

Description

Title of Invention: RETARDATION FILM, POLARIZING PLATE WITH OPTICAL COMPENSATION LAYER, IMAGE DISPLAY DEVICE AND METHOD FOR PRODUCING RETARDATION FILM

Technical Field

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

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 conventional retardation film involves a problem in that an undesired color shift occurs 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 to solve the conventional problem, 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 method of producing such retardation film.

Solution to Problem

[0005] A retardation film according to an embodiment of the present invention has an $\text{Re}(550)$ of from 10 nm to 400 nm, a ratio " $\text{Re}(450)/\text{Re}(550)$ " of from 0.8 to 0.9, and an N_z coefficient of from 0.3 to 0.7, where $\text{Re}(450)$ represents an in-plane retardation measured at 23°C with light having a wavelength of 450 nm, and $\text{Re}(550)$

represents an in-plane retardation measured at 23°C with light having a wavelength of 550 nm.

In one embodiment of the present invention, the retardation film includes a resin film containing a polymer having positive intrinsic birefringence and a polymer having negative intrinsic birefringence.

According to another aspect of the present invention, a polarizing plate with an optical compensation layer is provided. The polarizing plate with an optical compensation layer includes: an optical compensation layer formed of the retardation film as described above; and a polarizer. 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 another polarizing plate with an optical compensation layer, an angle formed by a slow axis of the optical compensation layer and an absorption axis of the polarizer is from 80° to 100°, or from -10° to 10°.

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

According to still another aspect of the present invention, a method of producing a retardation film is provided. The production method includes the steps of: applying a birefringent material containing a cellulose-based resin and a cinnamic acid ester copolymer onto a shrinkable film, followed by drying to produce a laminate of the shrinkable film and a coating film; and stretching the laminate and shrinking the laminate in a direction perpendicular to a direction of the stretching to set a refractive index characteristic of the coating film to $n_x > n_z > n_y$.

In one embodiment of the present invention, a shrinkage ratio of the shrinkable film in the direction perpendicular to the stretching direction is from 0.50 times to 0.99 times.

Advantageous Effects of Invention

[0006] According to the present invention, the $R_e(550)$ is from 10 nm to 400 nm, the N_z coefficient is from 0.3 to 0.7, and the ratio " $R_e(450)/R_e(550)$ " is from 0.8 to 0.9, and hence the retardation film capable of achieving a polarizing plate with an optical compensation layer having a neutral hue in an oblique direction can be obtained.

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 (Re)

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

(3) Thickness Direction Retardation (Rth)

"Rth(λ)" refers to a thickness direction retardation measured at 23°C with light having a wavelength of λ nm. For example, "Rth(550)" refers to a thickness direction retardation measured at 23°C with light having a wavelength of 550 nm. The Rth(λ) is determined from the equation "Rth(λ)=(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 "Nz=Rth/Re".

[0010] A. Retardation Film

A retardation film of the present invention has an Re(550) of from 10 nm to 400 nm. Further, the retardation film has a ratio "Re(450)/Re(550)" of from 0.8 to 0.9, and an Nz coefficient of from 0.3 to 0.7. That is, the retardation film shows such a reverse wavelength dispersion characteristic that its retardation value increases in accordance with an increase in wavelength of measurement light, and its refractive index characteristic shows a relationship of $n_x > n_z > n_y$. In one embodiment, the retardation film includes a resin film containing a polymer having positive intrinsic birefringence and a polymer having negative intrinsic birefringence. The retardation film of the present invention may be used as a polarizing plate with an optical compensation layer by being

laminated on a polarizer (or a polarizing plate). The retardation film of the present invention has a ratio "Re(450)/Re(550)" of from 0.8 to 0.9, and an Nz coefficient of from 0.3 to 0.7, and hence can achieve a hue that is neutral (i.e., free of undesired coloring) in an oblique direction when used as a polarizing plate with an optical compensation layer.

[0011] In one embodiment, the in-plane retardation Re(550) of the retardation film is preferably from 100 nm to 180 nm, more preferably from 110 nm to 170 nm, still more preferably from 120 nm to 160 nm, particularly preferably from 130 nm to 150 nm. In another embodiment, the in-plane retardation Re(550) of the retardation film is preferably from 190 nm to 360 nm, more preferably from 200 nm to 340 nm, still more preferably from 210 nm to 320 nm, particularly preferably from 220 nm to 300 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. In addition, a polarizing plate with an optical compensation layer obtained by laminating the retardation film and the polarizer so that the angle formed by the slow axis direction of the retardation film and the

absorption axis direction of the polarizer may be about 0° or about 90° may be used as a polarizing plate with an optical compensation layer that can achieve an excellent viewing angle characteristic.

