensitive adhesive-equipped optical film 25. A laminate as shown in FIG. 5, in which the protrusion amount of
20 the release film 43 is large, can be obtained by cutting the release film 41 of the laminate in a region where the both sides pressure sensitive adhesive-equipped optical film 25 is not provided.

[0112] The mother substrate is bonded to a carrier sheet, and the laminate is cut to a sheet-like shape. A carrier sheet 49 is adhered to a surface on the release film 41-side of the
25 laminate in which the release films 41 and 42 are arranged on both surfaces, and half-cutting is performed from the release film 42-side. In this case, first half-cutting is performed so as to cut the release film 42 and the both sides pressure sensitive adhesive-equipped optical film 25, and the second half-cutting is performed outside the cutting line of the first half-cutting so as to cut the release film 42, the both sides pressure sensitive adhesive-equipped optical film 25
30 and the release film 42. After the first and the second half-cuttings, a laminate of the release film 42 surrounded by the cutting line, the both sides pressure sensitive adhesive-equipped

optical film 25 surrounded by the cutting line, and the entire release film 42 are peeled off from the surface of the carrier sheet 49. Thereafter, another release film 43 is bonded onto the second pressure sensitive adhesive layer 22 of the both sides pressure sensitive adhesive-equipped optical film 25 to obtain a laminate 308 shown in FIG. 8.

5 [0113] A laminate as shown in FIG. 5 in which the protrusion amount of the release film 43 is larger can be formed by cutting the release film 43 of the laminate 308 and peeling off a laminate from the carrier sheet 49, wherein the laminate peeled off from the carrier sheet 49 includes the release film 41, the both sides pressure sensitive adhesive-equipped optical film 25 and the release film 43.

10 [0114] When the release film is arranged so as to protrude outside the lateral surface of the pressure sensitive adhesive layer, the protrusion amount of the release film on one surface may be equal to or different from the protrusion amount of the release film on the other surface. As shown in FIG. 5, the protrusion amounts of the release films on both surfaces are different from each other, so that it is easy to selectively pick a release sheet to be peeled.

15 Workability is further improved by increasing the protrusion amount of the release film that is peeled off first. The protrusion amount of the second release film 42 (43) may be larger when the second release film 42 (43) is peeled off from the second pressure sensitive adhesive layer 22 followed by bonding the image display cell 70 to the second pressure sensitive adhesive layer 22, and the first release film 41 is thereafter peeled off from the first pressure sensitive adhesive layer 21 followed by bonding the cover window 80 to the first pressure sensitive adhesive layer 21.

[0115] [Formation of through-hole]

25 The second release film 42 temporarily attached on the surface of the second pressure sensitive adhesive layer 22 is peeled off, and the image display cell 70 is bonded and firmly adhered to the second pressure sensitive adhesive layer 22 to form the optical laminate 103. The optical laminate 103 may be formed by bonding the optical film 10 onto the image display cell 70 with the second pressure sensitive adhesive layer 22 interposed therebetween, and laminating the first pressure sensitive adhesive layer 21 and the first release film 41 thereon.

30 [0116] An ultraviolet laser is applied from the image display cell 70-side of the laminate 103 to form a through-hole (pore) extending through the image display cell 70, the second

pressure sensitive adhesive layer 22, the optical film 10, the first pressure sensitive adhesive layer 21, and the release film 41 temporarily attached on the first pressure sensitive adhesive layer 21. The ultraviolet laser is not particularly limited as long as it can emit laser light having a wavelength of 400 nm or less, and a third harmonic (wavelength: 355 nm) of a YAG
5 laser is preferable because of high power and excellent processability. The laser power is, for example, about 0.1 to 50 W.

[0117] The shape of the through-hole 5 is not particularly limited, and may be appropriately set in conformity to the shape of an optical element 91 arranged under the image display cell 70. The through-hole 5 may have a circular shape, an elliptic shape, a
10 triangular shape, a quadrangular shape, a polygonal shape, a linear shape or the like. When a camera is disposed as the optical element 91, a circular through-hole may be formed in conformity to the shape of the camera lens. A plurality of through-holes may be formed in the optical laminate.

