

IMAGE DISPLAY DEVICE AND METHOD FOR MANUFACTURING SAME

TECHNICAL FIELD

[0001] The present invention relates to an image display device having on a surface of
5 an image display cell a polarizing plate in which a polarizer and a retardation film are laminated, and a method for manufacturing the image display device.

BACKGROUND ART

[0002] Flat panel displays such as liquid crystal displays and OLED displays are widely
10 used as various image display devices such as mobile equipment such as mobile phones, smartphones and tablet terminals, on-vehicle devices such as car navigation devices, monitors for personal computers, and televisions. In the liquid crystal display, polarizers are disposed on both surfaces of a liquid crystal cell under its image displaying principle. A retardation film may be arranged between the liquid crystal cell and the polarizer for
15 the purpose of performing optical compensation such as contrast improvement and widening viewing angle. In the OLED display, a circularly polarizing plate (laminated of a polarizer and a retardation film having a quarter wave retardation) may be provided on a viewing-side surface of the cell for suppressing a situation in which external light is reflected by a metal electrode (cathode) to appear as a mirror surface.

[0003] A polarizing plate generally has a configuration in which a transparent
20 protective film (polarizer protective film) is bonded to one surface or both surfaces of a polarizer, and a retardation film may be used as the transparent protective film. In addition, the transparent protective film may be bonded to the surface of the polarizer, and the retardation film may be bonded onto the transparent protective film. A polarizing
25 plate in which a polarizer and a retardation film are laminated is generally bonded to a substrate on a surface of an image display cell with a pressure sensitive adhesive interposed therebetween.

[0004] If the optical characteristics of a retardation film arranged between a polarizer
and an image display cell are not uniform in the plane, unevenness occurs in a display
30 image. Therefore, the retardation film is required to have uniformity in thickness and optical characteristics. For example, Patent Document 1 discloses a technique for uniformizing an optical axis direction of a retardation film.

[0005] It is known that when an image display device is exposed to a high-temperature

and high-humidity environment or exposed to a rapid environmental change, display unevenness occurs due to a change in optical characteristics of a retardation film, deterioration of a polarizer, or the like, and various methods have been proposed to provide a polarizing plate in which a change in optical characteristics hardly occurs.

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PRIOR ART DOCUMENTS

PATENT DOCUMENTS

[0006] Patent Document 1: Japanese Patent Laid-Open No. 2016-109924

10 SUMMARY OF THE INVENTION

PROBLEMS TO BE SOLVED BY THE INVENTION

[0007] There is an increasing demand for weight reduction and thickness reduction of displays, and retardation films having a smaller thickness come to be used. Since the retardation of a retardation film is a product of a birefringence and a thickness, it is
15 necessary to increase the birefringence of the retardation film by using a high-birefringence material or increasing a draw ratio for coping with thickness reduction.

[0008] In addition to weight reduction and thickness reduction, the luminance and the image quality of displays have been enhanced, and very small defects and unevenness that had not been visually recognized heretofore have become apparent as quality
20 problems. When a polarizing plate in which a polarizer and a retardation film having a large birefringence are laminated is bonded to an image display cell with a pressure sensitive adhesive interposed therebetween, unevenness may be visually recognized in a display image of an image display device although the polarizing plate itself has high optical uniformity.

25 [0009] Such display unevenness is different from unevenness caused by nonuniformity of optical characteristics, and unevenness caused by a change with time or an environmental change in a high-temperature and high-humidity environment, and there are no findings about a cause of occurrence, a guideline for solution and the like of such unevenness. In view of the above, an object of the present invention is to provide an
30 image display device including a polarizing plate in which a high-birefringence retardation film and a polarizer are laminated, the image display device having reduced unevenness of a display image.

MEANS FOR SOLVING THE PROBLEMS

[0010] An image display device of the present invention includes a polarizing plate bonded to a surface of an image display cell with a pressure sensitive adhesive layer interposed therebetween. The polarizing plate includes a polarizer and a retardation film, and the retardation film is arranged between the polarizer and the image display cell. The retardation film has an in-plane birefringence of 8×10^{-3} or more at a wavelength of 550 nm.

[0011] An image display device is formed by bonding a pressure sensitive adhesive-equipped polarizing plate to an image display cell. The pressure sensitive adhesive-equipped polarizing plate includes a retardation film having an in-plane birefringence of 8×10^{-3} or more at a wavelength of 550 nm laminated on one surface of a polarizer and a pressure sensitive adhesive layer arranged on the retardation film. In the pressure sensitive adhesive-equipped polarizing plate, the retardation film may be in contact with the pressure sensitive adhesive layer.

[0012] In the pressure sensitive adhesive layer disposed on the retardation film, a value G'/D obtained by dividing a shear storage elastic modulus G' at a temperature of 25°C by a thickness D may be 5 kPa/ μ m or more. The thickness of the pressure sensitive adhesive layer may be 25 μ m or less.

[0013] The lamination pressure during bonding of the pressure sensitive adhesive-equipped polarizing plate to an image display cell is preferably 0.05 to 0.4 MPa.

[0014] The in-plane retardation of the retardation film may be 200 nm or more. The retardation film may satisfy $n_x > n_z > n_y$, where n_x is an in-plane slow-axis-direction refractive index, n_y is an in-plane fast-axis-direction refractive index, and n_z is a thickness-direction refractive index. In the retardation film, the amount of change in the slow axis with respect to tension in application of the tension in a direction of 45° with respect to the slow axis direction may be 0.1°/N/10 mm or more.

[0015] An absolute value of a difference $|\theta_1 - \theta_0|$ between the angle θ_0 and θ_1 is preferably 0.4° or less, where θ_0 is an angle formed by the absorption axis direction of the polarizer and the slow axis direction of the retardation film in the pressure sensitive adhesive-equipped polarizing plate before the polarizing plate is bonded to the image display cell, and θ_1 is an angle formed by the absorption axis direction of the polarizer and the slow axis direction of the retardation film after the pressure sensitive adhesive-equipped polarizing plate is bonded to the image display cell. An absolute value $|\theta_1 - \theta_2|$

of a difference between the angle and θ_1 and θ_2 is preferably 0.4° or less, wherein θ_2 is an angle formed by the absorption axis direction of the polarizer and the slow axis direction of the retardation film in peeling of the pressure sensitive adhesive-equipped polarizing plate from the image display cell. θ_1 may be in the range of $0 \pm 0.4^\circ$ or $90 \pm 0.4^\circ$.

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EFFECTS OF THE INVENTION

[0016] Even when a retardation film having a small thickness and a large birefringence is used, it is possible to obtain an image display device which hardly suffers display unevenness and is excellent in display quality.

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BRIEF DESCRIPTION OF THE DRAWINGS

[0017] FIG. 1 is a sectional view of a configuration of a liquid crystal display.

FIG. 2 is a sectional view of an OLED display.

FIGS. 3A and 3B show cross nicol observation images of samples obtained by bonding a pressure sensitive adhesive-equipped polarizing plate to a glass plate, where FIG. 3A shows a sample in which unevenness is visually recognized, and FIG. 3B is a sample in which unevenness is not visually recognized.

MODE FOR CARRYING OUT THE INVENTION

[0018] An image display device of the present invention includes a polarizing plate bonded to a surface of an image display cell with a pressure sensitive adhesive layer interposed therebetween. The polarizing plate includes a polarizer and a retardation film disposed on one surface of the polarizer, and the retardation film is arranged between the polarizer and an image display cell. Examples of the image display device in which the retardation film is arranged between the polarizer and the image display cell include liquid crystal displays and OLED displays.

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[0019] [Configuration of Liquid Crystal Display]

FIG. 1 is a sectional view of a configuration of a liquid crystal display according to an embodiment. A liquid crystal display 201 includes a liquid crystal panel 100 and a light source 105. The liquid crystal panel 100 includes a first polarizing plate 36 on the viewing-side surface of a liquid crystal cell 10, and a second polarizing plate 56 on the light source 105-side of the liquid crystal cell 10.