[0012] As described above, the value of the ratio "Re(450)/Re(550)" between the in-plane retardations of the retardation film is from 0.8 to 0.9. The ratio "Re(450)/Re(550)" is preferably from 0.82 to 0.88, more preferably from 0.84 to 0.86, particularly preferably about 0.85. That is, the retardation film satisfies a relationship of $\text{Re}(450) < \text{Re}(550)$, and hence shows a reverse wavelength dispersion characteristic. Further, the in-plane retardations of the retardation film preferably satisfy a relationship of $\text{Re}(550) < \text{Re}(650)$. When such relationship is satisfied, a more excellent reflection hue can be achieved.

[0013] As described above, the Nz coefficient of the retardation film is preferably from 0.3 to 0.7, more preferably from 0.4 to 0.6, still more preferably from 0.45 to 0.55, particularly preferably about 0.5. When the Nz coefficient falls within such range, a more excellent reflection hue can be achieved.

[0014] The absolute value of the photoelastic coefficient of the retardation film is preferably 40×10^{-12} (m^2/N) or less, more preferably from 1×10^{-12} (m^2/N) to 30×10^{-12} (m^2/N), still more preferably from 1×10^{-12} (m^2/N) to 20×10^{-12} (m^2/N). When the absolute value of

the photoelastic coefficient falls within such range, even in the case where the thickness of the film is small, the bendability of an image display apparatus (especially 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 glass transition temperature (T_g) of the retardation film is preferably 100°C or more. The lower limit of the glass transition temperature is more preferably 110°C, still more preferably 120°C, particularly preferably 130°C. Meanwhile, the upper limit of the glass transition temperature is preferably 200°C, more preferably 180°C. 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).

[0016] The thickness of the retardation film is preferably from 10 μm to 150 μm , more preferably from 30 μm to 120 μm , still more

preferably from 50 μm to 100 μm . With such thickness, the desired in-plane retardation and the desired Nz coefficient described above can be obtained.

[0017] B. Method of producing Retardation Film

The above-mentioned retardation film may be obtained by a production method of the present invention. The method of producing a retardation film of the present invention includes: applying a birefringent material containing a cellulose-based resin and a cinnamic acid ester copolymer onto a shrinkable film, followed by drying to produce a laminate of the shrinkable film and a coating film; and stretching the laminate and shrinking the laminate in a direction perpendicular to a direction of the stretching to set a refractive index characteristic of the coating film to $n_x > n_z > n_y$.

[0018] In a conventional production method, it has been difficult to obtain a retardation film having an in-plane retardation $\text{Re}(550)$ of from 10 nm to 400 nm, a ratio " $\text{Re}(450)/\text{Re}(550)$ " of from 0.8 to 0.9, and an Nz coefficient of from 0.3 to 0.7. Specifically, the in-plane retardation $\text{Re}(550)$, the ratio " $\text{Re}(450)/\text{Re}(550)$ ", and the Nz coefficient are in a trade-off relationship with each other, and hence it has been difficult to obtain a retardation film in which all of these values fall within the above-mentioned desired ranges. In contrast, according to the above-mentioned production method, an ideal retardation film in which all of the values fall

within the desired ranges can be obtained.

[0019] B-1. Step of producing Laminate

As described above, a production process for the retardation film includes the step of applying the birefringent material onto the shrinkable film, followed by drying to produce the laminate of the shrinkable film and the coating film.

[0020] The shrinkage ratio of the shrinkable film in the direction perpendicular to the stretching direction in a stretching step to be described later preferably falls within the range of from 0.50 times to 0.99 times. The shrinkage ratio is more preferably from 0.60 times to 0.98 times, still more preferably from 0.75 times to 0.95 times.

[0021] 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.

[0022] 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 coating film. 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).

[0023] The birefringent material preferably contains a resin composition containing a polymer having positive intrinsic birefringence and a polymer having negative intrinsic birefringence. The resin composition typically contains the cellulose-based resin and the cinnamic acid ester copolymer. The resin composition may be obtained by blending the polymer having positive intrinsic birefringence and the polymer having negative intrinsic birefringence. A method such as melt blending or solution blending may be used as a method of blending the polymers. The melt blending method in the case where an additive having an aromatic hydrocarbon ring or an aromatic heterocycle is incorporated into the resin composition is a method involving melting the resins and the additive having an aromatic hydrocarbon ring or an aromatic heterocycle through heating, and kneading the molten materials to produce the composition. The solution blending method is a method involving dissolving the resins and the additive having an aromatic hydrocarbon ring or an aromatic heterocycle in a solvent, and blending the materials. As the solvent to be used for the solution blending, there may be used, for example: a chlorine-based solvent, such as methylene chloride or chloroform; an aromatic solvent, such as toluene or xylene; a ketone solvent, such as acetone, methyl ethyl ketone, or methyl isobutyl ketone; an alcohol solvent, such as methanol, ethanol, or propanol; an ether solvent, such as dioxane or tetrahydrofuran; and dimethylformamide or N-methylpyrrolidone. The respective resins and the additive having an aromatic hydrocarbon