[0118] When laser irradiation is performed while the positions of a laser light source and
15 an optical laminate, the through-hole formed by laser processing is a pore having a diameter approximately equal to the diameter of laser light. When the size of the through-hole 5 is larger than the diameter of the laser light, the through-hole 5 having a desired size and shape can be formed by moving the laser light source relative to the optical laminate. The entire region where the through-hole 5 is formed may be irradiated with a laser to form an opening.
20 Alternatively, the through-hole 5 having a desired size and shape can be formed by applying a laser along the outer periphery of the shape of the through-hole 5, and hollowing out the inside of the shape.

[0119] Since the image display cell 70 includes an ultraviolet absorbing member such as a polyimide film, the image display cell 70 absorbs an ultraviolet laser. Absorption of the
25 ultraviolet laser causes the image display cell 70 to generate heat and vaporize, and thus the second pressure sensitive adhesive layer 22, the optical film 10, the first pressure sensitive adhesive layer 21 and the release film 41 arranged on the image display cell 70 are blown off with the vapor to form a through-hole.

[0120] When the second pressure sensitive adhesive layer 22, the optical film 10 and the
30 first pressure sensitive adhesive layer 21 have ultraviolet absorbability, these optical members absorb an ultraviolet laser, so that processing accuracy is improved. As described

above, when the thickness of the second pressure sensitive adhesive layer 22 is small (for example, 30 μm or less), sufficient processability is exhibited even when the second pressure sensitive adhesive layer 22 does not have ultraviolet absorbability. The release film 41 may have ultraviolet absorbability, or may have no ultraviolet absorbability.

5 [0121] The first pressure sensitive adhesive layer 21 has ultraviolet absorbability, and absorbs an ultraviolet laser, and therefore even when the first pressure sensitive adhesive layer 21 is thick and soft, good processability is exhibited. When the first pressure sensitive adhesive layer 21 has ultraviolet absorbability, the release film 41 temporarily attached on the first pressure sensitive adhesive layer 21 is processed due to heating and vaporization
10 during processing of the first pressure sensitive adhesive layer 21, and therefore it is possible to suppress peeling of the release film and ingress of bubbles.

[0122] [Formation of display device]

The release film 41 is temporarily attached on the first pressure sensitive adhesive layer 21 is peeled off therefrom, followed by bonding the cover window 80 thereon to obtain an
15 optical laminate (image display element) in which the cover window 80 is firmly adhered to the first pressure sensitive adhesive layer 21 and the image display cells 70 is firmly adhered to the second pressure sensitive adhesive layer 22. This optical laminate has the through-hole 5 extending through the laminate from the image display cell 70 to the first pressure sensitive adhesive layer 21.

20 [0123] The optical element 91 is arranged under the through-hole 5 to obtain a display device with an optical element. The optical element 91 may be a light receiving element such as a camera or an optical sensor, or a light emitting element such as an LED.

[0124] As the cover window 80, a transparent plate having an appropriate mechanical strength and thickness is used. As the transparent plate, a transparent resin plate of an
25 acryl-based resin, a polycarbonate-based resin, a transparent polyimide resin or the like, or a glass plate is used. The thickness of the cover window 80 is, for example, about 20 to 2000 μm . In a flexible device, a transparent resin film is preferably used as the cover window 80, and the thickness thereof is preferably 20 to 500 μm , more preferably 30 to 300 μm , further preferably from 50 to 200 μm . As the cover window 80, a bendable (flexible) thin glass
30 substrate may be used.

[0125] The cover window 80 may be integrated with a touch panel sensor. An

antireflection layer, a hard coat layer or the like may be disposed on a viewing-side surface of the cover window 80.

[0126] For removing bubbles at the bonding interface or near the printing level difference, treatment such as heating, pressurization or decompression may be performed after the cover
5 window 80 is bonded onto the first pressure sensitive adhesive layer 21. Autoclave treatment may be performed for the purpose of suppressing delay bubbles.

[0127] When the first pressure sensitive adhesive layer 21 is a photocurable pressure sensitive adhesive, it is preferable that the first pressure sensitive adhesive layer is photocured after the cover window 80 is bonded to the first pressure sensitive adhesive layer
10 21. For example, an active ray such as an ultraviolet ray is applied through the cover window 80 to photocure the first pressure sensitive adhesive layer 21. By photocuring the pressure sensitive adhesive, the bonding reliability is improved.

