

Description

Title of Invention: PHASE DIFFERENCE FILM, POLARIZER WITH OPTICAL COMPENSATION LAYER, IMAGE DISPLAY DEVICE, AND IMAGE DISPLAY DEVICE WITH TOUCH PANEL

Technical Field

[0001] The present invention relates to a retardation film, a polarizing plate with an optical compensation layer, an image display apparatus, and an image display apparatus with a touch panel.

Background Art

[0002] In recent years, along with widespread use of thin displays, an image display apparatus having an organic EL panel mounted thereon (organic EL display apparatus) has been proposed. The organic EL panel has a metal layer having high reflectivity, and hence is liable to cause a problem of, for example, reflection of ambient light or reflection of a background. In view of the foregoing, it has been known that such problem is prevented by arranging a polarizing plate with an optical compensation layer (circularly polarizing plate) on a viewer side. In addition, it has been known that the polarizing plate with an optical compensation layer is arranged on the viewer side of a liquid crystal display panel to improve its viewing angle. A product obtained as described below has been known as a general polarizing plate with an optical compensation layer. A retardation film and a polarizer are laminated

so that the slow axis of the retardation film and the absorption axis of the polarizer may form a predetermined angle (e.g., 45°) in accordance with applications. However, a related-art retardation film involves a problem in that undesired coloring may occur in a hue in an oblique direction when the film is used in a polarizing plate with an optical compensation layer.

Citation List

Patent Literature

[0003] [PTL 1] JP 3325560 B2

Summary of Invention

Technical Problem

[0004] The present invention has been made in order to solve the problem of the related art described above, and a primary object of the present invention is to provide a retardation film capable of achieving an image display apparatus having a neutral hue in an oblique direction, and a polarizing plate with an optical compensation layer, an image display apparatus, and an image display apparatus with a touch panel each including such retardation film.

Solution to Problem

[0005] According to one aspect of the present invention, there is provided a retardation film having: in-plane retardations that satisfy relationships of $100\text{ nm} \leq R_e(550) \leq 160\text{ nm}$, $R_e(450)/R_e(550) \leq 1$,

and $\text{Re}(650)/\text{Re}(550) \geq 1$; Nz coefficients that satisfy relationships of $0.4 < \text{Nz}(550) < 0.6$, $0 \leq |\text{Nz}(450) - \text{Nz}(550)| \leq 0.1$, and $0 \leq |\text{Nz}(650) - \text{Nz}(550)| \leq 0.1$; and a photoelastic coefficient of $14 \times 10^{-12} \text{ Pa}^{-1}$ or less.

In one embodiment, the retardation film contains a polycarbonate resin.

According to another aspect of the present invention, there is provided a polarizing plate with an optical compensation layer. The polarizing plate with an optical compensation layer includes: an optical compensation layer formed of the retardation film; and a polarizer, wherein an angle formed by a slow axis of the optical compensation layer and an absorption axis of the polarizer is from 35° to 55° .

In one embodiment, the polarizing plate with an optical compensation layer further includes a conductive layer on an opposite side of the optical compensation layer to the polarizer.

According to yet another aspect of the present invention, there is provided an image display apparatus. The image display apparatus includes the polarizing plate with an optical compensation layer.

According to still another aspect of the present invention,

there is provided an image display apparatus with a touch panel. The image display apparatus with a touch panel includes the polarizing plate with an optical compensation layer, wherein the conductive layer is configured to function as a touch panel sensor.

Advantageous Effects of Invention

[0006] According to the present invention, the retardation film has in-plane retardations that satisfy relationships of $100 \text{ nm} \leq R_e(550) \leq 160 \text{ nm}$, $R_e(450)/R_e(550) \leq 1$, and $R_e(650)/R_e(550) \geq 1$, and has N_z coefficients that satisfy relationships of $0.4 < N_z(550) < 0.6$, $0 \leq |N_z(450) - N_z(550)| \leq 0.1$, and $0 \leq |N_z(650) - N_z(550)| \leq 0.1$. Accordingly, when the retardation film is used for a polarizing plate with an optical compensation layer, there can be achieved a polarizing plate with an optical compensation layer having a neutral hue in an oblique direction.

Brief Description of Drawings

[0007] FIG. 1 is a schematic sectional view of a polarizing plate with an optical compensation layer according to one embodiment of the present invention.

Description of Embodiments

[0008] Embodiments of the present invention are described below. However, the present invention is not limited to these embodiments.

[0009] (Definitions of Terms and Symbols)

The definitions of terms and symbols used herein are as described below.

(1) Refractive Indices (n_x , n_y , and n_z)

" n_x " represents a refractive index in a direction in which an in-plane refractive index is maximum (that is, slow axis direction), " n_y " represents a refractive index in a direction perpendicular to the slow axis in the plane (that is, fast axis direction), and " n_z " represents a refractive index in a thickness direction.

(2) In-plane Retardation (R_e)

" $R_e(\lambda)$ " refers to an in-plane retardation measured at 23°C with light having a wavelength of λ nm. For example, " $R_e(550)$ " refers to an in-plane retardation measured at 23°C with light having a wavelength of 550 nm. The $R_e(\lambda)$ is determined from the equation " $R_e = (n_x - n_y) \times d$ " when the thickness of a layer (film) is represented by d (nm).

(3) Thickness Direction Retardation (R_{th})

" $R_{th}(\lambda)$ " refers to a thickness direction retardation measured at 23°C with light having a wavelength of λ nm. For example, " $R_{th}(550)$ " refers to a thickness direction retardation measured at 23°C with light having a wavelength of 550 nm. The $R_{th}(\lambda)$ is determined from the equation " $R_{th} = (n_x - n_z) \times d$ " when the thickness

of a layer (film) is represented by d (nm).

(4) Nz Coefficient

An Nz coefficient is determined from the equation " $N_z = R_{th}/R_e$ ".