ring or an aromatic heterocycle may be dissolved in the solvent and then blended, or the powders, pellets, or the like of the respective resins may be kneaded and then dissolved in the solvent. The resin composition may be precipitated by loading the resultant blended resin solution into a poor solvent, or the blended resin solution may be used as it is. The details of the cinnamic acid ester copolymer that may be used in this embodiment are described in, for example, JP 6048556 B2, the description of which is incorporated herein by reference in its entirety.

[0024] The birefringent material may contain a solvent for dissolving the resin composition. The solvent 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.

[0025] The birefringent material may contain an additive as required. Examples of the additive include a deterioration-preventing agent, a UV inhibitor, an optical anisotropy modifier, a plasticizer, an infrared absorber, and a filler. The additive may be solid or liquid.

[0026] Any appropriate application method may be adopted as a method of applying the birefringent material 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. Thus, the laminate of the shrinkable film and the birefringent material (the coating film) can be obtained. The application thickness of the birefringent material may be appropriately set so that the retardation film to be obtained may have a desired thickness.

[0027] Any appropriate drying method may be adopted as a method of drying the birefringent material after its application in accordance with the birefringent material. Examples of the drying method include natural drying, air drying involving blowing wind against the material, 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.

[0028] B-2. Step of stretching Laminate

In the step of stretching the laminate, the refractive index

characteristic of the coating film is set to $n_x > n_z > n_y$ by stretching the laminate and shrinking the laminate in the direction perpendicular to the stretching direction. Typically, the shrinkable film is shrunk by stretching the laminate while heating the laminate, and the coating film is shrunk by such shrinkage of the shrinkable film. In one embodiment, the laminate is stretched in its widthwise direction (TD direction) and shrunk in its lengthwise direction (MD direction).

[0029] The stretching ratio of the laminate is preferably from 1.01 times to 3.5 times, more preferably from 1.5 times to 3 times, still more preferably from 2 times to 2.5 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 of the laminate.

[0030] The stretching temperature (heating temperature) of the laminate is preferably from 25°C to 300°C, more preferably from 50°C to 200°C, still more preferably from 60°C to 180°C, particularly preferably from 130°C to 160°C. Further, the laminate is preferably preheated before its stretching. A preheating time is preferably from 10 seconds to 10 minutes, more preferably from 15 seconds to 5 minutes.

[0031] Thus, the birefringent layer having a refractive index characteristic of $n_x > n_z > n_y$ 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.

[0032] 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 another embodiment, an angle formed by a slow axis of the optical compensation layer and an absorption axis of the polarizer is from 80° to 100° , or from -10° to 10° . 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 inner touch panel-type input display apparatus.

[0033] C-1. Polarizer

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

[0034] Specific examples of the polarizer including 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.

[0035] 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.

[0036] The polarizer obtained by using the laminate is specifically, for example, 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 by, for example, a method involving: applying a PVA-based resin solution onto 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 the stretching of the laminate under a state in which the laminate is immersed in an aqueous solution of boric acid. The stretching may further include the aerial 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 about such method of producing a polarizer are described in, for example, JP 2012-73580 A. The entire description of the laid-open publication is incorporated herein by reference.

[0037] 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.

[0038] 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.

[0039] C-2. Protective Layer

The protective layer **20** is formed of any appropriate film that may be used as a protective layer for a polarizer. Specific examples

of a material serving as a main component for the film include: cellulose-based resins, such as triacetyl cellulose (TAC); and 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 transparent resins. The examples also include (meth)acrylic, urethane-based, (meth)acrylic urethane-based, epoxy-based, and silicone-based thermosetting resins or UV-curable resins. The examples also include glassy polymers, such as a siloxane-based polymer. In addition, a polymer film described in JP 2001-343529 A (WO 01/37007 A1) may also be used. For example, a resin composition containing a thermoplastic resin having a substituted or unsubstituted imide group in a side chain thereof and a thermoplastic resin having a substituted or unsubstituted phenyl group and a nitrile group in side chains thereof may be used as a material for the film, and 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 extruded product of the resin composition.