[0128] [Modification of perforation]

In the above example, a case has been mainly described where the laminate 103 in
15 which the image display cell 70 as an adherend is firmly adhered to the second pressure sensitive adhesive layer 22 is irradiated with an ultraviolet laser from the image display cell 70-side to form the through-hole 5. Formation of a through-hole with an ultraviolet laser is applicable to other embodiments.

[0129] For example, the through-hole 5 may be formed by applying an ultraviolet laser
20 from a surface of the release film 41 temporarily attached on the first pressure sensitive adhesive layer 21 of the optical laminate 103. When an ultraviolet laser is applied from the release film 41-side, it is preferable that the release film 41 has ultraviolet absorbability, and the light transmittance of the release film 41 at a wavelength of 355 nm is preferably 70% or less, more preferably 60% or less.

[0130] The efficiency of processing with an ultraviolet laser tends to be improved as the
25 ultraviolet absorbability of the release film 41 disposed on the laser-irradiated surface becomes higher (the light transmittance at a wavelength of 355 nm becomes lower). On the other hand, when the ultraviolet absorbability of the release film 41 is excessively large, bubbles may be generated on the periphery of the through-hole formed in the release film 41
30 (on the periphery of the laser-irradiated region, see FIG. 14). Although the reason why bubbles are generated in the release film are uncertain, this may be partly because a base

film (*e.g.*, PET film) of the release film has lower heat resistance as compared to a polyimide film or the like, so that bubbles are easily generated due to generation of heat in absorption of an ultraviolet laser.

[0131] At the time of producing a display device, the release film 41 is peeled off, and an adherend such as a cover window is bonded, so that even when bubbles are generated on the periphery of the through-hole of the release film 41, there is no quality-related problem. However, when bubbles are generated in the release film 41, it may be difficult to distinguish the bubbles from bubbles mixed in the pressure sensitive adhesive layer or the like, resulting in difficulty of process inspection or occurrence of error in judgement. In addition, deformation caused by bubbles generated in the release film 41 may cause deformation of the first pressure sensitive adhesive layer 21, resulting in poor appearance. Thus, when an ultraviolet laser is applied from the release film 41-side to perform perforation processing, it is preferable that bubbles are not generated in the release film 41.

[0132] Generation of bubbles tends to be suppressed when the release film 41 has low ultraviolet absorbability (high ultraviolet transmittance). From the viewpoint of suppressing generation of bubbles in the release film 41 by laser processing, the light transmittance of the release film 41 at a wavelength of 355 nm is preferably 15% or more, more preferably 20% or more, further preferably 30% or more. The light transmittance of the release film 41 at a wavelength of 355 nm may be 35% or more or 40% or more.

[0133] <Perforation processing before lamination with image display cell>

Before the image display cell is bonded to the second pressure sensitive adhesive layer 22, the laminate may be irradiated with an ultraviolet laser to perform perforation processing. For example, the laminate 102 with the release film 41 temporarily attached on the first pressure sensitive adhesive layer 21 and the release film 42 temporarily attached on the second pressure sensitive adhesive layer 22 may be irradiated with an ultraviolet laser to form the laminate 105 having a through-hole 7 as shown in FIG. 9. In formation of the through-hole 7, the ultraviolet laser may be applied from either the release film 41-side or the release film 42-side.

[0134] It is preferable that the release film on the laser-irradiated surface-side has ultraviolet absorbability, and the light transmittance of the release film on the laser-irradiated surface at a wavelength of 355 nm is preferably 70% or less, more preferably 60%

or less. From the viewpoint of suppressing generation of bubbles on the periphery of the laser-processed region, the light transmittance of the release film W on the laser-irradiated surface at a wavelength of 355 nm is preferably 15% or more, more preferably 20% or more, further preferably 30% or more. The light transmittance of the release film on the laser-irradiated surface at a wavelength of 355 nm may be 35% or more or 40% or more.