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[0020] The liquid crystal cell 10 includes a liquid crystal layer 11 between two

substrates 13 and 15. The substrates 13 and 15 are transparent substrates such as glass substrates and plastic substrates. In a general configuration, one substrate is equipped with a color filter and a black matrix, and the other substrate is equipped with a switching element or the like for controlling the electrooptical characteristics of the liquid crystal.

5 [0021] The liquid crystal layer 11 contains liquid crystal molecules oriented in a predetermined direction in a no voltage applied state, and the orientation direction (director) of the liquid crystal molecules changes when a voltage is applied. For example, in an in-plane switching (IPS) type liquid crystal cell, the liquid crystal molecules of the liquid crystal layer 11 are oriented uniformly and parallel to the substrate plane
10 (homogeneous orientation) in a no voltage applied state, and when a voltage is applied, the director rotates in the substrate plane. The orientation direction of the liquid crystal molecules in a no voltage applied state in the IPS type liquid crystal cell may be slightly inclined with respect to the substrate plane. In the IPS type liquid crystal cell, an angle (pre-tilt angle) formed by the substrate plane and the orientation direction of liquid crystal
15 molecules in a no voltage applied state is generally 10° or less.

[0022] A first polarizing plate 36 is bonded to the viewing-side substrate 13 of the liquid crystal cell 10 with a first pressure sensitive adhesive layer 39 interposed therebetween. A second polarizing plate 56 is bonded to the light source-side substrate 15 of the liquid crystal cell 10 with a second pressure sensitive adhesive layer 59 interposed therebetween.

20 [0023] The polarizing plates 36 and 56 include polarizers 31 and 51, respectively. The polarizers 31 and 51 absorb light vibrating in the absorption axis direction and transmit (emit) the light vibrating in the transmission axis direction as linearly polarized light. The polarizer 31 of the first polarizing plate 36 and the polarizer 51 of the second polarizing plate 56 are arranged such that their absorption axis directions of both the
25 polarizers are perpendicular to each other.

[0024] Examples of the polarizer include hydrophilic polymer films such as polyvinyl alcohol-based films, partially formalized polyvinyl alcohol-based films and ethylene-vinyl acetate copolymer-based partially saponified films which are uniaxially stretched with a dichroic substance such as iodine or a dichroic dye impregnated, and polyene-based
30 oriented films such as dehydrated products of polyvinyl alcohol and dehydrochlorinated products of polyvinyl chloride.

[0025] Of these, due to high polarization degree, polyvinyl alcohol (PVA)-based polarizers obtained by impregnating a dichroic substance such as iodine or dichroic dye to

a polyvinyl alcohol-based film such as a polyvinyl alcohol film or a partially formalized polyvinyl alcohol film, and unidirectionally orienting are preferable. For example, a polyvinyl alcohol-based film is iodine-stained and stretched to obtain a PVA-based polarizer.

5 [0026] A thin polarizer having a thickness of 10 μm or less can also be used as the PVA-based polarizer. Examples of the thin polarizer include one described in Japanese Patent Laid-open Publication No. 51-069644, Japanese Patent Laid-open Publication No. 2000-338329, WO 2010/100917, Japanese Patent No. 4691205 and Japanese Patent No. 4751481. Such a thin polarizer is obtained by stretching a PVA-based resin layer and a stretchable resin substrate in a laminate state, and performing iodine dying.

10 [0027] In the first polarizing plate 36, the transparent protective films 33 and 35 are bonded to both surfaces of the polarizer 31. In the second polarizing plate 56, the transparent protective films 53 and 55 are bonded to both surfaces of the polarizer 51.

[0028] The thickness of each of the transparent protective films 33, 35, 53 and 55 is, for example, about 5 to 200 μm . As resin materials that form these protective films, polymers excellent in transparency, mechanical strength and thermal stability are preferably used. Specific examples of such polymers include cellulose-based resins such as acetyl cellulose, polyester-based resins, polycarbonate-based resins, polyamide-based resins, polyimide-based resins, maleimide-based resins, polyolefin-based resins, (meth)acryl-based resins, cyclic polyolefin resins (norbornene-based resins), polyarylate-based resins, polystyrene-based resins, polyvinyl alcohol-based resins, polysulfone-based resins, and mixtures or copolymers thereof.

20 [0029] Each of the polarizers 31 and 51 is bonded to the transparent protective films 33 and 35, and 53 and 55 with an adhesive or a pressure sensitive adhesive (not shown) interposed therebetween. As an adhesive or a pressure sensitive adhesive for bonding the polarizer and the transparent protective film, one having an acryl-based polymer, a silicone-based polymer, polyester, polyurethane, polyamide, polyvinyl ether, a vinyl acetate/vinyl chloride copolymer, a modified polyolefin, an epoxy-based polymer, a fluorine-based polymer, a rubber-based polymer or the like as a base polymer can be appropriately selected.

30 [0030] In FIG. 1, the first polarizing plate 36 and the second polarizing plate 56 include transparent protective films on both surfaces of the polarizers 31 and 51, but the polarizing plate may include a transparent protective film only on one surface of the

polarizer. In addition, two or more transparent protective films may be bonded to one surface of the polarizer.

[0031] As a pressure sensitive adhesive that forms the pressure sensitive adhesive layers 39 and 59, one having an acryl-based polymer, a silicone-based polymer, polyester, polyurethane, polyamide, polyvinyl ether, a vinyl acetate/vinyl chloride copolymer, a modified polyolefin, an epoxy-based polymer, a fluorine-based polymer, a rubber-based polymer such as natural rubber or synthetic rubber or the like as a base polymer can be appropriately selected. In particular, an acryl-based pressure sensitive adhesive is preferably used because it is excellent in optical transparency and exhibits adhesion properties such as moderate wettability, cohesiveness, and adhesiveness. The thickness of each of the pressure sensitive adhesive layers 39 and 59 is about 5 to 50 μm .

[0032] In formation of the liquid crystal display, the polarizer and the transparent protective film are bonded to each other to form the polarizing plates 36 and 56 in advance, and the pressure sensitive adhesive layers 39 and 59 are attached to surfaces of the polarizing plates 36 and 56 to prepare a pressure sensitive adhesive-equipped polarizing plate. The pressure sensitive adhesive-equipped polarizing plate is bonded to the liquid crystal cell 10 using a laminator such as a roll laminator.

[0033] [Retardation Film]

In a liquid crystal display of an embodiment, the transparent protective film 35 of the first polarizing plate 36 is a retardation film. The retardation film 35 arranged between the polarizer 31 and the liquid crystal cell 10 can perform optical compensation such as enhancement of contrast and widening of viewing angle. For example, when an IPS-type liquid crystal display is viewed from an oblique direction at an angle of 45 degrees (Azimuth angle of 45 degrees, 135 degrees, 225 degrees or 315 degrees) with respect to the absorption axis of the polarizer, light leakage in black image is large, so that a decrease in contrast and a color shift easily occur. By disposing a retardation film having an in-plane retardation of $1/2$ of the wavelength λ and an Nz coefficient of 0.5 between the liquid crystal cell and the polarizer, black luminance in an oblique direction can be reduced to improve the contrast.

[0034] The Nz coefficient of the retardation film is defined by $N_z = (n_x - n_z)/(n_x - n_y)$ where n_x is an in-plane slow-axis-direction refractive index, n_y is an in-plane fast-axis-direction refractive index, and n_z is a thickness-direction refractive index. The in-plane retardation R_e of the retardation film is represented by $R_e = (n_x - n_y) \times d$, where d is a

thickness of the retardation film.