[0010] A. Retardation Film

A retardation film of the present invention has in-plane retardations that satisfy relationships of $100 \text{ nm} \leq R_e(550) \leq 160 \text{ nm}$, $R_e(450)/R_e(550) \leq 1$, and $R_e(650)/R_e(550) \geq 1$, and Nz coefficients that satisfy relationships of $0.4 < N_z(550) < 0.6$, $0 \leq |N_z(450) - N_z(550)| \leq 0.1$, and $0 \leq |N_z(650) - N_z(550)| \leq 0.1$. That is, the retardation film shows such a reverse wavelength dispersion characteristic that its retardation value increases with an increase in wavelength of measurement light. Besides, the Nz coefficient of the retardation film has small wavelength dependence, and its refractive index characteristic shows a relationship of $n_x > n_z > n_y$ for measurement light in a wide wavelength range. With this, when used for a polarizing plate with an optical compensation layer, the retardation film can achieve a polarizing plate with an optical compensation layer having a neutral hue in an oblique direction. Further, the retardation film has a photoelastic coefficient of $14 \times 10^{-12} \text{ Pa}^{-1}$ or less. With this, the ratio of a change in retardation value due to a stress is small, and hence, for example, reliability under a high-temperature environment is high. Typically, the retardation film has a single-layer structure and is formed of one film. In

one embodiment, the retardation film contains a polycarbonate resin. The retardation film may have a sheet shape, or may have an elongate shape.

[0011] The in-plane retardation $Re(550)$ of the retardation film is preferably from 120 nm to 150 nm, more preferably from 130 nm to 145 nm. When the in-plane retardation of the retardation film falls within the range, a polarizing plate with an optical compensation layer obtained by laminating the retardation film and the polarizer so that an angle formed by the slow axis direction of the retardation film and the absorption axis direction of the polarizer may be about 45° or about 135° may be used as a circularly polarizing plate that can achieve an excellent antireflection characteristic.

[0012] With regard to the in-plane retardations of the retardation film, the value of the ratio " $Re(450)/Re(550)$ " is preferably from 0.80 to 0.90, more preferably from 0.80 to 0.88, still more preferably from 0.80 to 0.86. The value of the ratio " $Re(650)/Re(550)$ " is preferably from 1.01 to 1.20, more preferably from 1.02 to 1.15, still more preferably from 1.03 to 1.10. With this, the retardation film can achieve a more excellent reflection hue.

[0013] As described above, the N_z coefficients of the

retardation film satisfy relationships of $0.4 < N_z(550) < 0.6$, $0 \leq |N_z(450) - N_z(550)| \leq 0.1$, and $0 \leq |N_z(650) - N_z(550)| \leq 0.1$. The $N_z(550)$ is preferably from 0.42 to 0.58, more preferably from 0.45 to 0.55, particularly preferably about 0.5. When the N_z coefficients fall within such range, the refractive index characteristic shows a relationship of $n_x > n_z > n_y$ for measurement light in a wide wavelength range, and with this, a polarizing plate with an optical compensation layer having a neutral hue in an oblique direction and having an excellent viewing angle characteristic can be achieved.

[0014] As described above, the photoelastic coefficient of the retardation film (absolute value thereof) is $14 \times 10^{-12} \text{ Pa}^{-1}$ or less. The photoelastic coefficient of the retardation film is preferably from $1 \times 10^{-12} \text{ Pa}^{-1}$ to $14 \times 10^{-12} \text{ Pa}^{-1}$, more preferably from $2 \times 10^{-12} \text{ Pa}^{-1}$ to $12 \times 10^{-12} \text{ Pa}^{-1}$. When the absolute value of the photoelastic coefficient falls within such range, a change in retardation value can be suppressed even under a high-temperature and high-humidity environment, and hence excellent reliability can be achieved. In addition, even in the case where the thickness of the film is small, the bendability of an image display apparatus (in particular, an organic EL panel) can be maintained while a sufficient retardation is secured. Further, a change in retardation (consequently a change in color of the organic EL panel) due to a stress at the time of the bending of the film can be further suppressed.

[0015] The water absorption ratio of the retardation film is preferably 3% or less, more preferably 2.5% or less, still more preferably 2% or less. When such water absorption ratio is satisfied, temporal changes in display characteristics can be suppressed. The water absorption ratio may be determined in conformity with JIS K 7209.

[0016] The retardation film preferably has barrier properties against moisture and a gas (e.g., oxygen). The water vapor transmission rate (moisture vapor transmission rate) of the retardation film under the conditions of 40°C and 90%RH is preferably less than 1.0×10^{-1} g/m²/24 hr. From the viewpoint of barrier properties, the lower limit of the moisture vapor transmission rate is preferably as low as possible. The gas barrier property of the retardation film under the conditions of 60°C and 90%RH is preferably from 1.0×10^{-7} g/m²/24 hr to 0.5 g/m²/24 hr, more preferably from 1.0×10^{-7} g/m²/24 hr to 0.1 g/m²/24 hr. When the moisture vapor transmission rate and the gas barrier property fall within such ranges, in the case where the polarizing plate with an optical compensation layer is bonded to an organic EL panel, the organic EL panel can be satisfactorily protected from moisture and oxygen in air. The moisture vapor transmission rate and the gas barrier property may both be measured in conformity with JIS K 7126-1.

[0017] The thickness of the retardation film is preferably from

10 μm to 150 μm , more preferably from 10 μm to 100 μm , still more preferably from 10 μm to 70 μm . With such thickness, the desired in-plane retardation and the desired Nz coefficient described above can be obtained.

[0018] B. Method of producing Retardation Film

The retardation film is formed of any appropriate resin capable of achieving the above-mentioned characteristics. The retardation film may be formed by, for example, applying an application liquid obtained by dissolving or dispersing the resin in any appropriate solvent onto a shrinkable film to form a coating film, and shrinking the coating film. The shrinkage of the coating film is typically performed as follows: a laminate of the shrinkable film and the coating film is heated to shrink the shrinkable film, and such shrinkage of the shrinkable film causes the coating film to be shrunk. The shrinkage ratio of the coating film is preferably from 0.50 to 0.99, more preferably from 0.60 to 0.98, still more preferably from 0.70 to 0.95. A heating temperature is preferably from 130°C to 170°C, more preferably from 150°C to 160°C. In one embodiment, during the shrinkage of the coating film, the laminate may be stretched in a direction perpendicular to the direction of the shrinkage. In this case, the stretching ratio of the laminate is preferably from 1.01 times to 3.0 times, more preferably from 1.05 times to 2.0 times, still more preferably from 1.10 times to 1.50 times. Any appropriate stretching machines, such as a roll stretching

machine, a tenter stretching machine, and a biaxial stretching machine, may each be adopted as a stretching machine to be used in the stretching. Thus, a birefringent layer can be formed on the shrinkable film. The resultant birefringent layer may be peeled from the shrinkable film and used as the retardation film of the present invention, or the laminate of the birefringent layer (retardation film) and the shrinkable film may be used as it is without the peeling of the birefringent layer from the shrinkable film.