[0040] 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 image display 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 any 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 can be suitably applied even to an image display apparatus that may be used outdoors.

[0041] 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.

[0042] 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**.

[0043] 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 .

[0044] C-3. Conductive Layer or Conductive Layer with Substrate

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.

[0045] 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.

[0046] 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.

[0047] The conductive layer may be transferred from the substrate onto the optical compensation layer to serve alone as a layer constituting the polarizing plate with an optical compensation layer, or may be laminated as a laminate with the substrate (a 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.

[0048] 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.

[0049] It is preferred that the substrate be optically isotropic. Therefore, the conductive layer can be used as a conductive layer with an isotropic substrate in the polarizing plate with optical compensation layers. 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.

[0050] The substrate has a thickness of preferably from 10 μm to 200 μm , more preferably from 20 μm to 60 μm .

[0051] C-4. Others

Any appropriate pressure-sensitive adhesive layer or adhesive layer is used in the lamination of the respective layers constituting 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.

[0052] 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.

[0053] 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).

Examples

[0054] 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 and 550 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 coefficient were calculated from the resultant retardation values.

[0055] [Synthesis Example 1]

28 Grams of diisopropyl fumarate, 5 g of monoethyl fumarate, 17 g of n-propyl 4-methoxycinnamate, and 1.40 g of 2,5-dimethyl-2,5-di(2-ethylhexanoylperoxy)hexane that was a polymerization initiator were loaded into a glass ampoule having a volume of 75 mL, and a nitrogen purge and depressurization were repeated. After that, the ampoule was subjected to fusion sealing under a depressurized state. The ampoule was loaded into a thermostat at 60°C and held at the temperature for 48 hours to cause radical polymerization. After the completion of the polymerization

reaction, the polymer was removed from the ampoule, and was dissolved in 50 g of tetrahydrofuran. The polymer solution was dropped in 2 kg of a mixture containing methanol and water at 50/50 (wt%/wt%) to precipitate the polymer, and the polymer was washed with 2 kg of a mixture containing methanol and water at 50/50 (wt%/wt%), followed by vacuum drying at 80°C for 10 hours. Thus, 28 g of a diisopropyl fumarate/monoethyl fumarate/n-propyl 4-methoxycinnamate copolymer was obtained. The resultant polymer had a number-average molecular weight of 31,000, a diisopropyl fumarate residue unit content of 56 mol%, a monoethyl fumarate residue unit content of 13 mol%, and a n-propyl 4-methoxycinnamate residue unit content of 31 mol%.

[0056] [Example 1]

1. Preparation of Birefringent Material

89 Grams of ethyl cellulose (ETHOCEL Standard 300 manufactured by The Dow Chemical Company, molecular weight $M_n=85,000$, molecular weight $M_w=264,000$, $M_w/M_n=3.1$, total degree of substitution $DS=2.5$) serving as a cellulose-based resin, and 61 g of the diisopropyl fumarate/monoethyl fumarate/n-propyl 4-methoxycinnamate copolymer obtained in Synthesis Example 1 were dissolved in a mixture containing ethyl acetate, p-xylene, and toluene at 1:2:7 (weight ratio) to provide a 15 wt% resin solution, and the solution was used as a birefringent material.

2. Production of Retardation Film

The birefringent material was applied onto a shrinkable film (biaxially stretched film of PP, 500 mm×200 mm, thickness: 60 μm) with a coater so that its thickness after drying became 76 μm , and the material was dried under the drying conditions of 40°C and 15 minutes. Thus, a laminate of the shrinkable film and the coating film was produced.

Next, the laminate was preheated at 153°C for 60 seconds, and was then stretched at a stretching temperature of 153°C in its TD direction at 2.0 times with a simultaneous biaxial stretching machine. Thus, a retardation film was formed on the shrinkable film. Next, the retardation film was peeled from the shrinkable film.

[0057] [Example 2]

A retardation film was produced in the same manner as in Example 1 except that: the birefringent material was applied so that its thickness after drying became 84 μm ; the preheating temperature and the stretching temperature were each set to 143°C; and the stretching ratio of the laminate was set to 2.5 times.

[0058] [Example 3]

A retardation film was produced in the same manner as in Example 2 except that: the birefringent material was applied so that its thickness after drying became 83 μm ; and the preheating temperature

and the stretching temperature were each set to 145°C.

[0059] [Example 4]

A retardation film was produced in the same manner as in Example 2 except that: the birefringent material was applied so that its thickness after drying became 85 μm ; and the preheating temperature and the stretching temperature were each set to 147°C.