[0135] For example, when an ultraviolet laser is applied from the release film 42-side, the light transmittance of the release film 42 at a wavelength of 355 nm is preferably in the above-described range. When an ultraviolet laser is applied from the release film 42-side, the release film 41 may have ultraviolet absorbability, or may have no ultraviolet absorbability.

[0136] When an ultraviolet laser is applied from the release film 41-side, the light transmittance of the release film 41 at a wavelength of 355 nm is preferably in the above-described range. When an ultraviolet laser is applied from the release film 41-side, the release film 42 may have ultraviolet absorbability, or may have no ultraviolet absorbability.

[0137] In the laminate in which release films are temporarily attached on the surfaces of the pressure sensitive adhesive layers 21 and 22 of the both sides pressure sensitive adhesive-equipped optical film 25, it is enough that the through-hole extends through the first pressure sensitive adhesive layer 21, the optical film 10 and the second pressure sensitive adhesive layer 22. The through-hole is not necessarily formed through one or both of the release films.

[0138] For example, in the optical laminate 110 shown in FIG. 10, the through-hole 8 formed in the both sides pressure sensitive adhesive-equipped optical film 25 extends through the release film 41 temporarily attached on the first pressure sensitive adhesive layer 21, and no through-hole is formed in the release film 47 temporarily attached on the second pressure sensitive adhesive layer 22. The through hole may be formed in the release film temporarily attached on the second pressure sensitive adhesive layer 22, and the through-hole is not necessarily formed in the release film temporarily attached on the first pressure sensitive adhesive layer 21.

[0139] In the optical laminate 111 shown in FIG. 11, through-hole 9 is formed through the first pressure sensitive adhesive layer 21, the optical film 10 and the second pressure sensitive adhesive layer 22 that constitute the both sides pressure sensitive adhesive-equipped optical film 25, and no thorough-hole is formed in release films 46 and 47 temporarily attached on the pressure sensitive adhesive layers 21 and 22, respectively.

[0140] The optical laminate 102 with the release films 41 and 42 temporarily attached on the pressure sensitive adhesive layers 21 and 22 is irradiated with an ultraviolet laser to form the through-hole 7, and one or both of the release films 41 and 42 of the laminate 109 provided with the through-hole are then replaced by other release films 46 and 47 to obtain
5 an optical laminate in which no through-hole is formed in release films on both surfaces.

[0141] By replacing the release film after forming the through-hole by laser processing, the through-hole of the both sides pressure sensitive adhesive-equipped optical film 25 is covered with the release film, so that it is possible to ingress of contaminants into the through-hole, etc. in handling or storage of the optical laminate. When the release film temporarily
10 attached on the pressure sensitive adhesive layer is replaced after the through-hole is formed in the optical film and the pressure sensitive adhesive layer, the release film after the replacement may have ultraviolet absorbability, or may have no ultraviolet absorbability.

[0142] Each of the through-hole-formed release films temporarily attached on the pressure sensitive adhesive layers 21 and 22 may protrude outside the lateral surfaces of the pressure sensitive adhesive layers 21 and 22. The release film temporarily attached on the first
15 pressure sensitive adhesive layer 21 may protrude outside the lateral surface of the first pressure sensitive adhesive layer, and the release film temporarily attached on the second pressure sensitive adhesive layer 22 may protrude outside the lateral surface of the second pressure sensitive adhesive layer 22. As shown in FIG. 12, the release films 41 and 48 on
20 both sides may protrude outside the lateral surface of the first pressure sensitive adhesive layer 21 and the lateral surface of the second pressure sensitive adhesive layer 22, respectively. When the release films on both surfaces protrude outside the lateral surface of the pressure sensitive adhesive layer (lateral surface of the both sides pressure sensitive adhesive-equipped optical film 25), the protrusion amount of the release film on one surface
25 may be equal to or different from the protrusion amount of the release film on the other surface.

[0143] When sheet-like optical laminates are cut out from a large-area mother substrate, formation of a through-hole by laser processing may be performed either before or after the cutting. After the mother substrate is irradiated with an ultraviolet laser to form a through-
30 hole, the release film on one or both of the surfaces may be replaced before or after the cutting.