[0019] Examples of the resin for forming the retardation film include polyarylate, polyimide, polyamide, polyester, polyvinyl alcohol, polyfumarate, a norbornene resin, a polycarbonate resin, a cellulose resin, and polyurethane. Those resins may be used alone or in combination thereof. Of those, a polycarbonate resin is preferred. Specific examples of the resin are described, for example, as thermoplastic resins in JP 2015-212828 A, the description of which is incorporated herein by reference in its entirety.

[0020] The glass transition temperature of the polycarbonate resin is preferably 110°C or more and 180°C or less, more preferably 120°C or more and 165°C or less. When the glass transition temperature is excessively low, the heat resistance of the film tends to be poor, and hence a dimensional change thereof may occur after the forming of the film. In addition, the image quality of

an organic EL panel to be obtained may be reduced. When the glass transition temperature is excessively high, forming stability at the time of the forming of the film may be poor, and the transparency of the film may be impaired. The glass transition temperature is determined in conformity with JIS K 7121 (1987).

[0021] The solvent for dissolving or dispersing the resin may be appropriately determined in accordance with the kind of the resin composition, and examples thereof include chloroform, dichloromethane, toluene, methylene chloride, xylene, cyclohexanone, and cyclopentanone. The solvents may be used alone or in combination thereof.

[0022] A formation material for the shrinkable film is not particularly limited, but a thermoplastic resin is preferred because the thermoplastic resin is suitable for stretching treatment to be described later. Specific examples thereof include: an acrylic resin; a polyolefin resin, such as polyethylene or polypropylene (PP); a polyester resin, such as polyethylene terephthalate (PET); polyamide; a polycarbonate resin; a norbornene resin; polystyrene; polyvinyl chloride; polyvinylidene chloride; a cellulose resin, such as triacetyl cellulose; polyether sulfone; polysulfone; polyimide; polyacryl; an acetate resin; polyarylate; polyvinyl alcohol; and mixtures thereof. In addition, a liquid crystal polymer or the like may also be used. The shrinkable film is preferably

a uniaxially or biaxially stretched film formed of one kind or two or more kinds of the formation materials. As the shrinkable film, for example, a commercially available product may be used. Examples of the commercially available product include "SPACECLEAN" manufactured by Toyobo Co., Ltd., "Fancywrap" manufactured by Gunze Limited, "TORAYFAN" manufactured by Toray Industries, Inc., "Lumirror" manufactured by Toray Industries, Inc., "ARTON" manufactured by JSR Corporation, "ZEONOR" manufactured by Zeon Corporation, and "SUNTEC" manufactured by Asahi Kasei Corporation.

[0023] The thickness of the shrinkable film, which is not particularly limited, falls within, for example, the range of from 10 μm to 300 μm , preferably the range of from 20 μm to 200 μm , more preferably the range of from 40 μm to 150 μm . The surface of the shrinkable film may be subjected to surface treatment for the purpose of, for example, improving its adhesiveness with the birefringent layer. The surface treatment is, for example, chemical or physical treatment, such as chromic acid treatment, ozone exposure, flame exposure, high-voltage electric shock exposure, or ionizing radiation treatment. In addition, a primer layer may be formed on the surface of the shrinkable film by applying an undercoating agent (e.g., a pressure-sensitive adhesive substance).

[0024] Any appropriate application method may be adopted as a method of applying the application liquid onto the shrinkable

film. Examples of the application method include a spin coating method, a roll coating method, a flow coating method, a printing method, a dip coating method, a casting deposition method, a bar coating method, and a gravure printing method. In addition, at the time of the application, multilayer coating may be adopted as required. The thickness of the application liquid may be appropriately set so that the retardation film to be obtained may have a desired thickness.

[0025] Any appropriate drying method may be adopted as a method of drying the application liquid after its application in accordance with the application liquid. Examples of the drying method include natural drying, air drying involving blowing wind against the liquid, low-temperature drying, and drying by heating. A method obtained by combining two or more of those methods is also permitted. The drying method is preferably the low-temperature drying from the viewpoint of suppressing the shrinkage of the shrinkable film before the stretching step to be described later. The drying temperature of the low-temperature drying is preferably from 20°C to 100°C.

[0026] C. Polarizing Plate with Optical Compensation Layer

FIG. 1 is a schematic sectional view of a polarizing plate with an optical compensation layer according to one embodiment of the present invention. A polarizing plate **100** with an optical compensation layer of this embodiment includes a polarizer **10** and

an optical compensation layer **30**. The optical compensation layer **30** is formed of the retardation film described in the section A. In one embodiment, an angle formed by a slow axis of the optical compensation layer and an absorption axis of the polarizer is from 35° to 55° . In practical use, a protective layer **20** may be arranged on the side of the polarizer **10** opposite to the optical compensation layer **30** like the illustrated example. In addition, the polarizing plate with an optical compensation layer may include another protective layer (also referred to as "inner protective layer") between the polarizer **10** and the optical compensation layer **30**. In the illustrated example, the inner protective layer is omitted. In this case, the optical compensation layer **30** may also function as an inner protective layer. With such configuration, further thinning of the polarizing plate with an optical compensation layer can be achieved. Further, a conductive layer and a substrate (none of which is shown) may be arranged on the side of the optical compensation layer **30** opposite to the polarizer **10** (i.e., outside the optical compensation layer **30**) in the stated order as required. The substrate is laminated so as to be in close contact with the conductive layer. The phrase "laminated so as to be in close contact" as used herein means that two layers are laminated directly and fixedly without an adhesion layer (e.g., an adhesive layer or a pressure-sensitive adhesive layer) being interposed. The conductive layer and the substrate may be typically introduced as a laminate of the substrate and the conductive layer into the

polarizing plate **100** with an optical compensation layer. When the conductive layer and the substrate are further arranged, the polarizing plate **100** with an optical compensation layer can be suitably used for an image display apparatus with an inner touch panel.

[0027] C-1. Polarizer

Any appropriate polarizer may be adopted as the polarizer **10**. For example, a resin film for forming the polarizer may be a single-layer resin film, or may be produced by using a laminate of two or more layers.

[0028] Specific examples of the polarizer formed of a single-layer resin film include: a polarizer obtained by subjecting a hydrophilic polymer film, such as a polyvinyl alcohol (PVA)-based film, a partially formalized PVA-based film, or an ethylene-vinyl acetate copolymer-based partially saponified film, to dyeing treatment with a dichroic substance, such as iodine or a dichroic dye, and stretching treatment; and a polyene-based alignment film, such as a dehydration-treated product of PVA or a dehydrochlorination-treated product of polyvinyl chloride. A polarizer obtained by dyeing the PVA-based film with iodine and uniaxially stretching the resultant is preferably used because the polarizer is excellent in optical characteristics.