[0035] For developing an in-plane retardation of $\lambda/2$ with respect to light having a wavelength of around 550 nm, which has high luminosity factor, with one thin retardation film having a small thickness (*e.g.* 35 μm or less), it is required that the in-plane
5 birefringence $\Delta n = (n_x - n_y)$ of the retardation film be 8×10^{-3} or more. As described in, for example, Japanese Patent Application Laid-Open No. 2005-181451, Japanese Patent Laid-Open No. 2011-227430 and Japanese Patent Laid-Open No. 2016-109924, such a retardation film having a small thickness and a large birefringence can be obtained by a method in which a resin solution is applied onto a support film, a solvent is dried, and a
10 laminate of the support and a resin coating film is stretched. The handling property can be improved by using a retardation film having a small thickness as a laminate with a support film. By shrinking the laminate in a direction perpendicular to the stretching direction during stretching with a heat-shrinkable film used as the support film, a retardation film having a refractive index anisotropy of $n_x > n_z > n_y$ can be obtained. A
15 heat-shrinkable film other than the support film may be bonded to impart a shrinkage force in a specific direction.

[0036] The method for producing the retardation film is not limited to the above, and various known methods can be adopted. In addition, an appropriate refractive index anisotropy and retardation of the retardation film can be adopted depending on the type of
20 liquid crystal cell and the like. The retardation film may be a positive A plate ($n_x > n_y = n_z$), a negative B plate ($n_x > n_y > n_z$), a negative A plate ($n_z = n_x > n_y$) or a positive B plate ($n_z > n_x > n_y$).

[0037] A polymer having a positive intrinsic birefringence is preferably used for preparing a retardation film having a refractive index anisotropy of $n_x > n_z > n_y$, a positive
25 A plate, and a negative B plate. The polymer having a positive intrinsic birefringence refers to one having a relatively large refractive index in the orientation direction when the polymer is oriented by stretching or the like. Examples of the polymer having a positive intrinsic birefringence include polycarbonate-based resins, polyester-based resins such as polyethylene terephthalate and polyethylene naphthalate, polyarylate-based
30 resins, sulfone-based resins such as polysulfone and polyethersulfone, sulfide-based resins such as polyphenylene sulfide, polyimide-based resins, cyclic polyolefin-based (polynorbornene-based) resins, polyamide resins, polyolefin-based resins such as polyethylene and polypropylene, and cellulose esters. In addition, a liquid crystal

material may be used as a material having a positive intrinsic birefringence.

[0038] For the preparation of the negative A plate and the positive B plate, a polymer having a negative intrinsic birefringence is preferably used. The polymer having a negative intrinsic birefringence refers to one having a relatively small refractive index in the orientation direction when the polymer is oriented by stretching or the like. Examples of the polymer having a negative intrinsic birefringence include polymers in which a chemical bond or a functional group having high polarization anisotropy, such as an aromatic group or a carbonyl group, is introduced into a side chain of the polymer, and specific examples thereof include acryl-based resins, styrene-based resins, maleimide-based resins and fumaric acid ester-based resins. In addition, a liquid crystal material may be used as a material having a negative intrinsic birefringence. For example, a negative A plate can be obtained from a discotic liquid crystal oriented in direction perpendicular to the film surface.

[0039] When a polymer is used as a material of the retardation film, the retardation film can be formed by stretching the polymer film to enhance the molecular orientation in a specific direction. Examples of the method for stretching the polymer film include a longitudinal uniaxial stretching method, a transverse uniaxial stretching method, a longitudinal-transverse sequential biaxial stretching method and a longitudinal-transverse simultaneous biaxial stretching method. As the stretching means, any appropriate stretching machine such as a roll stretching machine, a tenter stretching machine, a pantograph-type or a linear motor-type biaxial stretching machine can be used. As described above, the refractive index anisotropy can also be controlled by utilizing the shrinkage force of the heat-shrinkable film during stretching. The laminate in which a liquid crystal layer is formed on a substrate may be used as it is as a retardation film or may be transferred to another film.

[0040] As described above, the in-plane birefringence $\Delta n = (n_x - n_y)$ of the retardation film is preferably 8×10^{-3} or more for realizing a large in-plane retardation (*e.g.* 200 nm or more) even with a small thickness. The in-plane birefringence Δn of the retardation film may be 1.0×10^{-2} or more, 1.2×10^{-2} or more, or 1.3×10^{-2} or more.

[0041] From the viewpoint of thickness reduction, the thickness of the retardation film is preferably 35 μm or less. The thickness of the retardation film may be 30 μm or less, 25 μm or less, or 20 μm or less. The thickness of the retardation film is generally 1 μm or more, and may be 3 μm or more, 5 μm or more, or 7 μm or more. As described above, by

stretching the resin coating film integrally with the film substrate, a retardation film having a small thickness can be produced without impairing the handleability.

[0042] [Pressure Sensitive Adhesive-Equipped Polarizing Plate]

By bonding a retardation film as the transparent protective film 35 on one surface of the polarizer 31, a polarizing plate can be obtained. An optically isotropic film may be bonded onto the polarizer 31 as the transparent protective film 35, followed by bonding a retardation film to the transparent protective film 35 with an appropriate adhesive or pressure sensitive adhesive interposed therebetween. The transparent protective film 33 is bonded to the other surface of the polarizer 31. The transparent protective film 33 may be omitted. When the transparent protective film 33 is omitted, the polarizing plate 36 includes the transparent protective film 35 only on one surface of the polarizer.

[0043] In the polarizing plate used in an IPS-type liquid crystal display, the polarizer and the retardation film are bonded such that the absorption axis direction of the polarizer is parallel or perpendicular to the slow axis direction of the retardation film. For enhancing the accuracy of the optical axis, it is preferable that the bonding of the polarizer and the retardation film is performed by a roll-to-roll method. The polarizer generally has an absorption axis in the machine direction (stretching direction). Thus, when the absorption axis direction of the polarizer is parallel to the slow axis direction of the retardation film, it is preferable to use a retardation film having a slow axis in the machine direction, and when the absorption axis direction of the polarizer is perpendicular to the slow axis direction of the retardation film, it is preferable to use a retardation film having a slow axis in the transverse direction.

[0044] By bonding the pressure sensitive adhesive layer 39 to the surface of the retardation film 35, a pressure sensitive adhesive-equipped polarizing plate in which the pressure sensitive adhesive layer 39 is attached to the surface of the polarizing plate 36 can be obtained. It is preferable that the bonding of the pressure sensitive adhesive layer is also performed by a roll-to-roll method.

[0045] It is preferable that a release film (separator) is temporarily attached to an exposed surface of the pressure sensitive adhesive layer 39 adhered on the surface of the polarizing plate until the polarizing plate is bonded to the image display cell. As the release film, a plastic film in which a surface thereof is subjected to release treatment may be used.

[0046] [Bonding of Pressure Sensitive Adhesive-Equipped Polarizing Plate to Image Display Cell]

A pressure sensitive adhesive-equipped polarizing plate having the retardation film 35 between the polarizer 31 and the pressure sensitive adhesive layer 39 is bonded to the substrate 13 of the liquid crystal cell 10 to form a liquid crystal panel. A pressure sensitive adhesive-equipped polarizing plate in which the pressure sensitive adhesive layer 59 is adhered to a surface of the polarizing plate 56 is bonded to the substrate 15 on the light source-side of the liquid crystal cell. The front and rear polarizing plates 36 and 56 may be bonded to the liquid crystal cell 10 simultaneously or sequentially.

[0047] In bonding process using a pressure sensitive adhesive layer, pressure is applied for enhancing adhesion at a bonding interface to prevent ingress of bubbles and peeling. Examples of the pressure-bonding method include those of roller type and drum type.