[0144] After the through-hole is formed by irradiating the mother substrate with a laser,

the release film may be replaced in the process of cutting to a sheet-like shape. In one embodiment, a through-hole is formed in a laminate with the release films 41 and 42 disposed on both surfaces, the release film 42 and the both sides pressure sensitive adhesive-equipped optical film are then cut by half-cutting. The both sides pressure sensitive adhesive-equipped optical film in a region surrounded by a cutting line, and the release film 42 over the entire surface is peeled off from the surface of the release film 41. Another release film 48 is bonded onto the second pressure sensitive adhesive layer 22 of the both sides pressure sensitive adhesive-equipped optical film 25 to form a laminate 313 as shown in as shown in FIG. 13, in which a plurality of sheet-like both sides pressure sensitive adhesive-equipped optical films 25 each having the through-hole 8 are disposed between two release films 41 and 48.

[0145] In the laminate 313, the through-hole 8 extends through the release film 41 on the first pressure sensitive adhesive layer 21, and the through-hole is not formed in the release film 48. By cutting the laminate 313, a sheet-like laminate as shown in FIG. 12 is obtained in which a through-hole is formed through the second pressure sensitive adhesive layer 22, the optical film 10, the first pressure sensitive adhesive layer 21, and the release film 41 temporarily attached on the first pressure sensitive adhesive layer 21, and the release films 41 and 48 protrude outside the lateral surfaces of the pressure sensitive adhesive layers 21 and 22.

[0146] The release film temporarily attached on the second pressure sensitive adhesive layer 22 is peeled off from the optical laminate after formation of the through-hole, the image display cell 70 is bonded to the second pressure sensitive adhesive layer 22, the release film temporarily attached on the first pressure sensitive adhesive layer 21 is peeled off, and the cover window is bonded to the first pressure sensitive adhesive layer 21 to form an image display element.

[0147] A through-hole may be formed in the image display cell 70 beforehand. In this case, alignment may be performed so that the position of the through-hole formed in the image display cell 70 coincides with the position of the through-hole formed in the both sides pressure sensitive adhesive-equipped optical film 25.

[0148] When a through-hole is formed in the image display cell 70 after the image display cell 70 is bonded to the second pressure sensitive adhesive layer 22, an ultraviolet laser etc.

may be applied to the position of the through-hole formed in the both sides pressure sensitive adhesive-equipped optical film. In this case, the laser may be applied from any surface.

EXAMPLES

[0149] Hereinafter, the present invention will be described in more detail with reference to experimental examples of laser processing of an optical laminate, but the present invention is not limited to these examples.

[0150] [Both sides pressure sensitive adhesive-equipped polarizing plate]

<Production Example 1>

As an optical film, a polarizing plate with a 40 μm -thick triacetyl cellulose film bonded to both surfaces of a polarizer composed of a 25 μm -thick stretched polyvinyl alcohol film impregnated with iodine was used. The triacetyl cellulose film contained an ultraviolet absorber, and had a light transmittance of 0% at a wavelength of 355 nm.

[0151] A 150 μm -thick acryl-based pressure sensitive adhesive sheet (light transmittance at a wavelength of 355 nm: 64%, light transmittance at a wavelength of 420 nm: 92 %, storage elastic modulus at 25°C: 0.1 MPa) containing a benzotriazole-based ultraviolet absorber as a first pressure sensitive adhesive layer, and a 75 μm -thick release film (a biaxially stretched PET film having a silicone-based release layer on a surface thereof, light transmittance at a wavelength of 355 nm: 85%) were attached to one surface of the polarizing plate. A 20 μm -thick acryl-based pressure sensitive adhesive sheet (light transmittance at a wavelength of 355 nm: 85%, light transmittance at a wavelength of 420 nm: 92%, storage elastic modulus at 25°C: 0.12 MPa), which did not contain an ultraviolet absorber, as a second pressure sensitive adhesive layer, and a 38 μm -thick release film were bonded to the other surface of the polarizing plate to obtain a laminate having a pressure sensitive adhesive layer disposed on each of both surfaces of a polarizing plate and release films temporarily attached on the pressure sensitive adhesive layers.