[0029] The dyeing with iodine is performed by, for example, immersing the PVA-based film in an aqueous solution of iodine. The stretching ratio of the uniaxial stretching is preferably from 3 times to 7 times. The stretching may be performed after the dyeing treatment, or may be performed while the dyeing is performed. In addition, the dyeing may be performed after the stretching has been performed. The PVA-based film is subjected to swelling treatment, cross-linking treatment, washing treatment, drying treatment, or the like as required. For example, when the PVA-based film is immersed in water to be washed with water before the dyeing, contamination or an antiblocking agent on the surface of the PVA-based film can be washed off. In addition, the PVA-based film is swollen and hence dyeing unevenness or the like can be prevented.

[0030] A specific example of the polarizer obtained by using a laminate is a polarizer obtained by using a laminate of a resin substrate and a PVA-based resin layer (PVA-based resin film) laminated on the resin substrate or a laminate of a resin substrate and a PVA-based resin layer formed on the resin substrate through application. The polarizer obtained by using the laminate of the resin substrate and the PVA-based resin layer formed on the resin substrate through application may be produced, for example, by: applying a PVA-based resin solution to the resin substrate; drying the solution to form the PVA-based resin layer on the resin substrate, to thereby provide the laminate of the resin substrate and the

PVA-based resin layer; and stretching and dyeing the laminate to turn the PVA-based resin layer into the polarizer. In this embodiment, the stretching typically includes stretching of the laminate under a state in which the laminate is immersed in an aqueous solution of boric acid. Further, the stretching may further include in-air stretching of the laminate at high temperature (e.g., 95°C or more) before the stretching in the aqueous solution of boric acid as required. The resultant laminate of the resin substrate and the polarizer may be used as it is (i.e., the resin substrate may be used as a protective layer for the polarizer). Alternatively, a product obtained as described below may be used: the resin substrate is peeled from the laminate of the resin substrate and the polarizer, and any appropriate protective layer in accordance with purposes is laminated on the peeling surface. Details of such method of producing the polarizer are described in, for example, JP 2012-73580 A, the description of which is incorporated herein by reference in its entirety.

[0031] The thickness of the polarizer is preferably 25 μm or less, more preferably from 1 μm to 12 μm , still more preferably from 3 μm to 12 μm , particularly preferably from 3 μm to 8 μm . When the thickness of the polarizer falls within such range, curling at the time of heating can be satisfactorily suppressed, and satisfactory appearance durability at the time of heating is obtained.

[0032] The polarizer preferably shows absorption dichroism at any wavelength in the wavelength range of from 380 nm to 780 nm. As described above, the single layer transmittance of the polarizer is from 43.0% to 46.0%, preferably from 44.5% to 46.0%. The polarization degree of the polarizer is preferably 97.0% or more, more preferably 99.0% or more, still more preferably 99.9% or more.

[0033] C-2. Protective Layer

The protective layer **20** is formed of any appropriate film that may be used as a protective layer for the polarizer. As a material serving as a main component of the film, there are specifically given, for example, cellulose-based resins, such as triacetylcellulose (TAC), and transparent resins, such as polyester-based, polyvinyl alcohol-based, polycarbonate-based, polyamide-based, polyimide-based, polyether sulfone-based, polysulfone-based, polystyrene-based, polynorbornene-based, polyolefin-based, (meth)acrylic, and acetate-based resins. There are also given, for example, thermosetting resins or UV-curable resins, such as (meth)acrylic, urethane-based, (meth)acrylic urethane-based, epoxy-based, and silicone-based resins. There are also given, for example, glassy polymers, such as a siloxane-based polymer. In addition, a polymer film described in JP 2001-343529 A (WO 01/37007 A1) may be used. For example, a resin composition containing a thermoplastic resin having a substituted or

unsubstituted imide group on a side chain thereof, and a thermoplastic resin having a substituted or unsubstituted phenyl group and a nitrile group on side chains thereof may be used as a material for the film, and the composition is, for example, a resin composition containing an alternating copolymer formed of isobutene and N-methylmaleimide, and an acrylonitrile-styrene copolymer. The polymer film may be, for example, an extrudate of the resin composition.

[0034] The protective layer **20** may be subjected to surface treatment, such as hard coat treatment, antireflection treatment, anti-sticking treatment, or antiglare treatment, as required. Further/alternatively, the protective layer **20** may be subjected to treatment for improving viewability when the display screen of the apparatus is viewed through polarized sunglasses (typically the impartment of a circular (elliptical) polarization function or the impartment of an ultra-high retardation) as required. When such treatment is performed, even in the case where the display screen is viewed through a polarizing lens, such as polarized sunglasses, excellent viewability can be achieved. Therefore, the polarizing plate with an optical compensation layer is suitably applicable even to an image display apparatus that may be used outdoors.

[0035] The thickness of the protective layer **20** is typically 5 mm or less, preferably 1 mm or less, more preferably from 1 μm

to 500 μm , still more preferably from 5 μm to 150 μm . When the protective layer is subjected to surface treatment, its thickness is a thickness including the thickness of a surface-treated layer.

[0036] When an inner protective layer is arranged between the polarizer **10** and the optical compensation layer **30**, it is preferred that the inner protective layer be optically isotropic. The phrase "optically isotropic" as used herein means that the layer has an in-plane retardation $R_e(550)$ of from 0 nm to 10 nm and a thickness direction retardation $R_{th}(550)$ of from -10 nm to +10 nm. The inner protective layer may include any appropriate material as long as the layer is optically isotropic. The material may be appropriately selected from, for example, the materials described above for the protective layer **20**.

[0037] The thickness of the inner protective layer is preferably from 5 μm to 200 μm , more preferably from 10 μm to 100 μm , still more preferably from 15 μm to 95 μm .

[0038] C-3. Conductive Layer or Conductive Layer with Substrate

The conductive layer may be patterned as required. Through the patterning, a conductive part and an insulating part may be formed. As a result, an electrode may be formed. The electrode may function as a touch sensor electrode for detecting contact on a touch panel. The shape of the pattern is preferably a pattern

that satisfactorily operates as a touch panel (e.g., a capacitance-type touch panel). Specific examples thereof include patterns described in, for example, JP 2011-511357 A, JP 2010-164938 A, JP 2008-310550 A, JP 2003-511799 A, and JP 2010-541109 A.

