

Description

Title of Invention: RETARDATION FILM AND METHOD OF PRODUCING THE SAME, AND CIRCULARLY POLARIZING PLATE AND IMAGE DISPLAY APPARATUS EACH USING THE RETARDATION FILM

Technical Field

[0001] The present invention relates to a retardation film and a method of producing the same, and to a circularly polarizing plate and an image display apparatus each using the retardation film.

Background Art

[0002] The number of opportunities for the use of a display apparatus for, for example, a smart device typified by a smartphone, digital signage, or a window display under strong ambient light has been increasing in recent years. Along with the increase, there has been occurring a problem such as: the reflection of the ambient light by the display apparatus itself or a reflector to be used in the display apparatus, such as a touch panel portion, a glass substrate, or a metal wiring; or the reflection of a background on the display apparatus or the reflector. In particular, an organic electroluminescence (EL) display apparatus that has started to be put into practical use in recent years is liable to cause a problem such as the reflection of the ambient light or the reflection of the

background because the apparatus has a metal layer having high reflectivity. In view of the foregoing, it is known that such problem is prevented by arranging a circularly polarizing plate including a retardation film (typically a $\lambda/4$ plate) on a viewer side as an antireflection film. Further, in order to achieve satisfactory retardation characteristics at various wavelengths in a visible region, progress is being made in development of a retardation film showing such so-called reverse wavelength dispersion dependency that its retardation value increases with an increase in wavelength of measurement light (hereinafter sometimes referred to simply as "reverse dispersion retardation film"). In the development of the reverse dispersion retardation film, investigations are continued in order to further improve the characteristics.

Citation List

Patent Literature

[0003] [PTL 1] JP 3325560 B2

Summary of Invention

Technical Problem

[0004] A primary object of the present invention is to provide a reverse dispersion retardation film that is excellent in expansibility and retardation developability, and that has a small haze.

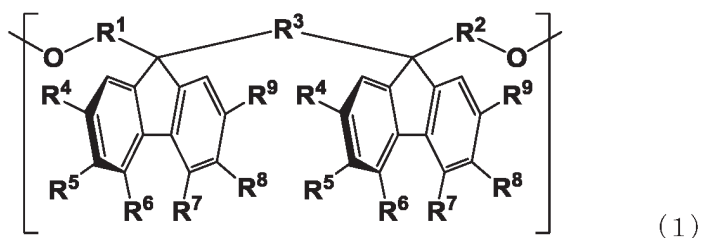
Solution to Problem

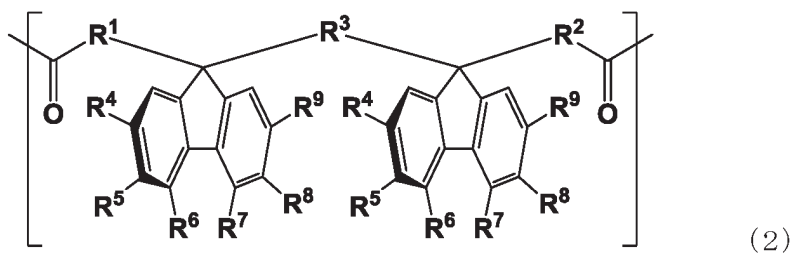
[0005] A retardation film according to an embodiment of the present invention includes: a resin having positive refractive index anisotropy,

the resin containing: at least one bonding group selected from the group consisting of a carbonate bond and an ester bond; and at least one structural unit selected from the group consisting of a structural unit represented by the following general formula (1) and a structural unit represented by the following general formula (2); and

an acrylic resin,

wherein a content of the acrylic resin is from 0.5 mass% to 2.0 mass%, wherein the acrylic resin contains 70 mass% or more of a structural unit derived from methyl methacrylate, and has a weight-average molecular weight Mw of from 10,000 to 200,000, and wherein the retardation film has an Re(550) of from 100 nm to 200 nm, and an Re(450)/Re(550) of more than 0.5 and less than 1.0:





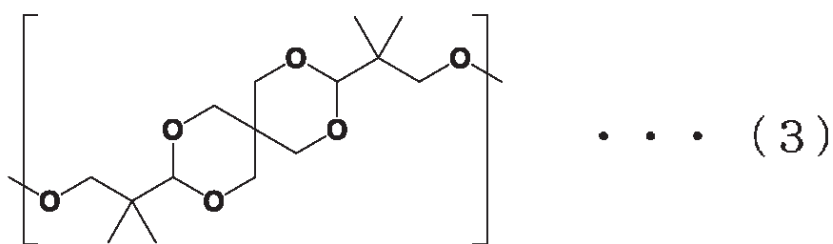
in the general formulae (1) and (2), R^1 to R^3 each independently represent a direct bond, or a substituted or unsubstituted alkylene group having 1 to 4 carbon atoms, and R^4 to R^9 each independently represent a hydrogen atom, a substituted or unsubstituted alkyl group having 1 to 10 carbon atoms, a substituted or unsubstituted aryl group having 4 to 10 carbon atoms, a substituted or unsubstituted acyl group having 1 to 10 carbon atoms, a substituted or unsubstituted alkoxy group having 1 to 10 carbon atoms, a substituted or unsubstituted aryloxy group having 1 to 10 carbon atoms, a substituted or unsubstituted amino group, a substituted or unsubstituted vinyl group having 1 to 10 carbon atoms, a substituted or unsubstituted ethynyl group having 1 to 10 carbon atoms, a sulfur atom having a substituent, a silicon atom having a substituent, a halogen atom, a nitro group, or a cyano group, provided that R^4 to R^9 may be identical to or different from each other, and at least two adjacent groups of R^4 to R^9 may be bonded to each other to form a ring,

where Re(550) represents an in-plane retardation of the

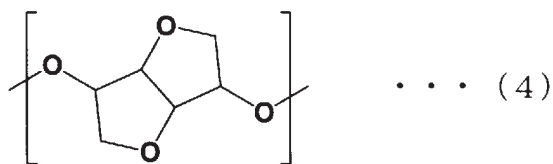
film measured at 23°C with light having a wavelength of 550 nm, and $\text{Re}(450)$ represents an in-plane retardation of the film measured at 23°C with light having a wavelength of 450 nm.