[0152] <Production Examples 2 to 4>

Except that the amount of the ultraviolet absorber in the first pressure sensitive adhesive layer was changed, the same procedure as in Production Example 1 was carried out to form a laminate. In Production Example 4, a pressure sensitive adhesive which did not contain an ultraviolet absorber was used as the first pressure sensitive adhesive layer. The light transmittance of the first pressure sensitive adhesive layer at a wavelength of 355 nm in

each of Production Examples 2 to 4 was as shown in Table 1.

[0153] <Production Example 5>

Except that the thickness of the second pressure sensitive adhesive layer was changed to 40 μm , the same procedure as in Production Example 1 was carried out to form a laminate.

[0154] <Production Example 6>

As a release film on the first pressure sensitive adhesive layer, a biaxially stretched PET film containing an ultraviolet absorber was used. The release film had a light transmittance of 1% at a wavelength of 355 nm. Except that the release film on the first pressure sensitive adhesive layer was changed, the same procedure as in Production Example 1 was carried out to form a laminate.

[0155] [Preparation of sample for evaluation of processability]

The release film on the second pressure sensitive adhesive layer of the laminates of Production Examples 1 to 6 was peeled off, and a 25 μm -thick polyimide film ("Kapton EN100" manufactured by DU PONT-TORAY CO., LTD., light transmittance at a wavelength of 355 nm: 0%) was bonded onto the second pressure sensitive adhesive layer to prepare a sample for evaluation of processability.

[0156] [Processing by ultraviolet laser]

The sample for evaluation of processability was irradiated with a YAG third harmonic ultraviolet laser (wavelength: 355 nm, frequency: 40 Hz, power: 0.4 W) to form a through-hole. A laser was applied while a laser light source was moved at a speed of 10 mm/second so as to circle the outer periphery (circumference) of a circle having a diameter of 3 mm. The laser light source was caused to circle the circumference 30 times, so that the inside of the circumference was hollowed out to form a circular through-hole having a diameter of about 3 mm. For the samples of Production Examples 1 to 5, the laser was applied from the polyimide film-side (second pressure sensitive adhesive layer-side), and for the sample of Production Example 6, the laser was applied from the PET release film-side (first pressure sensitive adhesive layer-side).

[0157] [Evaluation]

<Existence or non-existence of bubbles in first pressure sensitive adhesive layer>

The release film was peeled off from the sample after formation of the through-hole,

and the surface of the first pressure sensitive adhesive layer was vertically observed with an optical microscope (direct magnification: 5 times) to examine whether bubbles exist or not. A sample with no bubbles was rated “Good”, and a sample with bubbles was rated “Poor”.

[0158] <Cutting processability>

Cutting processability in laser processing performed by circling the circumference 30 times was evaluated in accordance with the following criteria.

Good: the inside of the circumference falls out after laser processing, or the inside of the circumference can be hollowed out without deformation outside the circumference.

Poor: the inside of the circumference does not fall out after laser processing, deformation occurs outside the circumference at the time of hollowing out the inside of the circumference, or the inside of the circumference cannot be hollowed out.

[0159] Table 1 shows the configurations and the laser processability evaluation results of the laminates of Production Examples.

[0160] [Table 1]

	Production Example		1	2	3	4	5	6
Configuration	Release film	355 nm Light transmittance (%)	85	85	85	85	85	1
	First pressure sensitive adhesive layer	355 nm Light transmittance (%)	64	72	38	85	64	64
	Second pressure sensitive adhesive layer	Thickness (μm)	20	20	20	20	40	20
Processing	Laser incidence surface		PI side	PI side	PI side	PI side	PI side	PET side
	Bubbles in first pressure sensitive adhesive layer		Good	Good	Good	Poor	Good	Good
	Cutting processability		Good	Good	Good	Good	Poor	Good

[0161] In all of Production Examples 1 to 3 where the first pressure sensitive adhesive layer had ultraviolet absorbability, good processability was exhibited. In Production Example 4 where the first pressure sensitive adhesive layer did not contain an ultraviolet absorber, the first pressure sensitive adhesive layer had bubbles, and the laminate was poor in laser

processability. These results show that by imparting ultraviolet absorbability to the first pressure sensitive adhesive layer, processability with an ultraviolet laser is improved, so that cutting processing can be performed with high accuracy.