[0039] The conductive layer may be formed by forming a metallic oxide film on any appropriate substrate through any appropriate film forming method (e.g., a vacuum vapor deposition method, a sputtering method, a CVD method, an ion plating method, and a spraying method). After the film formation, heating treatment (e.g., at from 100°C to 200°C) may be performed as required. When the heating treatment is performed, an amorphous film can be crystallized. Examples of the metal oxide include indium oxide, tin oxide, zinc oxide, indium-tin composite oxide, tin-antimony composite oxide, zinc-aluminum composite oxide, and indium-zinc composite oxide. An indium oxide may be doped with a divalent metal ion or a tetravalent metal ion. The metal oxide is preferably an indium-based composite oxide, more preferably indium-tin composite oxide (ITO). The indium-based composite oxide has features of having a high transmittance (e.g., 80% or more) in a visible light region (380 nm to 780 nm) and having a low surface resistance value per unit area.

[0040] When the conductive layer contains the metal oxide, the thickness of the conductive layer is preferably 50 nm or less, more

preferably 35 nm or less. The lower limit of the thickness of the conductive layer is preferably 10 nm.

[0041] The surface resistance value of the conductive layer is preferably 300 ohms per square ($\Omega/\square$) or less, more preferably 150 $\Omega/\square$ or less, still more preferably 100 $\Omega/\square$ or less.

[0042] The conductive layer may be transferred from the substrate onto the optical compensation layer to serve alone as a layer forming the polarizing plate with an optical compensation layer, or may be laminated as a laminate with the substrate (conductive layer with a substrate) on the optical compensation layer. Typically, as described above, the conductive layer and the substrate may be introduced as a conductive layer with a substrate into the polarizing plate with an optical compensation layer.

[0043] Any appropriate resin is given as a material forming the substrate. The resin is preferably a resin excellent in transparency. Specific examples thereof include a cyclic olefin-based resin, a polycarbonate-based resin, a cellulose-based resin, a polyester-based resin, and an acrylic resin.

[0044] It is preferred that the substrate be optically isotropic. Therefore, the conductive layer may be used as a conductive layer with an isotropic substrate in the polarizing plate with an optical

compensation layer. A material forming the substrate that is optically isotropic (isotropic substrate) is, for example, a material using a resin free of any conjugated system, such as a norbornene-based resin or an olefin-based resin, as a main skeleton, or a material having a cyclic structure, such as a lactone ring or a glutarimide ring, in the main chain of an acrylic resin. The use of any such material can suppress the expression of a retardation in association with the orientation of the molecular chain of the material at the time of the formation of the isotropic substrate to a low level.

[0045] The substrate has a thickness of preferably from 10 μm to 200 μm , more preferably from 20 μm to 60 μm .

[0046] C-4. Others

Any appropriate pressure-sensitive adhesive layer or adhesive layer is used in the lamination of the respective layers forming the polarizing plate with an optical compensation layer of the present invention. The pressure-sensitive adhesive layer is typically formed of an acrylic pressure-sensitive adhesive. The adhesive layer is typically formed of a polyvinyl alcohol-based adhesive.

[0047] A pressure-sensitive adhesive layer may be arranged on the optical compensation layer **30** side of the polarizing plate **100** with an optical compensation layer, though the layer is not shown.

When the pressure-sensitive adhesive layer is arranged in advance, the polarizing plate can be easily bonded to any other optical member (e.g., an organic EL cell). A release film is preferably bonded to the surface of the pressure-sensitive adhesive layer until the polarizing plate is used.

[0048] D. Image Display Apparatus

An image display apparatus of the present invention includes a display cell and the polarizing plate with an optical compensation layer described in the section C on the viewer side of the display cell. The polarizing plate with an optical compensation layer is laminated so that the optical compensation layer may be on a display cell side (the polarizer may be on the viewer side). In an image display apparatus including the polarizing plate with an optical compensation layer including the conductive layer, the conductive layer may function as a touch panel sensor to form a so-called image display apparatus with an inner touch panel, which includes a build-in touch sensor between a display cell (e.g., a liquid crystal cell or an organic EL cell) and a polarizer.

Examples

[0049] Now, the present invention is specifically described by way of Examples. However, the present invention is not limited by these Examples. Measurement methods for characteristics are as described below. In Examples and Comparative Examples, "part(s)"

and "%" are by weight unless otherwise specified.

(1) Thickness

Measurement was performed with a dial gauge (manufactured by PEACOCK, product name: "DG-205 type pds-2").

(2) Retardation

A sample measuring 50 mm by 50 mm was cut out of each retardation film to provide a measurement sample, and its retardation values were measured with AxoScan manufactured by Axometrics, Inc. Measurement wavelengths were 450 nm, 550 nm, and 650 nm, and a measurement temperature was 23°C.

In addition, the average refractive indices of the sample were measured with an Abbe refractometer manufactured by Atago Co., Ltd., and its refractive indices n_x , n_y , and n_z and N_z coefficients were calculated from the resultant retardation values.

[0050] [Example 1]

1. Production of Polycarbonate Resin

Polymerization was performed with a batch polymerization apparatus formed of two vertical reactors each including a stirring blade and a reflux condenser controlled to 100°C. 29.60 Parts by mass (0.046 mol) of bis[9-(2-phenoxy-carbonyl-ethyl)fluoren-9-yl]methane (Compound 3),

29.21 parts by mass (0.200 mol) of ISB, 42.28 parts by mass (0.139 mol) of SPG, 63.77 parts by mass (0.298 mol) of DPC, and 1.19×10^{-2} part by mass (6.78×10^{-5} mol) of calcium acetate monohydrate were loaded. A first reactor was purged with nitrogen while the pressure therein was reduced, and was then heated with a heating medium. When the internal temperature reached 100°C, stirring was started. The internal temperature was caused to reach 220°C after 40 minutes from the start of the temperature increase, and while the temperature was controlled to be kept at this temperature, pressure reduction was simultaneously started, and the pressure was caused to reach 13.3 kPa in 90 minutes after the internal temperature had reached 220°C. A phenol vapor produced as a by-product along with the polymerization reaction was introduced into the reflux condenser at 100°C, a monomer component contained in a slight amount in the phenol vapor was returned to the first reactor, and a phenol vapor that did not condense was introduced into a condenser at 45°C and recovered. Nitrogen was introduced into the first reactor to temporarily return the pressure to the atmospheric pressure. After that, the oligomerized reaction liquid in the first reactor was transferred to a second reactor. Then, temperature increase and pressure reduction in the second reactor were started, and the internal temperature and the pressure were caused to reach 240°C and 0.2 kPa, respectively in 50 minutes. After that, the polymerization was allowed to proceed until predetermined stirring power was achieved. When the predetermined power was achieved,

nitrogen was introduced into the reactor to return the pressure to the atmospheric pressure. The produced polyester carbonate was extruded into water, and the strand was cut to provide pellets.