In one embodiment of the present invention, the resin having positive refractive index anisotropy contains 1 mass% to 40 mass% of the at least one structural unit selected from the group consisting of the structural unit represented by the general formula (1) and the structural unit represented by the general formula (2).

In one embodiment of the present invention, the resin having positive refractive index anisotropy further contains a structural unit represented by the following general formula (3).



In one embodiment of the present invention, the resin having positive refractive index anisotropy further contains a structural unit represented by the following general formula (4).



In one embodiment of the present invention, the retardation film has a haze value of 1.5% or less.

In one embodiment of the present invention, the retardation film has an elongation at break of 200% or more.

In one embodiment of the present invention, the retardation film has a limiting birefringence Δn of 0.0039 or more.

According to another aspect of the present invention, there is provided a method of producing the retardation film as described above. The method includes stretching a resin film containing the resin having positive refractive index anisotropy and the acrylic resin. The stretching is performed at a temperature equal to or lower than a glass transition temperature of the resin having positive refractive index anisotropy.

In one embodiment of the present invention, the stretching is performed while the resin film having an elongate shape is conveyed in an elongate direction, and a slow axis direction of the retardation film having an elongate shape to be obtained is

a direction at from 40° to 50° or from 130° to 140° with respect to the elongate direction.

According to still another aspect of the present invention, there is provided a circularly polarizing plate. The circularly polarizing plate includes a polarizer; and the retardation film as described above. An angle formed between an absorption axis of the polarizer and a slow axis of the retardation film is from 40° to 50° or from 130° to 140° .

According to still another aspect of the present invention, there is provided an image display apparatus. The image display apparatus includes the above-described circularly polarizing plate on a viewer side, wherein the polarizer of the circularly polarizing plate is arranged on the viewer side.

Advantageous Effects of Invention

[0006] According to the embodiments of the present invention, the reverse dispersion retardation film that is excellent in expansibility and retardation developability, and that has a small haze can be obtained by incorporating the specific resin having positive refractive index anisotropy (typically a polycarbonate-based resin, a polyester-based resin, or a polyester carbonate-based resin) and the specific acrylic resin.

Brief Description of Drawings

[0007] FIG. 1 is a schematic sectional view of a circularly polarizing plate according to one embodiment of the present invention.

FIG. 2 is a schematic sectional view of a circularly polarizing plate according to another 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(λ)" refers to an in-plane retardation measured at 23°C with light having a wavelength of λ nm. For example, "Re(450)" refers to an in-plane retardation measured at 23°C with light having a wavelength of 450 nm. The Re(λ) is determined from the equation "Re(λ)=(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(450)" refers to a thickness direction retardation measured at 23°C with light having a wavelength of 450 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".

(5) Angle

When reference is made to an angle herein, the angle encompasses both angles in a clockwise direction and a

counterclockwise direction with respect to a reference direction.

[0010] A. Retardation Film

A-1. Constituent Materials for Retardation Film

A retardation film according to an embodiment of the present invention contains a resin containing at least one bonding group selected from the group consisting of a carbonate bond and an ester bond. In other words, the retardation film contains a polycarbonate-based resin, a polyester-based resin, or a polyester carbonate-based resin (these resins are hereinafter sometimes collectively referred to as "polycarbonate-based resin or the like"). The polycarbonate-based resin or the like contains at least one structural unit selected from the group consisting of a structural unit represented by the general formula (1) and/or a structural unit represented by the general formula (2). Each of those structural units is a structural unit derived from a divalent oligofluorene, and is hereinafter sometimes referred to as "oligofluorene structural unit". Such polycarbonate-based resin or the like has positive refractive index anisotropy.

[0011] The retardation film further contains an acrylic resin. The content of the acrylic resin is from 0.5 mass% to 1.5 mass%. Herein, a percentage or parts in a "mass" unit have the same meaning as a percentage or parts in a "weight" unit.

[0012] A-1-1. Polycarbonate-based Resin or the like

<Oligofluorene Structural Unit>

The oligofluorene structural unit is represented by the general formula (1) or (2). In the general formulae (1) and (2), R^1 to R^3 each independently represent a direct bond, or a substituted or unsubstituted alkylene group having 1 to 4 carbon atoms, and R^4 to R^9 each independently represent a hydrogen atom, a substituted or unsubstituted alkyl group having 1 to 10 carbon atoms, a substituted or unsubstituted aryl group having 4 to 10 carbon atoms, a substituted or unsubstituted acyl group having 1 to 10 carbon atoms, a substituted or unsubstituted alkoxy group having 1 to 10 carbon atoms, a substituted or unsubstituted aryloxy group having 1 to 10 carbon atoms, a substituted or unsubstituted amino group, a substituted or unsubstituted vinyl group having 1 to 10 carbon atoms, a substituted or unsubstituted ethynyl group having 1 to 10 carbon atoms, a sulfur atom having a substituent, a silicon atom having a substituent, a halogen atom, a nitro group, or a cyano group, provided that R^4 to R^9 may be identical to or different from each other, and at least two adjacent groups of R^4 to R^9 may be bonded to each other to form a ring.