[0048] As shown in Examples described later, the direction of the optical axis in a high-birefringence retardation film easily changes due to the tension (stress). The change in the optical axis direction of the retardation film due to the tension is determined by cutting the retardation film into a 10 mm-wide strip shape at an angle of 45° with respect to the slow axis direction, and performing measurement in the slow axis direction with tension applied in the long side direction of the strip-shaped sample. Where the tension is plotted on the abscissa and the (change of amount of) angle of the slow axis is plotted on the ordinate, the inclination of a straight line obtained by the least squares method is the amount of change in the slow axis (unit: °/N/10 mm) with respect to the tension.

[0049] In a retardation film having an in-plane birefringence of 8×10^{-3} or more, the amount of change in the slow axis with respect to the tension may be 0.1°/N/10 mm or more. A retardation film having a smaller thickness and a larger in-plane birefringence tends to have a larger amount of change in the slow axis with respect to the tension, and the amount of change in the optical axis with respect to the tension may be 0.2°/N/10 mm or more or 0.3°/N/10 mm or more.

[0050] Thus, if a polarizing plate including a retardation film in which the direction of the optical axis easily changes is bonded to the image display cell, a deviation may occur in an angle of bonding between the polarizer and the retardation film, and the deviation of the angle can be visually recognized as optical unevenness in a display image.

[0051] The amount of change (deviation) in angle formed by the absorption axis direction of the polarizer 31 and the optical axis (slow axis or fast axis) direction of the

retardation film 35 is preferably 0.4° or less, more preferably 0.3° or less. The amount of change in the axis angle is a difference between θ_1 and θ_0 , where θ_1 is an angle formed by the absorption axis direction of the polarizer 31 and the slow axis direction of the retardation film 35 after the polarizing plate 36 being bonded to the image display cell with the pressure sensitive adhesive layer 39 interposed therebetween, and θ_0 is an angle between the absorption axis direction and the slow axis direction before the bonding. The amount of change in the axis angle may be 0.2° or less or 0.1° or less. When the amount of deviation of the axis angle is 0.4° or less, occurrence of optical unevenness can be suppressed even when the birefringence of the retardation film 35 is large, and occurrence of the unevenness tends to be suppressed as the amount of deviation becomes smaller.

[0052] In a state where the polarizing plate is bonded to the image display cell with the pressure sensitive adhesive layer interposed therebetween, the angle formed by the absorption axis direction of the polarizer and the optical axis direction of the retardation film is preferably 0.4° or less, more preferably 0.3° or less, further preferably 0.2° or less.

When the absorption axis direction of the polarizer is parallel to the slow axis direction of the retardation film, θ_1 is preferably within the range of $0 \pm 0.4^\circ$, more preferably within the range of $0 \pm 0.3^\circ$, further preferably within the range of $0 \pm 0.2^\circ$. When the absorption axis direction of the polarizer is perpendicular to the slow axis direction of the retardation film, θ_1 is preferably within the range of $90 \pm 0.4^\circ$, more preferably within the range of $90 \pm 0.3^\circ$, further preferably within the range of $90 \pm 0.2^\circ$.

[0053] The amount of deviation of the axis angle between the polarizer 31 and the retardation film 35 tends to increase as the thickness of the pressure sensitive adhesive layer 39 used for bonding the polarizing plate 36 (retardation film 35) to the image display cell 10 increases and the pressure sensitive adhesive becomes softer. The shear storage elastic modulus G' at normal temperature (25°C) can be used as an index of the hardness of the pressure sensitive adhesive. The pressure sensitive adhesive becomes harder as G' increases, and the pressure sensitive adhesive becomes softer as G' decreases.

[0054] The amount of deviation of the axis angle after the polarizing plate being bonded to the image display cell with the pressure sensitive adhesive layer interposed therebetween tends to decrease as a value G'/D obtained by dividing the shear storage elastic modulus G' at a temperature of 25°C by the thickness D of the pressure sensitive adhesive layer 39 increases (*i.e.*, as the pressure sensitive adhesive layer becomes harder and thinner). The pressure sensitive adhesive layer 39 preferably has a G'/D of 5.0

kPa/ μm or more, more preferably 5.2 kPa/ μm or more. If G'/D is excessively large, the adhesion retaining force may decrease, leading to occurrence of bonding failure such as ingress of bubbles into a bonding interface. Thus, the pressure sensitive adhesive layer 39 preferably has a G'/D of 28 kPa/ μm or less, more preferably 25 kPa/ μm or less.

5 [0055] The thickness D of the pressure sensitive adhesive layer 39 is preferably 5 to 25 μm , more preferably 7 to 20 μm . The shear storage elastic modulus G' of the pressure sensitive adhesive layer 39 at 25°C is preferably 50 kPa or more, more preferably 60 to 250 kPa, further preferably 70 to 200 kPa.

[0056] In addition to the physical properties of the pressure sensitive adhesive used for
10 bonding the polarizing plate to the image display cell, the bonding pressure (lamination pressure) in bonding of the pressure sensitive adhesive-equipped polarizing plate to the image display cell may also have an effect on deviation of the axis angle between the polarizer and the retardation film, and the amount of deviation of the axis angle between the polarizer and the retardation film tends to increase as the lamination pressure
15 becomes higher. When a polarizing plate including a retardation film having large birefringence and a large amount of change in optical axis with respect to the tension is bonded to the image display cell, the lamination pressure is preferably 0.4 MPa or less, more preferably 0.3 MPa or less. On the other hand, when the lamination pressure is excessively small, bonding failure such as ingress of bubbles into a bonding interface may
20 occur. Thus, the lamination pressure is preferably 0.05 MPa or more, more preferably 0.1 MPa or more.

[0057] As described above, when the retardation film has a large birefringence, a change (deviation) in the axis angle due to bonding easily occurs, and this may cause optical unevenness in the display image. The occurrence of unevenness can be
25 suppressed by adjusting the thickness and hardness of the pressure sensitive adhesive layer and/or the lamination pressure during bonding.

[0058] The physical properties and the lamination pressure of the pressure sensitive adhesive layer 59 in bonding of the polarizing plate 56 on the other surface to the liquid crystal cell 10 are not particularly limited. The thickness and the shear storage elastic
30 modulus of the pressure sensitive adhesive layer 59 may be equal to or different from those of the pressure sensitive adhesive layer 39. The lamination pressure in bonding of the polarizing plate 56 may be equal to or different from the lamination pressure in bonding of the polarizing plate 36.

[0059] <Estimated Mechanism for Occurrence and Reduction of Unevenness>

As described above, an image display device in which display unevenness occurs has a large amount of change $|\theta_1 - \theta_0|$ in the angle formed by the absorption axis direction of the polarizer and the slow axis direction of the retardation film before and after bonding.

5 When the polarizing plate is peeled (reworked) from the image display device in which display unevenness is generated, and the angle θ_2 formed by the absorption axis direction of the polarizer and the slow axis direction of the retardation film is measured, a value substantially equal to that before bonding is obtained. That is, the angle θ_0 formed by the absorption axis direction of the polarizer and the slow axis direction of the retardation film
10 before the polarizing plate is bonded to the image display cell is substantially equal to the angle θ_2 formed by the absorption axis direction of the polarizer and the slow axis direction of the retardation film after the pressure sensitive adhesive-equipped polarizing plate is bonded to the image display cell and reworked. When the reworked polarizing plate is bonded again to the image display cell at a low lamination pressure, the change in the axis
15 angle is small, and unevenness does not occur.

[0060] Therefore, it can be said that the change in the axis angle in bonding of the polarizing plate to the image display cell is a reversible change. Display unevenness caused by such a reversible change in the axis angle is ascribable to the remaining of distortion from pressure in bonding of the polarizing plate. For example, when bonding is
20 performed at a high lamination pressure, the pressure sensitive adhesive layer having an elastic modulus lower than that of the film is deformed, and elastic distortion is generated. Since pressure is applied from directions other than the normal direction of the bonding surface during bonding by a roll laminator or a drum laminator, distortion from pressure in various directions may be accumulated in the pressure sensitive adhesive layer.