The glass transition temperature of the resultant polycarbonate resin was 130°C.

2. Production of Retardation Film

The resultant polycarbonate resin was dissolved in methylene chloride to provide a 25 wt% resin solution. The resin solution was applied onto a shrinkable film (biaxially stretched film of PP, 400 mm×300 mm, thickness: 60 µm) with a coater so as to have a thickness of 60 µm after drying, and was dried at 30°C for 5 minutes and at 80°C for 5 minutes to produce a laminate of the shrinkable film and a coating film.

The resultant laminate was cut to have a length of 150 mm and a width of 120 mm, and was shrunk in its widthwise direction at a shrinkage ratio of 0.78 times and stretched in its lengthwise direction at a stretching ratio of 1.3 times at a temperature of 134°C through the use of Lab Stretcher KARO IV (manufactured by Bruckner). Thus, a retardation film (thickness: 60 µm) was obtained.

The resultant retardation film had an $Re(450)$ of 116 nm, an $Re(550)$ of 136 nm, and an $Re(650)$ of 144 nm, and had an $Nz(450)$

of 0.54, an $N_z(550)$ of 0.59, and an $N_z(650)$ of 0.62.

3. Production of Conductive Layer

A transparent conductive layer (thickness: 20 nm) formed of an indium-tin composite oxide was formed on the surface of the retardation film by sputtering to produce a laminate of the retardation film and the conductive layer. A specific procedure is as follows: under a vacuum atmosphere (0.40 Pa) into which Ar and O₂ (at a flow rate ratio of Ar:O₂=99.9:0.1) were introduced, a sintered body of 10 wt% of tin oxide and 90 wt% of indium oxide was used as a target, and an RF-superimposed DC-magnetron sputtering method at a film temperature of 130°C and a horizontal magnetic field of 100 mT (discharge voltage: 150 V, RF frequency: 13.56 MHz, ratio of RF power to DC power (RF power/DC power): 0.8) was used. The resultant transparent conductive layer was subjected to crystallizing treatment by being heated in a hot-air oven at 150°C.

4. Production of Polarizer

An elongate roll of a polyvinyl alcohol (PVA)-based resin film having a thickness of 30 μm (manufactured by Kuraray Co., Ltd., product name: "PE3000") was uniaxially stretched in its lengthwise direction with a roll stretching machine at a ratio of 5.9 times in the lengthwise direction, and at the same time, was subjected to swelling, dyeing, cross-linking, and washing treatments, followed finally by drying treatment. Thus, a polarizer having a thickness

of 12 μm was produced.

Specifically, in the swelling treatment, the film was stretched at a ratio of 2.2 times while being treated with pure water at 20°C. Then, in the dyeing treatment, the film was stretched at a ratio of 1.4 times while being treated in an aqueous solution at 30°C containing iodine and potassium iodide at a weight ratio of 1:7, the aqueous solution having an iodine concentration adjusted so that the polarizer to be obtained had a single layer transmittance of 45.0%. Further, two-stage cross-linking treatment was adopted for the cross-linking treatment. In the first-stage cross-linking treatment, the film was stretched at a ratio of 1.2 times while being treated in an aqueous solution at 40°C having dissolved therein boric acid and potassium iodide. The boric acid content and potassium iodide content of the aqueous solution of the first-stage cross-linking treatment were set to 5.0 wt% and 3.0 wt%, respectively. In the second-stage cross-linking treatment, the film was stretched at a ratio of 1.6 times while being treated in an aqueous solution at 65°C having dissolved therein boric acid and potassium iodide. The boric acid content and potassium iodide content of the aqueous solution of the second-stage cross-linking treatment were set to 4.3 wt% and 5.0 wt%, respectively. In addition, in the washing treatment, the film was treated in a potassium iodide aqueous solution at 20°C. The potassium iodide content of the aqueous solution of the washing treatment was set to 2.6 wt%. Finally, in the drying

treatment, the film was dried at 70°C for 5 minutes. Thus, the polarizer was obtained.

5. Production of Polarizing Plate with Optical Compensation Layer

A triacetylcellulose film (thickness: 40 μm , manufactured by Konica Minolta, Inc., product name: "KC4UYW") was bonded to one side of the polarizer via a polyvinyl alcohol-based adhesive. The retardation film was bonded to the other side of the polarizer via a polyvinyl alcohol-based adhesive. In this case, the bonding was performed so that the slow axis of the retardation film was at 45° counterclockwise with respect to the absorption axis of the polarizer.

Thus, a polarizing plate with an optical compensation layer having a laminated structure "protective layer/polarizer/retardation film (optical compensation layer)/conductive layer" was obtained.

6. Production of Image Display Apparatus Substitute

A substitute for an organic EL display apparatus was produced as described below. An aluminum metallized film (manufactured by Toray Advanced Film Co., Ltd., product name: "DMS Metallized X-42", thickness: 50 μm) was bonded to a glass plate with a pressure-sensitive adhesive, and the resultant was used as a substitute for an organic EL display apparatus. A pressure-sensitive adhesive layer was

formed on the conductive layer side of the obtained polarizing plate with an optical compensation layer using an acrylic pressure-sensitive adhesive. The resultant was cut into dimensions of 50 mm×50 mm and mounted to the organic EL display apparatus substitute.

[0051] [Example 2]

A retardation film (thickness: 60 μm) was obtained in the same manner as in the method of Example 1 except that, in the step of producing the retardation film, the shrinkage ratio in the widthwise direction was set to 0.75 times, and the stretching ratio in the lengthwise direction was set to 1.35 times.

The resultant retardation film had an $\text{Re}(450)$ of 119 nm, an $\text{Re}(550)$ of 139 nm, and an $\text{Re}(650)$ of 147 nm, and had an $\text{Nz}(450)$ of 0.47, an $\text{Nz}(550)$ of 0.52, and an $\text{Nz}(650)$ of 0.54.

A polarizing plate with an optical compensation layer and an organic EL display apparatus substitute were obtained in the same manner as in Example 1 except that the above-mentioned retardation film was used.