[0013] As R^1 and R^2 , for example, the following alkylene groups may be adopted: linear alkylene groups, such as a

methylene group, an ethylene group, a n-propylene group, and a n-butylene group; and alkylene groups each having a branched chain, such as a methylenemethylene group, a dimethylenemethylene group, an ethylenemethylene group, a propylenemethylene group, a (1-methylethyl)methylene group, a 1-methylethylene group, a 2-methylethylene group, a 1-ethylethylene group, a 2-ethylethylene group, a 1-methylpropylene group, a 2-methylpropylene group, a 1,1-dimethylethylene group, a 2,2-dimethylpropylene group, and a 3-methylpropylene group. Herein, the position of a branched chain in each of R^1 and R^2 is indicated by a number given in such a manner that carbon on the fluorene ring side is at the 1-position.

[0014] Choices for R^1 and R^2 may be related to the expression of reverse wavelength dispersion dependency. The polycarbonate-based resin or the like shows its strongest reverse wavelength dispersion dependency in a state in which fluorene rings thereof are aligned perpendicularly to a main chain direction (stretching direction). In order to make the alignment state of the fluorene rings close to such state to express strong reverse wavelength dispersion dependency, it is preferred to adopt R^1 and R^2 each having 2 or 3 carbon atoms on the main chain of the alkylene group. When the number of carbon atoms is 1, surprisingly, the reverse wavelength dispersion dependency may not be shown. A possible reason therefor is, for example, that

the steric hindrance of the carbonate group and/or the ester group serving as a linking group between oligofluorene structural units fixes the alignment of the fluorene rings to a direction that is not perpendicular to the main chain direction. Meanwhile, when the number of carbon atoms is excessively large, the fixation of the alignment of the fluorene rings is weakened, resulting in a risk in that the reverse wavelength dispersion dependency may become insufficient. Further, the heat resistance of the polycarbonate-based resin or the like may be reduced.

[0015] As R^3 , for example, the following alkylene groups may be adopted: linear alkylene groups, such as a methylene group, an ethylene group, a n-propylene group, and a n-butylene group; and alkylene groups each having a branched chain, such as a methyldimethylene group, a dimethyldimethylene group, an ethyldimethylene group, a propyldimethylene group, a (1-methylethyl)methylene group, a 1-methylethylene group, a 2-methylethylene group, a 1-ethylethylene group, a 2-ethylethylene group, a 1-methylpropylene group, a 2-methylpropylene group, a 1,1-dimethylethylene group, a 2,2-dimethylpropylene group, and a 3-methylpropylene group. R^3 has preferably 1 or 2 carbon atoms, more preferably 1 carbon atom on a main chain of an alkylene group thereof. When the number of carbon atoms on the main chain is excessively large, as in the case of R^1 and R^2 , the fixation

of the fluorene rings is weakened, resulting in a risk of causing, for example, a reduction in reverse wavelength dispersion dependency, an increase in photoelastic coefficient, and a reduction in heat resistance. Meanwhile, as the number of carbon atoms on the main chain decreases, optical characteristics and the heat resistance become more satisfactory, but when the 9-positions of two fluorene rings are linked via a direct bond, thermal stability may be degraded.

[0016] Examples of the substituent in each of R^1 to R^3 include: halogen atoms (a fluorine atom, a chlorine atom, a bromine atom, and an iodine atom); alkoxy groups each having 1 to 10 carbon atoms, such as a methoxy group and an ethoxy group; acyl groups each having 1 to 10 carbon atoms, such as an acetyl group and a benzoyl group; acylamino groups each having 1 to 10 carbon atoms, such as an acetamide group and a benzoylamide group; a nitro group; a cyano group; and aryl groups each having 6 to 10 carbon atoms, such as a phenyl group and a naphthyl group, each of which has 1 to 3 hydrogen atoms that may be substituted with, for example, the halogen atom, the alkoxy group, the acyl group, the acylamino group, the nitro group, or the cyano group.

[0017] As the substituted or unsubstituted alkyl group in each of R^4 to R^9 , for example, the following alkyl groups may be

adopted: linear alkyl groups, such as a methyl group, an ethyl group, a n-propyl group, a n-butyl group, a n-pentyl group, a n-hexyl group, and a n-decyl group; alkyl groups each having a branched chain, such as an isopropyl group, a 2-methylpropyl group, a 2,2-dimethylpropyl group, and a 2-ethylhexyl group; and cyclic alkyl groups, such as a cyclopropyl group, a cyclopentyl group, a cyclohexyl group, and a cyclooctyl group. The number of carbon atoms of the alkyl group is preferably 4 or less, more preferably 2 or less. When the number of carbon atoms falls within such ranges, steric hindrance between the fluorene rings hardly occurs, and desired optical characteristics derived from the fluorene rings can be easily obtained. Examples of the substituent of the alkyl group include the substituents described above for R^1 to R^3 .

[0018] As the substituted or unsubstituted aryl group in each of R^4 to R^9 , for example, the following aryl groups may be adopted: aryl groups, such as a phenyl group, a 1-naphthyl group, and a 2-naphthyl group; and heteroaryl groups, such as a 2-pyridyl group, a 2-thienyl group, and a 2-furyl group. The number of carbon atoms of the aryl group is preferably 8 or less, more preferably 7 or less. When the number of carbon atoms falls within such ranges, steric hindrance between the fluorene rings hardly occurs, and desired optical characteristics derived from the fluorene rings can be easily obtained. Examples of the

substituent of the aryl group include the substituents described above for R^1 to R^3 .

[0019] As the substituted or unsubstituted acyl group in each of R^4 to R^9 , for example, the following acyl groups may be adopted: aliphatic acyl groups, such as a formyl group, an acetyl group, a propionyl group, a 2-methylpropionyl group, a 2,2-dimethylpropionyl group, and a 2-ethylhexanoyl group; and aromatic acyl groups, such as a benzoyl group, a 1-naphthylcarbonyl group, a 2-naphthylcarbonyl group, and a 2-furylcarbonyl group. The number of carbon atoms of the acyl group is preferably 4 or less, more preferably 2 or less. When the number of carbon atoms falls within such ranges, steric hindrance between the fluorene rings hardly occurs, and desired optical characteristics derived from the fluorene rings can be easily obtained. Examples of the substituent of the acyl group include the substituents described above for R^1 to R^3 .