[0162] In Production Example 5 where the second pressure sensitive adhesive layer had a large thickness, bubbles were not generated in the first pressure sensitive adhesive layer, but cutting failure of the second pressure sensitive adhesive layer occurred. In Production Examples 1 to 4 where the second pressure sensitive adhesive layer had a small thickness, cutting failure of the second pressure sensitive adhesive layer did not occur. Therefore, in Production Example 5, processability with a laser was deteriorated because the second pressure sensitive adhesive layer had a large thickness. Thus, it is apparent that the thickness of the second pressure sensitive adhesive layer is preferably small, and when the thickness of the second pressure sensitive adhesive layer is large, it is preferable to impart ultraviolet absorbability by adding an ultraviolet absorber or the like.

[0163] In Production Example 6 where a laser was applied from the first pressure sensitive adhesive layer-side, the pressure sensitive adhesive layer had good processability as in the case of Production Examples 1 to 3. These results show that processing with an ultraviolet laser is possible when an adherend on a laser-irradiated surface has ultraviolet absorbability.

[0164] In Production Example 6, the pressure sensitive adhesive layer had good processability, but in observation of the release film on the laser-irradiated surface, bubbles of about 20 μm were generated on the periphery of the through-hole as shown in FIG. 14. In Production Examples 1 to 5, air bubbles as in FIG. 14 did not exist in any of the polyimide film and the release film. In addition, bubbles did not exist in the polyimide film of Production Example 6.

[0165] From these results, it is considered that in Production Example 6, air bubbles were generated in the release film because the release film on the ultraviolet laser-irradiated surface had high ultraviolet absorbability, and generated a large amount of heat during application of the ultraviolet laser. Therefore, when an ultraviolet laser is applied from a surface on the release film-side, it is preferable to adjust the ultraviolet absorbability (ultraviolet transmittance) of the release film suitable for laser processing such that generation of bubbles due to excessive ultraviolet absorption is suppressed.

Claims

1. An optical laminate comprising:
 - an optical film including a polarizer;
 - 5 a first pressure sensitive adhesive layer disposed on a first principal surface of the optical film;
 - a first adherend bonded to the first pressure sensitive adhesive layer;
 - a second pressure sensitive adhesive layer disposed on a second principal surface of the optical film; and
 - 10 a second adherend bonded to the second pressure sensitive adhesive layer, wherein each of the first pressure sensitive adhesive layer and the second pressure sensitive adhesive layer has a light transmittance of 85% or more at a wavelength of 420 nm, and the first pressure sensitive adhesive layer has a light transmittance of 80% or less at a wavelength of 355 nm,
 - 15 wherein
 - the optical laminate has a through-hole that extends through at least the first pressure sensitive adhesive layer, the optical film, and the second pressure sensitive adhesive layer.
- 20 2. The optical laminate according to claim 1, wherein any one of the first adherend and the second adherend has a light transmittance of 70% or less at a wavelength of 355 nm.
3. The optical laminate according to claim 1 or 2, wherein the second adherend is an image display cell firmly adhered to the second pressure sensitive adhesive layer.
- 25 4. The optical laminate according to claim 3, wherein the image display cell is an organic EL cell.
5. The optical laminate according to claim 3 or 4, wherein the image display cell includes a polyimide film.
- 30 6. The optical laminate according to any one of claims 3 to 5, wherein the through-hole extends through the image display cell.

7. The optical laminate according to any one of claims 3 to 6, wherein the first adherend is a first release film temporarily attached on the first pressure sensitive adhesive layer

5 8. The optical laminate according to claim 7, wherein the through-hole extends through the first adherend.

9. The optical laminate according to claim 1 or 2, wherein

the first adherend is a first release film temporarily attached on the first pressure
10 sensitive adhesive layer

the second adherend is a second release film temporarily attached on the second
pressure sensitive adhesive layer

10. The optical laminate according to claim 9,

15 wherein the through-hole extends through at least one of the first release film and the second release film.

11. The optical laminate according to claim 9 or 10, wherein at least one of the first
release film and the second release film has a light transmittance of 70% or less at a
20 wavelength of 355 nm.