[0052] [Example 3]

A retardation film (thickness: 60 μm) was obtained in the same manner as in the method of Example 1 except that, in the step of

producing the retardation film, the shrinkage ratio in the widthwise direction was set to 0.72 times, and the stretching ratio in the lengthwise direction was set to 1.40 times.

The resultant retardation film had an $Re(450)$ of 120 nm, an $Re(550)$ of 141 nm, and an $Re(650)$ of 150 nm, and had an $Nz(450)$ of 0.37, an $Nz(550)$ of 0.42, and an $Nz(650)$ of 0.44.

A polarizing plate with an optical compensation layer and an organic EL display apparatus substitute were obtained in the same manner as in Example 1 except that the above-mentioned retardation film was used.

[0053] [Comparative Example 1]

A retardation film (thickness: 60 μm) was obtained in the same manner as in the method of Example 1 except that: in the step of producing the polycarbonate resin, 9,9-[4-(2-hydroxyethoxy)phenyl]fluorene (BHEPF), isosorbide (ISB), diethylene glycol (DEG), diphenyl carbonate (DPC), and magnesium acetate tetrahydrate were used at a molar ratio of BHEPF/ISB/DEG/DPC/magnesium acetate=0.348/0.490/0.162/1.005/1.00 $\times 10^{-5}$; and in the step of producing the retardation film, the stretching temperature was set to 155°C, the shrinkage ratio in the widthwise direction was set to 0.8 times, and the stretching ratio in the lengthwise direction

was set to 1.3 times.

The resultant retardation film had an $\text{Re}(450)$ of 125 nm, an $\text{Re}(550)$ of 140 nm, and an $\text{Re}(650)$ of 146 nm, and had an $\text{Nz}(450)$ of 0.47, an $\text{Nz}(550)$ of 0.50, and an $\text{Nz}(650)$ of 0.52.

A polarizing plate with an optical compensation layer and an organic EL display apparatus substitute were obtained in the same manner as in Example 1 except that the above-mentioned retardation film was used.

[0054] [Comparative Example 2]

1. Production of Retardation Film

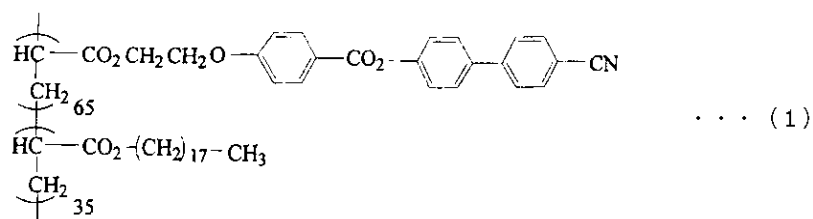
A polycarbonate resin film having a length of 3 m, a width of 300 mm, and a thickness of 120 μm was produced from a polycarbonate resin produced in the same manner as in Example 1 through the use of a film-forming apparatus including a single-screw extruder (manufactured by Isuzu Kakoki, screw diameter: 25 mm, cylinder preset temperature: 220°C), a T-die (width: 300 mm, preset temperature: 220°C), a chill roll (preset temperature: from 120°C to 130°C), and a take-up unit. The polycarbonate resin film was cut to have a length of 150 mm and a width of 120 mm, and subjected to fixed-end uniaxial stretching with Lab Stretcher KARO IV (manufactured by Bruckner) at a temperature of 134°C and a ratio of 2.8 times to provide a retardation film (thickness: 47 μm).

The resultant retardation film had an $Re(450)$ of 119 nm, an $Re(550)$ of 139 nm, and an $Re(650)$ of 147 nm, and had an $Nz(450)$ of 1.08, an $Nz(550)$ of 1.13, and an $Nz(650)$ of 1.15.

2. Production of Liquid Crystal Fixed Layer

20 Parts by weight of a side chain-type liquid crystal polymer represented by the following chemical formula (I) (numerical values "65" and "35" in the formula each represent the mole percent of a monomer unit, and the polymer is represented in the form of a block polymer for convenience: weight-average molecular weight: 5,000), 80 parts by weight of a polymerizable liquid crystal showing a nematic liquid crystal phase (manufactured by BASF SE: product name: Paliocolor LC242), and 5 parts by weight of a photopolymerization initiator (manufactured by Ciba Specialty Chemicals Inc.: product name: IRGACURE 907) were dissolved in 200 parts by weight of cyclopentanone to prepare a liquid crystal application liquid. Then, the application liquid was applied onto a substrate film (norbornene-based resin film: manufactured by Zeon Corporation, product name: "ZEONEX") with a bar coater, and was then dried by heating at 80°C for 4 minutes to align the liquid crystal. The liquid crystal layer was cured by irradiating the liquid crystal layer with UV light. Thus, a liquid crystal fixed layer (thickness: 1 μ m) serving as a second retardation layer was formed on the substrate. The layer had an $Re(550)$ of 0 nm and an $R_{th}(550)$

of -100 nm (n_x : 1.5326, n_y : 1.5326, n_z : 1.6550), and showed a refractive index characteristic of $n_z > n_x = n_y$.



3. Production of Polarizing Plate with Optical Compensation Layer

The liquid crystal fixed layer was bonded to the retardation film via an acrylic pressure-sensitive adhesive, and then the substrate film was removed to provide a laminate (thickness: 48 μm) having the liquid crystal fixed layer transferred onto the retardation film.

The resultant laminate had an $\text{Re}(450)$ of 119 nm, an $\text{Re}(550)$ of 139 nm, and an $\text{Re}(650)$ of 147 nm, and had an $\text{Nz}(450)$ of 0.31, an $\text{Nz}(550)$ of 0.52, and an $\text{Nz}(650)$ of 0.60.

A conductive layer was formed on the surface of the laminate on its liquid crystal fixed layer side in the same manner as in Example 1 to produce a laminate of the retardation film, the liquid crystal fixed layer, and the conductive layer.

A polarizing plate with an optical compensation layer having

a laminated structure "protective layer/polarizer/retardation film/liquid crystal fixed layer/conductive layer" was obtained in the same manner as in Example 1 except that the retardation film side of the above-mentioned laminate was bonded to a polarizer obtained in the same manner as in Example 1.

4. Production of Image Display Apparatus Substitute

A substitute for an organic EL display apparatus was produced as described below. An aluminum metallized film (manufactured by Toray Advanced Film Co., Ltd., product name: "DMS Metallized X-42", thickness: 50 μ m) was bonded to a glass plate with a pressure-sensitive adhesive, and the resultant was used as a substitute for an organic EL display apparatus. A pressure-sensitive adhesive layer was formed on the conductive layer side of the obtained polarizing plate with an optical compensation layer using an acrylic pressure-sensitive adhesive. The resultant was cut into dimensions of 50 mm×50 mm and mounted to the organic EL display apparatus substitute.