[0020] As the substituted or unsubstituted alkoxy group or aryloxy group in each of R^4 to R^9 , for example, the following groups may be adopted: a methoxy group, an ethoxy group, an isopropoxy group, a tert-butoxy group, a trifluoromethoxy group, and a phenoxy group. The number of carbon atoms of the alkoxy group or the aryloxy group is preferably 4 or less, more preferably 2 or less. When the number of carbon atoms falls

within such ranges, steric hindrance between the fluorene rings hardly occurs, and desired optical characteristics derived from the fluorene rings can be easily obtained. Examples of the substituent of the alkoxy group or the aryloxy group include the substituents described above for R^1 to R^3 .

[0021] As the substituted or unsubstituted amino group in each of R^4 to R^9 , for example, the following amino groups may be adopted: an amino group; aliphatic amino groups, such as an N-methylamino group, an N,N-dimethylamino group, an N-ethylamino group, an N,N-diethylamino group, an N,N-methylethylamino group, an N-propylamino group, an N,N-dipropylamino group, an N-isopropylamino group, and an N,N-diisopropylamino group; aromatic amino groups, such as an N-phenylamino group and an N,N-diphenylamino group; acylamino groups, such as a formamide group, an acetamide group, a decanoylamide group, a benzoylamide group, and a chloroacetamide group; and alkoxycarbonylamino groups, such as a benzyloxycarbonylamino group and a tert-butyloxycarbonylamino group. Of those, an N,N-dimethylamino group, an N-ethylamino group, or an N,N-diethylamino group is preferred, and an N,N-dimethylamino group is more preferred. Each of those amino groups does not have a highly acidic proton, and has a small molecular weight, thereby allowing a fluorene ratio to be increased.

[0022] As the substituted or unsubstituted vinyl group or ethynyl group in each of R^4 to R^9 , for example, the following groups may be adopted: a vinyl group, a 2-methylvinyl group, a 2,2-dimethylvinyl group, a 2-phenylvinyl group, a 2-acetylvinyl group, an ethynyl group, a methylethynyl group, a tert-butylethynyl group, a phenylethynyl group, an acetylene group, and a trimethylsilylethynyl group. The number of carbon atoms of the vinyl group or the ethynyl group is preferably 4 or less. When the number of carbon atoms falls within such range, steric hindrance between the fluorene rings hardly occurs, and desired optical characteristics derived from the fluorene rings can be easily obtained. In addition, the conjugated system of the fluorene rings is lengthened, and hence stronger reverse wavelength dispersion dependency can be easily obtained.

[0023] As the sulfur atom having a substituent in each of R^4 to R^9 , for example, the following sulfur-containing groups may be adopted: a sulfo group; alkylsulfonyl groups, such as a methylsulfonyl group, an ethylsulfonyl group, a propylsulfonyl group, and an isopropylsulfonyl group; arylsulfonyl groups, such as a phenylsulfonyl group and a p-tolylsulfonyl group; alkylsulfinyl groups, such as a methylsulfinyl group, an ethylsulfinyl group, a propylsulfinyl group, and an isopropylsulfinyl group; arylsulfinyl groups, such as a phenylsulfinyl group and a p-tolylsulfinyl group; alkylthio

groups, such as a methylthio group and an ethylthio group; arylthio groups, such as a phenylthio group and a p-tolylthio group; alkoxysulfonyl groups, such as a methoxysulfonyl group and an ethoxysulfonyl group; aryloxysulfonyl groups, such as a phenoxysulfonyl group; an aminosulfonyl group; alkylsulfonyl groups, such as an N-methylaminosulfonyl group, an N-ethylaminosulfonyl group, an N-tert-butylaminosulfonyl group, an N,N-dimethylaminosulfonyl group, and an N,N-diethylaminosulfonyl group; and arylaminosulfonyl groups, such as an N-phenylaminosulfonyl group and an N,N-diphenylaminosulfonyl group. The sulfo group may form a salt with, for example, lithium, sodium, potassium, magnesium, or ammonium. Of those, a methylsulfinyl group, an ethylsulfinyl group, or a phenylsulfinyl group is preferred, and a methylsulfinyl group is more preferred. Each of those sulfur-containing groups does not have a highly acidic proton, and has a small molecular weight, thereby allowing a fluorene ratio to be increased.

[0024] As the silicon atom having a substituent in each of R^4 to R^9 , for example, the following silyl groups may be adopted: trialkylsilyl groups, such as a trimethylsilyl group and a triethylsilyl group; and trialkoxysilyl groups, such as a trimethoxysilyl group and a triethoxysilyl group. Of those, a trialkylsilyl group is preferred because the trialkylsilyl group

is excellent in stability and handleability.

[0025] The content of the oligofluorene structural unit in the polycarbonate-based resin or the like is preferably from 1 mass% to 40 mass%, more preferably from 10 mass% to 35 mass%, still more preferably from 15 mass% to 30 mass%, particularly preferably from 18 mass% to 25 mass% with respect to the entire resin. When the content of the oligofluorene structural unit is excessively high, there may occur a problem in that the photoelastic coefficient is excessively increased, reliability becomes insufficient, or retardation developability becomes insufficient. Further, as a result of an increase in ratio of the oligofluorene structural unit in the resin, the range of molecular design is reduced, and hence an improvement may be difficult to make at a time when modification of the resin is required. Meanwhile, even if desired reverse wavelength dispersion dependency is obtained with an extremely small amount of the oligofluorene structural unit, in this case, the optical characteristics sensitively change in accordance with a slight variation in content of the oligofluorene structural unit, and hence it may be difficult to produce the resin so that various characteristics fall within certain ranges.