25 **[0061]** When the pressure is released after bonding, the pressure sensitive adhesive layer is apt to return to its original shape. However, since the pressure sensitive adhesive layer is bonded to the substrate of the image display cell, the degree of freedom of deformation decreases as compared to that before bonding. Thus, the pressure sensitive adhesive layer cannot completely return to the original shape, and a part of distortion
30 from pressure applied in various directions during bonding remains inside the pressure sensitive adhesive layer. This distortion may be a cause of generating distortion at the bonding interface with the retardation film bonded to the pressure sensitive adhesive layer, and thus changing the optical axis of the retardation film.

[0062] When the lamination pressure during bonding is reduced, distortion accumulated in the pressure sensitive adhesive layer 39 is small, so that distortion remaining in the pressure sensitive adhesive layer after bonding is small, and distortion at the bonding interface with the retardation film is small. In addition, when the thickness
5 D of the pressure sensitive adhesive layer 39 is small and the shear storage elastic modulus G' is large, the amount of deformation of the pressure sensitive adhesive layer by pressure application is small, so that distortion remaining in the pressure sensitive adhesive layer 39 is small and distortion at the bonding interface with the retardation film is small. Thus, it is presumed that when bonding is performed at a low lamination
10 pressure using a hard pressure sensitive adhesive having a small thickness, distortion that causes a change in the optical axis direction of the retardation film is hardly accumulated, and the change amount $|\theta_1 - \theta_0|$ of the optical axis is small, so that occurrence of unevenness is suppressed.

[0063] [Other Optical Members]

15 A liquid crystal display is formed by combining the liquid crystal panel 100 in which the polarizing plates 36 and 56 are bonded to both surfaces of the liquid crystal cell 10 and the light source 105. The liquid crystal display may include an optical layer other than that described above and other members. For example, a brightness enhancement film (not shown) may be arranged between the liquid crystal panel 100 and the light
20 source 105. The brightness enhancement film may be laminated to the polarizing plate 56 on the light source-side.

[0064] The viewing-side transparent protective film 33 may be equipped with a hard coat layer for the purpose of, for example, imparting scratch resistance. In addition, the transparent protective film 33 may be equipped with an antireflection layer. A touch
25 panel sensor, a cover window and the like may be disposed on the viewing-side of the viewing-side polarizing plate 36.

[0065] In the example described above, the polarizing plate 36 disposed on the viewing-side of the liquid crystal cell 10 includes the high-birefringence retardation film 35. The film 55 disposed on the liquid crystal cell-side of the polarizing plate 56 on the light source-side may be a high-birefringence retardation film. In this case, occurrence of unevenness
30 can be suppressed by using a pressure sensitive adhesive layer having a large G'/D as the pressure sensitive adhesive layer 59 for bonding the polarizing plate 56 to the liquid crystal cell 10 and/or reducing the lamination pressure during bonding.

[0066] The absorption axis direction of the polarizer and the slow axis direction of the retardation film may be neither parallel nor perpendicular to each other. Even when the polarizer and the retardation film are laminated at an angle at which the optical axes of the polarizer and the retardation film are neither parallel nor perpendicular to each other, use of a pressure sensitive adhesive layer having a large G'/D ratio as a pressure sensitive adhesive layer for bonding the polarizing plate to the image display cell and/or reduction of the lamination pressure during bonding ensures that the amount of deviation of the optical axes before and after bonding is small, so that occurrence of unevenness can be suppressed.

[0067] [OLED Display]

Examples of the image display device including a polarizing plate in which a polarizer and a retardation film are laminated at an angle at which the optical axes are neither parallel nor perpendicular to each other include OLED displays in addition to liquid crystal displays. An OLED display 202 shown in FIG. 2 includes a bottom emission-type OLED cell 70 in which a transparent electrode 72, an organic light emitting layer 71 and a metal electrode 74 are arranged in this order on a transparent substrate 73.

[0068] As the transparent substrate 73, a glass substrate or a plastic substrate is used. The organic light emitting layer 71 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 72 is a metal oxide layer or a metal thin-film, and transmits light from the organic light emitting layer 71. Thus, light (image light) from the organic light emitting layer 71 is transmitted through the transparent electrode 72 and the substrate 73 and taken out to the viewing-side.

[0069] The metal electrode 74 has light reflectivity. Thus, when external light is incident to the inside of the OLED cell from the substrate 73, light is reflected at the metal electrode 74, and reflected light appears as a mirror surface when viewed from the outside. For preventing the re-emission of reflected light at the metal electrode 74 to the outside to improve the visibility and the visuality of the display device, a circularly polarizing plate 37 is bonded to the viewing-side surface of the OLED cell 70 with the pressure sensitive adhesive layer 39 interposed therebetween.

[0070] The circularly polarizing plate 37 has a configuration in which transparent protective films 33 and 34 are laminated on both surfaces of the polarizer 31, and the transparent protective film 34 arranged between the polarizer 31 and the OLED cell 70 is

a retardation film. When the retardation film 34 has a retardation of $\lambda/4$, and the angle between the slow axis direction of the retardation film 34 and the absorption axis direction of the polarizer 31 is 45° , the laminate of the polarizer and the retardation film (polarizing plate 37) functions as a circularly polarizing plate. The configuration of the polarizing plate 37 is the same as that of the polarizing plate 36 except that the retardation film 34 is a quarter wave plate and the angle formed by the retardation film 34 and the optical axis of the polarizer 31 is 45° .

[0071] The retardation film for forming 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 circularly polarizing plate that functions as a circularly polarizing plate over a wide band of visible light is obtained.

[0072] The circularly polarizing plate 37 is obtained by bonding the polarizer 31 to the retardation film 34 with an appropriate adhesive or pressure sensitive adhesive interposed therebetween. An optically isotropic film may be bonded onto the polarizer 31, followed by bonding a retardation film onto the optically isotropic film. The transparent protective film 33 may be bonded to the other surface of the polarizer 31.

[0073] A pressure sensitive adhesive-equipped polarizing plate having the retardation film 34 between the polarizer 31 and the pressure sensitive adhesive layer 39, is bonded to the substrate 73 of the OLED cell 70 to form an OLED display. As described above regarding the embodiment of the liquid crystal display, use of a pressure sensitive adhesive layer having a large G'/D ratio as the pressure sensitive adhesive layer 39 for bonding the OLED cell to the polarizing plate and/or reduction of the lamination pressure during bonding ensures that even when the retardation film 34 has a high birefringence, the amount of change in axis angle $|\theta_1 - \theta_2|$ before and after bonding is 0.4° or less, so that occurrence of unevenness can be suppressed.

[0074] An example of the bottom emission-type OLED cell 70 has been described above. The OLED cell may be of top emission type. The top emission-type OLED cell generally includes a metal electrode, an organic light emitting layer and a transparent electrode in this order on a substrate. A sealing substrate is provided on the transparent electrode layer, and a circularly polarizing plate is bonded onto the sealing substrate. The OLED display device may further include a touch panel sensor, a cover window and the like on the viewing-side of the circularly polarizing plate 37.

EXAMPLES

[0075] Hereinafter, the present invention will be described in more detail by showing examples, but the present invention is not limited to the following examples.

5 [0076] [Pressure Sensitive Adhesive Sheet]

<Preparation of Pressure Sensitive Adhesive Composition>

(Pressure Sensitive Adhesive Composition P)

99 parts by weight of butyl acrylate (BA) and 1 part by weight of 4-hydroxybutyl acrylate (4HBA) as monomers, and 0.3 parts of 2,2'-azobisisobutyronitrile (AIBN) as a polymerization initiator were put in a reaction vessel together with ethyl acetate, and the mixture was reacted at 60°C for 4 hours under a nitrogen gas stream. Thereafter, ethyl acetate was added to the reaction liquid to obtain a solution of an acryl-based polymer having a weight average molecular weight of 1,650,000. To this solution, based on 100 parts by weight of the polymer, 0.3 parts by weight of dibenzoyl peroxide ("NIPPER BMT" manufactured by NOF CORPORATION) and 0.1 parts by weight of trimethylolpropane xylene diisocyanate ("TAKENATE D 110N" manufactured by Mitsui Chemicals, Inc.) as crosslinkers and a silane coupling agent ("A-100" manufactured by Soken Chemical & Engineering Co., Ltd.) were added to obtain a pressure sensitive adhesive composition A.