[0055] [Comparative Example 3]

A polarizing plate with an optical compensation layer and an organic EL display apparatus substitute were obtained in the same manner as in Example 1 except that a retardation film produced in the same manner as in Comparative Example 2 was used.

[0056] <Evaluation>

The retardation film and organic EL display apparatus substitute of each of Examples and Comparative Examples were subjected to the following evaluations. The results of the evaluations are shown in Table 1.

(1) Photoelastic Coefficient of Retardation Film

The coating film obtained by peeling off the shrinkable film, or the unstretched film was cut into a rectangular shape having a width of 20 mm and a length of 100 mm to produce a sample. The sample was measured for its photoelastic coefficient with light having a wavelength of 550 nm through the use of an ellipsometer M-150 manufactured by JASCO Corporation.

(2) Retardation Change Ratio

The retardation film was bonded to glass via a pressure-sensitive adhesive to produce a sample, and its retardation was measured by the same method as in the above-mentioned measurement of the retardation. The sample after the measurement was loaded into a heating oven at 85°C for 180 hours, and then the sample was taken out and measured for its retardation again to determine the ratio of a change in $Re(550)$.

(3) Reflectance and Reflection Hue

The organic EL display apparatus substitute was used as a sample,

and measured for its front reflectance and front reflection hue using a spectrophotometer CM-2600d manufactured by Konica Minolta, Inc. The front reflectance was measured in an SCI mode. For the front reflection hue, a distance Δa^*b^* from an achromatic color on an a^*b^* chromaticity diagram was evaluated.

(4) Reflectance and Reflection Hue in Oblique Direction

The organic EL display apparatus substitute was used as a sample, and measured for its reflectance and reflection hue in an oblique direction using DMS 505 manufactured by Konica Minolta, Inc. For the reflectance in the oblique direction, the average value of luminous reflectances Y at four points at a polar angle of 60° and azimuth angles of 0° , 45° , 90° , and 135° , respectively, was evaluated. For the reflection hue in the oblique direction, a two-point distance Δa^*b^* on an a^*b^* chromaticity diagram between a reflection hue in the oblique direction at the time of measurement at an inclination angle of 60° with respect to a fast axis and a reflection hue at the time of measurement at an inclination angle of 60° with respect to a slow axis was evaluated.

[0057]

Table 1

	In-plane retardation (nm)				Nz coefficient					Photoelastic coefficient ($\times 10^{-12}$ Pa ⁻¹)	Front			Oblique		Retardation change ratio (%)
	Re (450)	Re (550)	Re (650)	Re (450) / Re (550)	Re (650) / Re (550)	Nz (450)	Nz (550)	Nz (650)	Nz (450) - Nz (550)		Nz (650) - Nz (550)	Reflection (%)	Reflection hue	Reflection (%)	Reflection hue	
Example 1	116	136	144	0.85	1.06	0.54	0.59	0.62	0.05	0.03	11	4.9	5.9	0.69	4.8	2.2
Example 2	119	139	147	0.86	1.06	0.47	0.52	0.54	0.05	0.02	11	4.6	4.2	0.56	2.5	2.4
Example 3	120	141	150	0.85	1.06	0.37	0.42	0.44	0.05	0.02	11	5.0	4.4	0.56	5.9	2.3
Comparative Example 1	125	140	146	0.89	1.04	0.47	0.50	0.52	0.03	0.02	30	8.4	13.3	0.55	3.0	8.1
Comparative Example 2	119	139	147	0.86	1.06	0.31	0.52	0.60	0.21	0.08	11	4.5	4.3	0.73	9.1	1.9
Comparative Example 3	119	139	147	0.86	1.06	1.08	1.13	1.15	0.05	0.02	11	4.5	4.3	3.00	16.3	2.5

[0058] The retardation films of Examples, each of which had a small retardation change ratio, and the organic EL display apparatus substitutes using the retardation films of Examples, each of which had a reflection hue of less than 6.0, were satisfactory.

Industrial Applicability

[0059] The polarizing plate with an optical compensation layer including the retardation film of the present invention is suitably used for an image display apparatus, such as an organic EL panel.

Reference Signs List

- [0060] **10** polarizer
- 20** protective layer
- 30** optical compensation layer (retardation film)
- 100** polarizing plate with optical compensation layer

Claims

[Claim 1] A retardation film having:

in-plane retardations that satisfy relationships of $100\text{ nm} \leq \text{Re}(550) \leq 160\text{ nm}$, $\text{Re}(450)/\text{Re}(550) \leq 1$, and $\text{Re}(650)/\text{Re}(550) \geq 1$;

Nz coefficients that satisfy relationships of $0.4 < \text{Nz}(550) < 0.6$, $0 \leq |\text{Nz}(450) - \text{Nz}(550)| \leq 0.1$, and $0 \leq |\text{Nz}(650) - \text{Nz}(550)| \leq 0.1$; and

a photoelastic coefficient of $14 \times 10^{-12}\text{ Pa}^{-1}$ or less,

where $\text{Re}(450)$, $\text{Re}(550)$, and $\text{Re}(650)$ represent in-plane retardations measured at 23°C with light having wavelengths of 450 nm, 550 nm, and 650 nm, respectively, and $\text{Nz}(450)$, $\text{Nz}(550)$, and $\text{Nz}(650)$ represent Nz coefficients determined from the equation $\text{Nz} = \text{Rth}/\text{Re}$, whereby Rth and Re represent respectively, thickness direction retardation and in-plane retardation measured at 23°C with light having wavelengths of 450 nm, 550 nm, and 650 nm, respectively.

[Claim 2] The retardation film according to claim 1, wherein the retardation film contains a polycarbonate resin.

[Claim 3] A polarizing plate, comprising:

an optical compensation layer formed of the retardation film of claim 1 or 2; and

a polarizer,

wherein an angle formed by a slow axis of the optical compensation layer and an absorption axis of the polarizer is from

35° to 55°.

[Claim 4] The polarizing plate according to claim 3, further comprising a conductive layer on an opposite side of the optical compensation layer to the polarizer.

[Claim 5] An image display apparatus, comprising the polarizing plate of claim 3.

[Claim 6] An image display apparatus with a touch panel, comprising the polarizing plate of claim 4, wherein the conductive layer is configured to function as a touch panel sensor.