12. The optical laminate according to claim 9 or 10, wherein at least one of the first
release film and the second release film has a light transmittance of 15 to 70% at a
wavelength of 355 nm.

25

13. The optical laminate according to claim 9,

wherein the through-hole does not extend through any of the first release film and
the second release film.

30 14. The optical laminate according to any one of claims 1 to 13, wherein the first pressure sensitive adhesive layer has a thickness of 30 μm or more.

15. The optical laminate according to any one of claims 1 to 14, wherein a thickness of the

second pressure sensitive adhesive layer is smaller than a thickness of the first pressure sensitive adhesive layer.

5 16. The optical laminate according to any one of claims 1 to 15, wherein the first pressure sensitive adhesive layer has a light transmittance of 20% or more at a wavelength of 355 nm.

10 17. The optical laminate according to any one of claims 1 to 16, wherein the first pressure sensitive adhesive layer has a storage elastic modulus of 0.35 MPa or less at 25°C.

18. The optical laminate according to any one of claims 1 to 17, wherein the first pressure sensitive adhesive layer is a photocurable pressure sensitive adhesive containing a photocurable compound and a photopolymerization initiator.

15 19. The optical laminate according to any one of claims 1 to 18, wherein a storage elastic modulus of the second pressure sensitive adhesive layer at 25°C is larger than a storage elastic modulus of the first pressure sensitive adhesive layer at 25°C.

20 20. The optical laminate according to any one of claims 1 to 19, wherein the second pressure sensitive adhesive layer has a light transmittance of 80% or more at a wavelength of 355 nm.

25 21. The optical laminate according to any one of claims 1 to 20, wherein a light transmittance of the second pressure sensitive adhesive layer at a wavelength of 355 nm is larger than a light transmittance of the first pressure sensitive adhesive layer at the wavelength of 355 nm.

30 22. The optical laminate according to any one of claims 1 to 21, wherein the optical film includes a resin film arranged so as to contact at least one surface of the polarizer, and the light transmittance of the resin film at a wavelength of 355 nm is 10% or less.

23. A method for producing an optical laminate, comprising forming a through-hole in a laminate by laser processing, wherein

the laminate comprising:

an optical film including a polarizer;

a first pressure sensitive adhesive layer disposed on a first principal surface of the optical film;

5 a first adherend bonded to the first pressure sensitive adhesive layer;

a second pressure sensitive adhesive layer disposed on a second principal surface of the optical film; and

a second adherend bonded to the second pressure sensitive adhesive layer,

the first pressure sensitive adhesive layer and the second pressure sensitive

10 adhesive layer have a light transmittance of 85% or more at a wavelength of 420 nm,

the first pressure sensitive adhesive layer has a light transmittance of 80% or less at a wavelength of 355 nm, wherein

in formation of the through-hole, one of the principal surface is irradiated with an ultraviolet laser to form a through-hole extending through the first adherend, the first
15 pressure sensitive adhesive layer, the optical film, the second pressure sensitive adhesive layer, and the second adherend, wherein

one of the first adherend and the second adherend that is arranged on the principal surface irradiated with the ultraviolet laser has a light transmittance of 70% or less at a wavelength of 355 nm.

20

24. A display device comprising:

an image display element; and

an optical element, wherein

the image display element comprising:

25 an optical film including a polarizer;

a first pressure sensitive adhesive layer disposed on a first principal surface of the optical film;

a transparent adherend bonded to the first pressure sensitive adhesive layer;

a second pressure sensitive adhesive layer disposed on a second principal surface

30 of the optical film; and

an image display cell bonded to the second pressure sensitive adhesive layer,

the first pressure sensitive adhesive layer and the second pressure sensitive adhesive layer have a light transmittance of 85% or more at a wavelength of 420 nm,

the first pressure sensitive adhesive layer has a light transmittance of 80% or less at a wavelength of 355 nm, wherein

a through-hole is formed through the image display cell, the second pressure sensitive adhesive layer, the optical film and the first pressure sensitive adhesive layer,

5 the optical element is arranged in the through-hole or under the through-hole,

the optical element is at least one selected from the group consisting of light receiving elements and light emitting elements.

25. The display device according to claim 24, wherein the image display cell is an organic

10 EL cell.