[0026] As a method of controlling the ratio of the oligofluorene structural unit in the resin, there are given, for

example, a method involving copolymerizing a monomer having the oligofluorene structural unit and another monomer, and a method involving blending a resin containing the oligofluorene structural unit and another resin. Of those, a method involving copolymerizing a monomer having the oligofluorene structural unit and another monomer is preferred because the method allows precise control of the content of the oligofluorene structural unit, and besides, provides high transparency and provides uniform characteristics across the entire surface of the film.

[0027] <Other Structural Unit>

The polycarbonate-based resin or the like may typically contain any other structural unit in addition to the oligofluorene structural unit. In one embodiment, the other structural unit may be preferably derived from a dihydroxy compound or a diester compound. In order to express the intended reverse wavelength dispersion property, a structural unit having positive intrinsic birefringence needs to be incorporated into the polymer structure together with the oligofluorene structural unit having negative intrinsic birefringence, and hence a dihydroxy compound or a diester compound that serves as a raw material for a structural unit having positive birefringence is more preferred as the other monomer to be copolymerized.

[0028] Examples of the copolymerization monomer include: a

compound capable of introducing a structural unit containing an aromatic ring; and a compound that does not introduce a structural unit containing an aromatic ring, namely a compound formed of an aliphatic structure.

Specific examples of the compound formed of an aliphatic structure include: dihydroxy compounds of linear aliphatic hydrocarbons, such as ethylene glycol, 1,3-propanediol, 1,2-propanediol, 1,4-butanediol, 1,3-butanediol, 1,2-butanediol, 1,5-heptanediol, 1,6-hexanediol, 1,9-nonanediol, 1,10-decanediol, and 1,12-dodecanediol; dihydroxy compounds of branched aliphatic hydrocarbons, such as neopentyl glycol and hexylene glycol; dihydroxy compounds serving as secondary alcohols and tertiary alcohols of alicyclic hydrocarbons, which are exemplified by 1,2-cyclohexanediol, 1,4-cyclohexanediol, 1,3-adamantanediol, hydrogenated bisphenol A, and 2,2,4,4-tetramethyl-1,3-cyclobutanediol; dihydroxy compounds serving as primary alcohols of alicyclic hydrocarbons, which are exemplified by 1,2-cyclohexanedimethanol, 1,3-cyclohexanedimethanol, 1,4-cyclohexanedimethanol, tricyclodecanedimethanol, pentacyclopentadecanedimethanol, 2,6-decalindimethanol, 1,5-decalindimethanol, 2,3-decalindimethanol, 2,3-norbornanedimethanol, 2,5-norbornanedimethanol, 1,3-adamantanedimethanol, and dihydroxy compounds derived from terpene compounds, such as limonene; oxyalkylene glycols, such

as diethylene glycol, triethylene glycol, tetraethylene glycol, polyethylene glycol, and polypropylene glycol; dihydroxy compounds each having a cyclic ether structure, such as isosorbide; dihydroxy compounds each having a cyclic acetal structure, such as spiroglycol and dioxane glycol; alicyclic dicarboxylic acids, such as 1,2-cyclohexanedicarboxylic acid, 1,3-cyclohexanedicarboxylic acid, and 1,4-cyclohexanedicarboxylic acid; and aliphatic dicarboxylic acids, such as malonic acid, succinic acid, glutaric acid, adipic acid, pimelic acid, suberic acid, azelaic acid, and sebacic acid.

Specific examples of the compound capable of introducing a structural unit containing an aromatic ring include: aromatic bisphenol compounds, such as 2,2-bis(4-hydroxyphenyl)propane, 2,2-bis(3-methyl-4-hydroxyphenyl)propane, 2,2-bis(4-hydroxy-3,5-dimethylphenyl)propane, 2,2-bis(4-hydroxy-3,5-diethylphenyl)propane, 2,2-bis(4-hydroxy-(3-phenyl)phenyl)propane, 2,2-bis(4-hydroxy-(3,5-diphenyl)phenyl)propane, 2,2-bis(4-hydroxy-3,5-dibromophenyl)propane, bis(4-hydroxyphenyl)methane, 1,1-bis(4-hydroxyphenyl)ethane, 2,2-bis(4-hydroxyphenyl)butane, 2,2-bis(4-hydroxyphenyl)pentane, 1,1-bis(4-hydroxyphenyl)-1-phenylethane, bis(4-hydroxyphenyl)diphenylmethane, 1,1-bis(4-hydroxyphenyl)-2-ethylhexane, 1,1-bis(4-hydroxyphenyl)decane, bis(4-hydroxy-3-nitrophenyl)methane, 3,3-bis(4-

hydroxyphenyl)pentane, 1,3-bis(2-(4-hydroxyphenyl)-2-propyl)benzene, 1,3-bis(2-(4-hydroxyphenyl)-2-propyl)benzene, 2,2-bis(4-hydroxyphenyl)hexafluoropropane, 1,1-bis(4-hydroxyphenyl)cyclohexane, bis(4-hydroxyphenyl)sulfone, 2,4'-dihydroxydiphenylsulfone, bis(4-hydroxyphenyl) sulfide, bis(4-hydroxy-3-methylphenyl) sulfide, bis(4-hydroxyphenyl) disulfide, 4,4'-dihydroxydiphenyl ether, and 4,4'-dihydroxy-3,3'-dichlorodiphenyl ether; dihydroxy compounds each having an ether group bonded to an aromatic group, such as 2,2-bis(4-(2-hydroxyethoxy)phenyl)propane, 2,2-bis(4-(2-hydroxypropoxy)phenyl)propane, 1,3-bis(2-hydroxyethoxy)benzene, 4,4'-bis(2-hydroxyethoxy)biphenyl, and bis(4-(2-hydroxyethoxy)phenyl)sulfone; and aromatic dicarboxylic acids, such as terephthalic acid, phthalic acid, isophthalic acid, 4,4'-diphenyldicarboxylic acid, 4,4'-diphenyl ether dicarboxylic acid, 4,4'-benzophenonedicarboxylic acid, 4,4'-diphenoxyethanedicarboxylic acid, 4,4'-diphenylsulfonedicarboxylic acid, and 2,6-naphthalenedicarboxylic acid.