[0077] <Pressure Sensitive Adhesive Composition Q>

94.9 parts by weight of BA, 5 parts by weight of acrylic acid (AA) and 0.1 parts by weight of 2-hydroxyethyl acrylate (2HEA) as monomers, and 0.1 parts by weight of AIBN as a polymerization initiator were put in a reaction vessel together with ethyl acetate, and the mixture was reacted at 55°C for 8 hours under a nitrogen gas stream. Thereafter, ethyl acetate was added to the reaction liquid to obtain a solution of an acryl-based polymer having a weight average molecular weight of 2,100,000. To this solution, 0.6 parts by weight of trimethylolpropane/tolylene diisocyanate adduct ("CORONATE L" manufactured by Tosoh Corporation) as a crosslinker and 0.2 parts by weight of a silane coupling agent ("X-41-1056" manufactured by Shin-Etsu Chemical Co., Ltd.) based on 100 parts by weight of the polymer were added to obtain a pressure sensitive adhesive composition B.

[0078] <Pressure sensitive adhesive composition R>

92 parts by weight of BA, 5 parts by weight of N-acryloylmorpholine (ACMO), 2.9 parts by weight of AA and 0.1 parts by weight of 2HEA as monomers, and 0.1 parts by

weight of AIBN as a polymerization initiator were added in a reaction vessel together with ethyl acetate, and the mixture was reacted at 55°C for 8 hours under a nitrogen gas stream. Thereafter, ethyl acetate was added to the reaction liquid to obtain a solution of an acryl-based polymer having a weight average molecular weight of 1,780,000. To this solution, 0.15 parts by weight of NIPER BMT as a crosslinker, and 0.6 parts by weight of CORONATE L based on 100 parts by weight of the polymer were added to obtain a pressure sensitive adhesive composition C.

[0079] <Preparation of Pressure Sensitive Adhesive Sheet>

The pressure sensitive adhesive compositions A to C were applied to a surface of a release treated 38 µm-thick polyethylene terephthalate film ("MRF38" manufactured by Mitsubishi Chemical Corporation), and drying and crosslinking treatment were performed at 150°C to prepare pressure sensitive adhesive sheets having thicknesses of 5 µm, 10 µm, 15 µm, 20 µm and 25 µm. The pressure sensitive adhesive sheets prepared using the pressure sensitive adhesive composition P are defined as pressure sensitive adhesive sheets P1 to P5, the pressure sensitive adhesive sheets prepared using the pressure sensitive adhesive composition Q are defined as pressure sensitive adhesive sheets Q1 to Q5, and the pressure sensitive adhesive sheets prepared using the pressure sensitive adhesive composition R are defined as pressure sensitive adhesive sheets R1 to R5.

[0080] [Experiment Example A1]

<Preparation of Retardation Film A>

In a reaction vessel equipped with a stirrer, 54 parts by weight of 2,2-bis(4-hydroxyphenyl)-4-methylpentane and 12 parts by weight of benzyltriethylammonium chloride were dissolved in a 1 M sodium hydroxide solution. While this solution was stirred, a solution obtained by dissolving 406 parts by weight of terephthalic acid chloride in chloroform was added at a time, and the mixture was stirred at room temperature for 90 minutes. Thereafter, the polymerization solution was subjected to settled separation to separate the chloroform solution containing the polymer, and the chloroform solution was then washed with acetic acid water, washed with ion-exchanged water, and then put in methanol to precipitate the polymer. The precipitated polymer was washed twice with distilled water and twice with methanol, and then dried under reduced pressure to obtain a polyarylate resin. The obtained polyarylate resin was dissolved in cyclopentanone to prepare a solution having a solid content concentration of 20%.

[0081] With a biaxially stretched polypropylene film as a support, the above-described

solution was applied to a thickness of 15 μm after drying, and dried at 100°C to obtain a laminate in which a polyarylate resin layer is stacked on the support film. The laminate was shrunk in a transverse direction while being stretched in a machine direction by a roll stretching machine. The stretched polyarylate-coated film (retardation film A) after
5 peeling of the support film had a thickness of 17 μm , an in-plane retardation of 250 nm at a wavelength of 550 nm and an Nz coefficient of 0.5.

[0082] <Preparation of Polarizing Plate>

A 40 μm -thick biaxially stretched acrylic film was bonded to one surface of a 18 μm -thick polyvinyl alcohol-based polarizer, and a surface of the laminate on the
10 retardation film A-side was bonded to the other surface with an ultraviolet-curable adhesive interposed therebetween. For the bonding, a roll laminator was used, and the adhesive was cured by irradiating the adhesive with an ultraviolet ray. Thereafter, the polypropylene film used as a support film was peeled off, and the pressure sensitive adhesive sheet prepared as described above was laminated on the retardation film A-side
15 to obtain a pressure sensitive adhesive-equipped polarizing plate including an acryl-based film on one surface of the polarizer, the retardation film A on the other surface of the polarizer, and a pressure sensitive adhesive layer on the surface on the retardation film A-side.

[0083] <Bonding to Glass Plate>

The pressure sensitive adhesive-equipped polarizing plate was placed on a 0.7 μm -thick alkali-free glass plate, and the polarizing plate and the glass plate were bonded to each other at a lamination pressure of 0.3 MPa with a pressure roller-type sized piece bonding apparatus to obtain a sample for evaluation.

[0084] [Experiment Example B1]

25 Using a norbornene-based resin film (retardation film B) having a thickness of 132 μm , an in-plane retardation of 250 nm and an Nz coefficient of 0.5 instead of the retardation film A, a pressure sensitive adhesive-equipped polarizing plate was prepared and bonded to a glass plate in the same manner as described above.

[0085] [Experiment Example C1]

30 Using a biaxially oriented norbornene-based resin film (retardation film C) having a thickness of 18 μm , an in-plane retardation of 120 nm and an Nz coefficient of 1.18 instead of the retardation film A, a pressure sensitive adhesive-equipped polarizing plate was prepared and bonded to a glass plate in the same manner as described above.

[0086] [Evaluation]

<Shear Storage Elastic Modulus of Pressure Sensitive Adhesive Sheet>

For each of the pressure sensitive adhesive sheets P3, Q3 and R3, 100 pressure sensitive adhesive sheets were laminated to prepare a test sample. This sample was punched to a disk shape having a diameter of 7.9 mm, and sandwiched between parallel plates, and using “Advanced Rheometric Expansion System (ARES)” manufactured by Rheometric Scientific Co., the dynamic viscoelasticity was measured under the following conditions, and the shear storage elastic modulus at 25°C was read.

(Measurement Conditions)

Deformation mode: twist

Measurement frequency: 1 Hz

Heating rate: 5°C/min

Measurement temperature: -40 to 150°C

[0087] <Change in Slow Axis Angle of Retardation Film with respect to Tension>

The retardation film was cut to a strip shape having a width of 10 mm in such a manner that the long side was at an angle of 45° with respect to the slow axis direction. The in-plane retardation and the slow axis direction were measured with tension applied in the machine direction of the sample while one short side of the strip-shaped sample was fixed on a measurement stage of a polarization/retardation measurement system ("AxoScan" manufactured by Axometrics) and a weight was hung on the other short side of the sample. The mass of the weight was changed, the amount of change in the slow axis angle with respect to the tension (based on the slow axis angle at a tension of 0), and the amount of change in the axis angle with respect to the tension (amount of change in axis/tension) was calculated from the inclination of the straight line.