[0060] [Comparative Example 1]

A retardation film was produced in the same manner as in Example 1 except that: the birefringent material was applied onto a polyethylene terephthalate film (500 mm×200 mm, thickness: 60 μm) so that its thickness after drying became 72 μm ; the birefringent material was dried at 40°C for 15 minutes, and was then further dried at 155°C for 5 minutes; the film of the birefringent material obtained by peeling the polyethylene terephthalate film from the laminate was stretched; the preheating time was set to 40 seconds; and the preheating temperature and the stretching temperature were each set to 143°C.

[0061] [Comparative Example 2]

A retardation film was produced in the same manner as in Comparative Example 1 except that: the birefringent material was applied so that its thickness after drying became 75 μm ; and the stretching ratio was set to 2.5 times.

[0062] [Comparative Example 3]

A retardation film was produced in the same manner as in Comparative Example 1 except that the stretching ratio was set to 3.0 times.

[0063] [Comparative Example 4]

A retardation film was produced in the same manner as in Comparative Example 1 except that the birefringent material was applied so that its thickness after drying became 83 μm .

[0064] [Comparative Example 5]

A retardation film was produced in the same manner as in Comparative Example 1 except that: the birefringent material was applied so that its thickness after drying became 76 μm ; the stretching ratio was set to 2.5 times; the drying at 155°C for 5 minutes was not performed (the material was dried in one stage); and the preheating time was set to 60 seconds.

[0065] <Evaluation>

The thickness of the birefringent material of the retardation film of each of Examples and Comparative Examples at the time of its application, and the in-plane retardation $\text{Re}(550)$, Nz coefficient, and ratio " $\text{Re}(450)/\text{Re}(550)$ " of the film were measured or calculated. The results are shown in Table 1.

[0066]

Table 1

	Thickness (μm)	Re(550)	Nz coefficient	Re(450)/Re(550)
Example 1	76	149.799	0.376	0.834
Example 2	84	220.900	0.486	0.874
Example 3	83	221.500	0.411	0.876
Example 4	85	199.900	0.355	0.862
Comparative Example 1	72	121.053	0.498	0.912
Comparative Example 2	75	133.913	0.626	0.912
Comparative Example 3	72	129.843	0.730	0.906
Comparative Example 4	83	141.727	0.490	0.923
Comparative Example 5	76	115.167	0.944	0.814

[0067] The retardation films of Examples each had an Re(550) of from 10 nm to 400 nm, a ratio "Re(450)/Re(550)" of from 0.8 to 0.9, and an Nz coefficient of from 0.3 to 0.7. Such retardation films can each achieve a polarizing plate with an optical compensation layer having a neutral hue in an oblique direction.

Industrial Applicability

[0068] The polarizing plate with an optical compensation layer of the present invention is suitably used for an organic EL panel.

Reference Signs List

[0069] **10** polarizer

- 20** protective layer
- 30** optical compensation layer
- 100** polarizing plate with an optical compensation layer

Claims

[Claim 1] A retardation film having an $\text{Re}(550)$ of from 10 nm to 400 nm, a ratio " $\text{Re}(450)/\text{Re}(550)$ " of from 0.8 to 0.9, and an N_z coefficient of from 0.3 to 0.7, where $\text{Re}(450)$ represents an in-plane retardation measured at 23°C with light having a wavelength of 450 nm, and $\text{Re}(550)$ represents an in-plane retardation measured at 23°C with light having a wavelength of 550 nm.

[Claim 2] The retardation film according to claim 1, wherein the retardation film comprises a resin film containing a polymer having positive intrinsic birefringence and a polymer having negative intrinsic birefringence.

[Claim 3] A polarizing plate with an optical compensation layer, 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] A polarizing plate with an optical compensation layer, 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 80° to 100° , or from -10° to 10° .

[Claim 5] An image display apparatus, comprising the polarizing plate with an optical compensation layer of claim 3 or 4.

[Claim 6] A method of producing a retardation film, comprising the steps of:

applying a birefringent material containing a cellulose-based resin and a cinnamic acid ester copolymer onto a shrinkable film, followed by drying to produce a laminate of the shrinkable film and a coating film; and

stretching the laminate and shrinking the laminate in a direction perpendicular to a direction of the stretching to set a refractive index characteristic of the coating film to $n_x > n_z > n_y$.

[Claim 7] The method of producing a retardation film according to claim 6, wherein a shrinkage ratio of the shrinkable film in the direction perpendicular to the stretching direction is from 0.50 times to 0.99 times.