Regarding the aliphatic dicarboxylic acid and aromatic dicarboxylic acid components described above, a dicarboxylic acid itself may be used as a raw material for the polyester carbonate, and a dicarboxylic acid ester, such as a methyl ester form or a phenyl ester form, or a dicarboxylic acid derivative,

such as a dicarboxylic acid halide, may also be used as a raw material therefor in accordance with production methods.

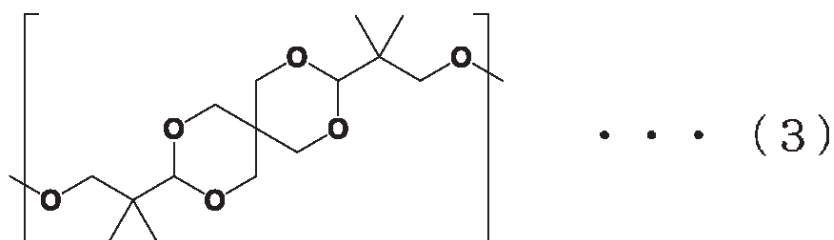
[0029] As the copolymerization monomer, a dihydroxy compound having a fluorene ring, such as 9,9-bis(4-(2-hydroxyethoxy)phenyl)fluorene, 9,9-bis(4-hydroxyphenyl)fluorene, or 9,9-bis(4-hydroxy-3-methylphenyl)fluorene, or a dicarboxylic acid compound having a fluorene ring, which has hitherto been known as a compound having a structural unit having negative birefringence, may also be used in combination with the oligofluorene compound.

[0030] From the viewpoint of optical characteristics, the resin to be used in the present invention preferably uses, as the structural unit other than the oligofluorene structural unit, one containing no aromatic component. That is, a compound formed of an aliphatic structure is preferably used as the copolymerization monomer. When the main chain of the polymer contains an aromatic component, the reverse wavelength dispersion property to be expressed by the oligofluorene structural unit is offset, and hence the content of the oligofluorene structural unit needs to be increased. Accordingly, there is a concern that the photoelastic coefficient and mechanical properties may be degraded. The adoption of the other structural unit containing no aromatic

component can prevent the incorporation of an aromatic component derived from the structural unit into the main chain. Among the compounds each formed of an aliphatic structure, a compound having an alicyclic structure, which is excellent in mechanical properties and heat resistance, is more preferred.

[0031] Meanwhile, in order to achieve balance with heat resistance, mechanical characteristics, and the like while securing optical characteristics, it is sometimes effective to incorporate an aromatic component into the main chain of the polymer or a side chain thereof. From the viewpoint of achieving balance among various characteristics, the content of a structural unit containing an aromatic group (excluding the oligofluorene structural unit) in the resin is preferably 5 mass% or less.

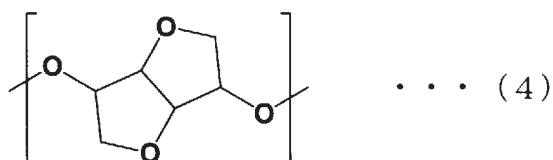
[0032] The resin to be used in the present invention preferably contains a structural unit represented by the following formula (3) as a copolymerization component among structural units each of which can be introduced by the compound having an alicyclic structure.



[0033] Spiroglycol may be used as a dihydroxy compound capable of introducing the structural unit of the formula (3).

[0034] The resin to be used in the present invention preferably contains 5 mass% or more and 90 mass% or less of the structural unit represented by the formula (3). The upper limit is more preferably 70 mass% or less, particularly preferably 50 mass% or less. The lower limit is more preferably 10 mass% or more, still more preferably 20 mass% or more, particularly preferably 25 mass% or more. When the content of the structural unit represented by the formula (3) is equal to or higher than the lower limit, sufficient mechanical properties and heat resistance, and a low photoelastic coefficient are obtained. Further, compatibility with the acrylic resin can be improved to further improve the transparency of the resin composition to be obtained. In addition, spiroglycol has a relatively low polymerization reaction rate, and hence, when its content is restricted to be equal to or lower than the upper limit, the polymerization reaction can be easily controlled.

[0035] The resin to be used in the present invention preferably further contains a structural unit represented by the following formula (4) as a copolymerization component.



[0036] As a dihydroxy compound capable of introducing the structural unit represented by the formula (4), there are given isosorbide (ISB), isomannide, and isoidide, which are in a stereoisomeric relationship. Those compounds may be used alone or in combination thereof.

[0037] The resin to be used in the present invention preferably contains 5 mass% or more and 90 mass% or less of the structural unit represented by the formula (4). The upper limit is more preferably 70 mass% or less, particularly preferably 50 mass% or less. The lower limit is more preferably 10 mass% or more, particularly preferably 15 mass% or more. When the content of the structural unit represented by the formula (4) is equal to or higher than the lower limit, sufficient mechanical properties and heat resistance, and a low photoelastic coefficient are obtained. In addition, the structural unit represented by the formula (4) has a characteristic of being

highly water-absorbent, and hence, when the content of the structural unit represented by the formula (4) is equal to or lower than the upper limit, the dimensional change of a formed body due to water absorption can be restricted to fall within an acceptable range.

[0038] The resin to be used in the present invention may contain still another structural unit. Such structural unit is sometimes referred to as "other structural unit". As a monomer having the other structural unit, 1,4-cyclohexanedimethanol, tricyclodecanedimethanol, and 1,4-cyclohexanedicarboxylic acid (and derivatives thereof) are more preferably adopted, and 1,4-cyclohexanedimethanol and tricyclodecanedimethanol are particularly preferred. A resin containing a structural unit derived from any such monomer is excellent in balance among optical characteristics, heat resistance, mechanical characteristics, and the like. In addition, the polymerization reactivity of a diester compound is relatively low, and hence, from the viewpoint of enhancing reaction efficiency, it is preferred to avoid the use of a diester compound other than a diester compound containing the oligofluorene structural unit.