[0088] <Amount of Change in Optical Axis of Polarizing Plate>

The angle θ_0 formed by the absorption axis direction of the polarizer and the slow axis direction of the retardation film in the pressure sensitive adhesive-equipped optical film was measured with a polarization/retardation measurement system. For the sample after bonding of the pressure sensitive adhesive-equipped optical film onto the glass plate, the angle θ_1 formed by the absorption axis direction of the polarizer and the slow axis direction of the retardation film was measured, and the absolute value of the angle difference ($\theta_1 - \theta_0$) before and after bonding was determined.

[0089] <Bonding State>

Existence or non-existence of bubbles at the bonding interface between the glass plate and the polarizing plate was visually observed.

[0090] <Optical unevenness>

5 A standard polarizing plate (manufactured by Nitto Denko Corporation) with an acryl-based film bonded as a transparent protective film to both surfaces of a polyvinyl alcohol-based polarizer was placed, and on the standard polarizing plate, the sample for evaluation was placed in such a manner that the glass plate was on the lower side. The two polarizing plates were arranged in such a manner that the absorption axis direction of the standard polarizing plate was perpendicular to the absorption axis direction of the polarizing plate of the sample for evaluation (cross nicol arrangement). The transmitted light from the trace base was visually examined, and samples were ranked for unevenness on the basis of the following criteria.

Excellent: Unevenness is not visually recognized (see FIG. 3A)

Average: Slight unevenness is observed

15 Poor: Significant unevenness is observed (see FIG. 3B)

[0091] <Evaluation Results>

Table 1 shows the thicknesses and optical characteristics of the retardation films A to C, the thickness D and the shear storage elastic modulus G' at 25°C of the pressure sensitive adhesive sheet, and the evaluation results of the bonded samples.

20

[0092] Table 1

	Retardation film					Pressure sensitive adhesive sheet				Glass plate laminated article		
	Material	Thickness (μm)	Re (nm)	Δn ($\times 10^3$)	Nz	Axis change/ tension ($^\circ/\text{N}/10\text{mm}$)	D (μm)	G' (kPa)	G'/D (kPa/ μm)	Amount of axis change ($^\circ$)	Bubbles	Unevenness
A	Polyarylate	17	250	14.7	0.5	0.47	P1	5	81	16.2	None	Excellent
							P2	10	81	8.1	None	Excellent
							P3	15	81	5.4	None	Excellent
							P4	20	81	4.1	None	Poor
							P5	25	81	3.2	None	Poor
							Q1	5	120	24.0	None	Excellent
							Q2	10	120	12.0	None	Excellent
							Q3	15	120	8.0	None	Excellent
							Q4	20	120	6.0	None	Excellent
							Q5	25	120	4.8	None	Poor
							R1	5	150	30.0	Present	Excellent
							R2	10	150	15.0	None	Excellent
							R3	15	150	10.0	None	Excellent
							R4	20	150	7.5	None	Excellent
							R5	25	150	6.0	None	Excellent
B	Norbornene	132	250	1.9	0.5	0.01	P4	20	81	4.1	None	Excellent
							P5	25	81	3.2	None	Excellent
							Q5	25	120	4.8	None	Excellent
C	Norbornene	18	120	6.7	1.2	0.01	P4	20	81	4.1	None	Excellent
							P5	25	81	3.2	None	Excellent
							Q5	25	120	4.8	None	Excellent

[0093] It is apparent that in both the retardation films B and C, the change in the slow axis direction with respect to the tension was 0.01°/N/10 mm, whereas the retardation film A having large birefringence had a large rate of change in the slow axis direction with respect to the tension.

5 [0094] In the polarizing plate with the polarizer laminated on the retardation film A, the slow axis direction of the retardation film was parallel to the absorption axis direction of the polarizer (θ_0 was 0.1° or less) before bonding to the glass plate, but after the pressure sensitive adhesive-equipped polarizing plate was bonded to the glass plate, axis deviation occurred, and the axis deviation tended to increase as the thickness D of the
10 pressure sensitive adhesive sheet became larger and the shear storage elastic modulus G' became smaller. In the sample using the pressure sensitive adhesive sheet R1, unevenness was not observed, but ingress of bubbles occurred at the bonding interface between the glass plate and the pressure sensitive adhesive layer.

[0095] Even when the polarizing plate obtained by laminating the retardation film B
15 and the polarizer was bonded to the glass plate with the pressure sensitive adhesive sheet P4, P5 or Q5 having a large thickness and a small shear storage elastic modulus G', clear axis deviation was not observed, and unevenness did not occur. The same applies to the case where the retardation film C was used.

[0096] [Experiment Example A2]
20 A pressure sensitive adhesive-equipped polarizing plate, which includes an acryl-based film on one surface of a polarizer and the retardation film A on the other surface and has the 15 μm -thick pressure sensitive adhesive sheet P3 laminated on a surface on the retardation film A-side, was used. A sample for evaluation was obtained by bonding a pressure sensitive adhesive-equipped polarizing plate to an alkali-free glass plate in the
25 same manner as in Experiment Example A1 except that the lamination pressure was changed within the range of 0.01 to 1.0 MPa as shown in Table 2.

[0097] [Experiment Example B2]
Bonding to a glass plate was performed in the same manner as in Experiment
Example B1 except that a pressure sensitive adhesive-equipped polarizing plate in which
30 a pressure sensitive adhesive sheet P3 is laminated on a surface on the retardation film B-side was used, and the lamination pressure was changed to 0.7 Pa or 1.0 MPa.

[0098] [Experiment Example C2]

Bonding to a glass plate was performed in the same manner as in Experiment

Example C1 except that a pressure sensitive adhesive-equipped polarizing plate in which a pressure sensitive adhesive sheet P3 is laminated on a surface on the retardation film C-side was used, and the lamination pressure was changed to 0.7 Pa or 1.0 MPa.

[0099] [Evaluation]

5 For the sample of Experiment Examples A2, B2 and C2, the amount of change in the optical axis, the bonding state and optical unevenness were evaluated. Table 2 shows the thicknesses and optical characteristics of the retardation films A to C, the conditions (lamination pressure) for bonding the pressure sensitive adhesive-equipped polarizing plate to the glass plate, and the evaluation results.

10 [0100] [Table 2]

Retardation film							Glass plate laminated article			
	Material	Thickness (μm)	Re (nm)	Δn (×10 ³)	Nz	Axis change/tension (°/N/10mm)	Lamination pressure (MPa)	Amount of axis change (°)	Bubbles	Unevenness
A	Polyarylate	17	250	14.7	0.5	0.47	0.01	0.05	Present	Excellent
							0.1	0.07	None	Excellent
							0.3	0.1	None	Excellent
							0.5	0.45	None	Average
							0.7	0.7	None	Poor
							1.0	1.1	None	Poor
B	Norbornene	132	250	1.9	0.5	0.01	0.7	0.05	None	Excellent
							1.0	0.05	None	Excellent
C	Norbornene	18	120	6.7	1.2	0.01	0.7	0.05	None	Excellent
							1.0	0.05	None	Excellent

[0101] In the pressure sensitive adhesive-equipped polarizing plate in which the retardation film A and the polarizer were laminated, the axis deviation tended to increase as the lamination pressure during bonding to the glass plate became larger. When bonding was performed at a lamination pressure of 0.5 MPa, unevenness was observed in inspection of optical unevenness, and unevenness became pronounced when the lamination pressure was further increased. In the sample obtained by performing bonding at a lamination pressure of 0.01 MPa, unevenness was not observed, but ingress of bubbles occurred at the bonding interface between the glass plate and the pressure sensitive adhesive layer.