[0039] Dihydroxy compounds and diester compounds for introducing the other structural units may be used alone or in combination thereof depending on the performance required of the

resin to be obtained. The content of the other structural unit in the resin is preferably 1 mass% or more and 50 mass% or less, more preferably 5 mass% or more and 40 mass% or less, particularly preferably 10 mass% or more and 30 mass% or less. The other structural unit particularly plays a role in adjusting the heat resistance of the resin, and imparting flexibility and toughness thereto, and hence an excessively low content thereof may degrade the mechanical characteristics and melt processability of the resin, and an excessively high content thereof may degrade the heat resistance and the optical characteristics.

[0040] The molecular weight of the polycarbonate-based resin may be expressed as, for example, a reduced viscosity. The reduced viscosity is measured with an Ubbelohde viscometer at a temperature of $20.0^{\circ}\text{C} \pm 0.1^{\circ}\text{C}$ after precise adjustment of the concentration of the polycarbonate-based resin to 0.6 g/dL through use of methylene chloride as a solvent. The lower limit of the reduced viscosity is generally preferably 0.30 dL/g or more, more preferably 0.35 dL/g or more, particularly preferably 0.40 dL/g or more. The upper limit of the reduced viscosity is generally preferably 1.00 dL/g or less, more preferably 0.80 dL/g or less, particularly preferably 0.60 dL/g or less. When the reduced viscosity is lower than the lower limit value, the mechanical strength of the film to be obtained may be

insufficient. Meanwhile, when the reduced viscosity is higher than the upper limit value, formability, handleability, and productivity may be insufficient.

[0041] The melt viscosity of the polycarbonate-based resin is preferably 700 Pa·s or more and 5,000 Pa·s or less under the measurement conditions of a temperature of 240°C and a shear rate of 91.2 sec⁻¹. The upper limit is more preferably 4,000 Pa·s or less, still more preferably 3,500 Pa·s or less, particularly preferably 3,000 Pa·s or less. The lower limit is more preferably 1,000 Pa·s or more, still more preferably 1,500 Pa·s or more, particularly preferably 2,000 Pa·s or more. The melt viscosity is measured with a capillary rheometer (manufactured by Toyo Seiki Seisaku-sho, Ltd.).

[0042] The glass transition temperature (T_g) of the resin to be used in the present invention is preferably 110°C or more and 160°C or less. The upper limit is more preferably 155°C or less, still more preferably 150°C or less, particularly preferably 145°C or less. The lower limit is more preferably 120°C or more, particularly preferably 130°C or more. When the glass transition temperature falls outside the above-mentioned ranges, the heat resistance tends to be degraded, leading to a risk of causing a dimensional change after film forming, or degrading the reliability of the quality of the retardation film

under its use conditions. Meanwhile, when the glass transition temperature is excessively high, unevenness in film thickness occurs at the time of film forming, or the film becomes brittle to be degraded in stretchability in some cases, and besides, the transparency of the film is impaired in some cases.

[0043] Details of, for example, the structure of the polycarbonate-based resin or the like and a production method therefor are described in, for example, WO 2015/159928 A1, the description of which is incorporated herein by reference.

[0044] A-1-2. Acrylic Resin

As the acrylic resin, an acrylic resin serving as a thermoplastic resin may be used. Examples of the monomer serving as a structural unit of the acrylic resin include: methyl methacrylate, methacrylic acid, methyl acrylate, acrylic acid, benzyl (meth)acrylate, n-butyl (meth)acrylate, i-butyl (meth)acrylate, t-butyl (meth)acrylate, 2-ethylhexyl (meth)acrylate, lauryl (meth)acrylate, tridecyl (meth)acrylate, stearyl (meth)acrylate, glycidyl (meth)acrylate, hydroxypropyl (meth)acrylate, 2-methoxyethyl (meth)acrylate, 2-ethoxyethyl (meth)acrylate, cyclohexyl (meth)acrylate, isobornyl (meth)acrylate, norbornyl (meth)acrylate, dicyclopentenyl (meth)acrylate, dicyclopentanyl (meth)acrylate, dicyclopentenylloxyethyl (meth)acrylate, tetrahydrofurfuryl

(meth)acrylate, acrylic (meth)acrylate, 2-hydroxyethyl (meth)acrylate, 2-(meth)acroyloxyethyl succinate, 2-(meth)acroyloxyethyl maleate, 2-(meth)acroyloxyethyl phthalate, 2-(meth)acryloyloxyethyl hexahydrophthalate, pentamethylpiperidyl (meth)acrylate, tetramethylpiperidyl (meth)acrylate, dimethylaminoethyl (meth)acrylate, diethylaminoethyl (meth)acrylate, cyclopentyl methacrylate, cyclopentyl acrylate, cyclohexyl methacrylate, cyclohexyl acrylate, cycloheptyl methacrylate, cycloheptyl acrylate, cyclooctyl methacrylate, cyclooctyl acrylate, cyclododecyl methacrylate, and cyclododecyl acrylate. Those monomers may be used alone or in combination thereof. As a mode of using two or more kinds of monomers in combination, there are given copolymerization of two or more kinds of monomers, a blend of two or more homopolymers each produced from one kind of monomer, and a combination thereof. Further, any such acrylic monomer may be used in combination with another monomer copolymerizable therewith (e.g., an olefin-based monomer or a vinyl-based monomer).