[0102] In the pressure sensitive adhesive-equipped polarizing plate in which the retardation film B and the polarizer were laminated, clear axis deviation was not observed and unevenness did not occur even when the lamination pressure during bonding to the glass plate was increased to 1.0 MPa. The same applies to the case where the retardation

film C was used.

[0103] In the sample with a glass plate bonded to a polarizing plate in which the polarizer and the retardation film A were laminated, the deviation of the optical axis of the retardation film was large and optical unevenness occurred when the pressure sensitive adhesive sheet had a large thickness D and a small shear storage elastic modulus G' (*i.e.*, the pressure sensitive adhesive sheet is thick and soft) and when the lamination pressure during bonding was large. On the other hand, in the polarizing plate in which the polarizer and the retardation film B or the retardation film C were laminated, optical unevenness was not observed even when the type of the pressure sensitive adhesive sheet or the lamination pressure was changed.

[0104] These results show that the optical unevenness when a polarizing plate including a retardation film is bonded to a glass plate (substrate of image display cell) is a problem peculiar to a retardation film having a large birefringence, and is caused by occurrence of axis deviation of the retardation film due to deformation of the pressure sensitive adhesive sheet during bonding. When a hard pressure sensitive adhesive sheet having a small thickness is used or when the pressure at the time of bonding is small, the axis deviation of the retardation film may be suppressed because the deformation of the pressure sensitive adhesive sheet is small.

[0105] For the samples in which significant unevenness was observed in Experiment Example A2 (a sample at a lamination pressure of 0.7 MPa and a sample at a lamination pressure of 1.0 MPa), the pressure sensitive adhesive-equipped polarizing plate was peeled (reworked) from the glass plate, and the angle difference θ_2 between the absorption axis direction of the polarizer and the slow axis direction of the retardation film was measured. The results showed that the angle difference θ_2 was 0.1° or less, which means the axis deviation was eliminated. The reworked pressure sensitive adhesive-equipped polarizing plate was again bonded to a glass plate at a lamination pressure of 0.3 MPa, and existence or non-existence of optical unevenness was examined. The result showed that unevenness did not occur.

[0106] From the above results, it is considered that the optical unevenness of a sample obtained by bonding a glass plate at a high lamination pressure to a polarizing plate including the retardation film A and a polarizer is due to the fact that distortion from deformation of the pressure sensitive adhesive sheet under pressure during bonding, and occurrence of unevenness can be suppressed by decreasing the pressure during bonding to

reduce the distortion. In addition, it is considered that even when an adhesive sheet having a small thickness and a small shear storage elastic modulus is used, axis deviation hardly occurs and occurrence of unevenness can be suppressed because distortion from deformation of the pressure sensitive adhesive sheet is small.

5

DESCRIPTION OF REFERENCE SIGNS

10	[0107]	10	Liquid crystal cell
		70	OLED cell
		11	Liquid crystal layer
		71	Organic light emitting layer
		72	Transparent electrode
		74	Metal electrode
		13, 15, 73	Substrate
15		36, 37, 56	Polarizing plate
		33, 51, 53	Transparent protective film
		34, 35	Transparent protective film (retardation film)
		39, 59	Pressure sensitive adhesive layer
		100	Liquid crystal panel
20		105	Light source
		201	Liquid crystal display
		202	OLED display

CLAIMS

1. An image display device comprising: an image display cell; and a polarizing plate bonded to a surface of the image display cell with a pressure sensitive adhesive layer
5 interposed therebetween, wherein
the polarizing plate includes a polarizer, and a retardation film disposed on one surface of the polarizer,
the retardation film is arranged between the polarizer and the image display cell,
the retardation film has an in-plane birefringence of 8×10^{-3} or more at a wavelength
10 of 550 nm, and
an absolute value of a difference $|\theta_1 - \theta_2|$ between an angle θ_1 and an angle θ_2 is 0.4° or less,
wherein θ_1 is an angle formed by an absorption axis direction of the polarizer and a slow axis direction of the retardation film in a state where the polarizing plate is bonded to
15 the image display cell with the pressure sensitive adhesive layer interposed therebetween, and θ_2 is an angle formed by the absorption axis direction of the polarizer and the slow axis direction of the retardation film when the polarizing plate is peeled from the image display cell.
- 20 2. The image display device according to claim 1, wherein in the retardation film, the amount of change in the slow axis with respect to tension in application of the tension in a direction of 45° with respect to the slow axis direction is $0.1^\circ/\text{N}/10 \text{ mm}$ or more.
- 25 3. The image display device according to claim 1 or 2, wherein the retardation film satisfies $n_x > n_z > n_y$, where n_x is an in-plane slow-axis-direction refractive index, n_y is an in-plane fast-axis-direction refractive index, and n_z is a thickness-direction refractive index.
- 30 4. The image display device according to any one of claims 1 to 3, wherein the θ_1 is in the range of $0 \pm 0.4^\circ$ or $90 \pm 0.4^\circ$.
5. The image display device according to any one of claims 1 to 4, wherein the retardation film has an in-plane retardation of 200 nm or more.

6. The image display device according to any one of claims 1 to 5, wherein the retardation film is in contact with the pressure sensitive adhesive layer.
- 5 7. The image display device according to any one of claims 1 to 6, wherein the pressure sensitive adhesive layer has a value G'/D of 5.0 kPa/ μm or more, where the value G'/D is obtained by dividing a shear storage elastic modulus G' at a temperature of 25°C by a thickness D .
- 10 8. The image display device according to any one of claims 1 to 7, wherein the pressure sensitive adhesive layer has a thickness of 25 μm or less.
9. A method for producing an image display device in which a polarizing plate is bonded to a surface of an image display cell with a pressure sensitive adhesive layer interposed
15 therebetween, the polarizing plate including a polarizer and a retardation film disposed on a surface of the polarizer,
the method comprising:
preparing a pressure sensitive adhesive-equipped polarizing plate in which a retardation film having an in-plane birefringence of 8×10^{-3} or more at a wavelength of
20 550 nm is laminated on one surface of a polarizer, and a pressure sensitive adhesive layer is adhered on the retardation film; and
bonding the pressure sensitive adhesive-equipped polarizing plate to the image display cell at a lamination pressure of 0.05 to 0.4 MPa.
- 25 10. The method for producing an image display device according to claim 9, wherein the pressure sensitive adhesive layer has a value G'/D of 5 kPa/ μm or more, wherein the value G'/D is obtained by dividing a shear storage elastic modulus G' at a temperature of 25°C by a thickness D .
- 30 11. The method for producing an image display device according to claim 9 or 10, wherein the pressure sensitive adhesive layer has a thickness of 25 μm or less.
12. The method for producing an image display device according to any one of claims 9 to

11, wherein

an absolute value of a difference $|\theta_1 - \theta_0|$ between an angle θ_1 and an angle θ_0 is 0.4° or less,

5 wherein θ_0 is an angle formed by an absorption axis direction of the polarizer and a slow axis direction of the retardation film in the pressure sensitive adhesive-equipped polarizing plate, and θ_1 is an angle formed by the absorption axis direction of the polarizer and the slow axis direction of the retardation film after the pressure sensitive adhesive-equipped polarizing plate being bonded to the image display cell.

10 13. The method for producing an image display device according to any one of claims 9 to 12, wherein the retardation film has an in-plane retardation of 200 nm or more.

14. The method for producing an image display device according to any one of claims 9 to 13, wherein in the retardation film, the amount of change in the slow axis with respect to
15 tension in application of the tension in a direction of 45° with respect to the slow axis direction is $0.1^\circ/\text{N}/10\text{ mm}$ or more.

15. The method for producing an image display device according to any one of claims 9 to 14, wherein the retardation film satisfies $n_x > n_z > n_y$, where n_x is an in-plane slow-axis-
20 direction refractive index, n_y is an in-plane fast-axis-direction refractive index, and n_z is a thickness-direction refractive index.