[0045] The acrylic resin contains a structural unit derived from methyl methacrylate. The content of the structural unit derived from methyl methacrylate in the acrylic resin is preferably 70 mass% or more and 100 mass% or less. The lower limit is more preferably 80 mass% or more, still more preferably

90 mass% or more, particularly preferably 95 mass% or more. When the content falls within such ranges, excellent compatibility with the polycarbonate-based resin of the present invention is obtained. As a structural unit other than methyl methacrylate, it is preferred to use methyl acrylate, phenyl (meth)acrylate, benzyl (meth)acrylate, or styrene. When methyl acrylate is copolymerized, the thermal stability can be improved. The use of phenyl (meth)acrylate, benzyl (meth)acrylate, or styrene allows the refractive index of the acrylic resin to be adjusted, and hence can improve the transparency of the resin composition to be obtained through matching with the refractive index of the resin to be used in combination therewith. When such acrylic resin is used, a reverse dispersion retardation film that is excellent in expansibility and retardation developability, and that has a small haze can be obtained.

[0046] The weight-average molecular weight M_w of the acrylic resin is 10,000 or more and 200,000 or less. The lower limit is preferably 30,000 or more, particularly preferably 50,000 or more. The upper limit is preferably 180,000 or less, particularly preferably 150,000 or less. When the molecular weight falls within such ranges, compatibility with the polycarbonate-based resin of the present invention is obtained, and hence the transparency of the finished retardation film can be improved, and besides, an effect of sufficiently improving

the expansibility at the time of stretching is obtained. The weight-average molecular weight is a molecular weight in terms of polystyrene measured by GPC. Details of the measurement method are described later. In addition, it is preferred from the viewpoint of compatibility that the acrylic resin be substantially free of a branched structure. That the acrylic resin is free of a branched structure may be recognized on the basis of, for example, a single-peaked GPC curve of the acrylic resin.

[0047] A-1-3. Blending of Polycarbonate-based Resin or the like and Acrylic Resin

The polycarbonate-based resin or the like and the acrylic resin are blended and used as a resin composition in a method of producing a retardation film (the production method is described later in the section A-3). The polycarbonate-based resin or the like and the acrylic resin may be preferably blended in a molten state. A method for the blending in a molten state is typically, for example, melt-kneading using an extruder. A kneading temperature (molten resin temperature) is preferably from 200°C to 280°C, more preferably from 220°C to 270°C, still more preferably from 230°C to 260°C. When the kneading temperature falls within such ranges, pellets of a resin composition in which both the resins are uniformly blended can be obtained while thermal decomposition is suppressed. When the molten resin

temperature in the extruder is more than 280°C, coloring and/or thermal decomposition of the resins may occur. Meanwhile, when the molten resin temperature in the extruder is less than 200°C, resin viscosity may become so high as to apply an excessive load to the extruder, or the melting of the resins may become insufficient. Any appropriate configurations may be adopted as the configuration of the extruder, a screw configuration, and the like. In order to obtain transparency of the resins enough for an optical film application, a twin-screw extruder is preferably used. Further, there is a concern that residual low-molecular-weight components in the resins, or low-molecular-weight thermally decomposed components in extrusion and kneading may contaminate a cooling roll or a conveying roll in a film formation step or a stretching step, and hence an extruder including a vacuum vent is preferably used in order to remove those components.

[0048] As described above, the content of the acrylic resin in the resin composition (consequently in the retardation film) is 0.5 mass% or more and 2.0 mass% or less. The lower limit is more preferably 0.6 mass% or more. The upper limit is preferably 1.5 mass% or less, more preferably 1.0 wt% or less, still more preferably 0.9 wt% or less, particularly preferably 0.8 mass% or less. When the polycarbonate-based resin is blended with the acrylic resin at a very limited ratio as just described, the

expansibility and the retardation developability can be remarkably enhanced. Further, the haze can be reduced. Such effects are not theoretically clear, and are unexpected excellent effects obtained through trial and error. When the content of the acrylic resin is excessively low, the effects may not be obtained. Meanwhile, when the content of the acrylic resin is excessively high, the haze may be increased. In addition, the expansibility and the retardation developability also become insufficient as compared to a case in which the content falls within the above-mentioned ranges, or are reduced contrarily in many cases.

[0049] In the resin composition, a synthetic resin, such as an aromatic polycarbonate, an aliphatic polycarbonate, an aromatic polyester, an aliphatic polyester, polyamide, polystyrene, polyolefin, acryl, amorphous polyolefin, ABS, AS, polylactic acid, or polybutylene succinate, a rubber, and combinations thereof may be further blended for the purpose of modifying characteristics, such as mechanical characteristics and/or solvent resistance.

[0050] The resin composition may further contain an additive. Specific examples of the additive include a heat stabilizer, an antioxidant, a catalyst deactivator, a UV absorber, a light stabilizer, a release agent, a pigment or a

dye, an impact modifier, an antistatic agent, a lubricant, a lubricating agent, a plasticizer, a compatibilizer, a nuclear agent, a flame retardant, an inorganic filler, and a foaming agent. The kinds, number, combination, contents, and the like of the additives to be contained in the resin composition may be appropriately set depending on purposes.

[0051] A-2. Characteristics of Retardation Film

The in-plane retardation $Re(550)$ of the retardation film is from 100 nm to 200 nm as described above, and is preferably from 110 nm to 180 nm, more preferably from 120 nm to 160 nm, still more preferably 130 nm to 150 nm. That is, the retardation film may function as a so-called $\lambda/4$ plate.

[0052] The retardation film typically satisfies a relationship of $Re(450) < Re(550) < Re(650)$. That is, the retardation film shows such reverse wavelength dispersion dependency that its retardation value increases with an increase in wavelength of measurement light. The $Re(450)/Re(550)$ of the retardation film is more than 0.5 and less than 1.0 as described above, and is preferably from 0.7 to 0.95, more preferably from 0.75 to 0.92, still more preferably from 0.8 to 0.9. The $Re(650)/Re(550)$ is preferably 1.0 or more and less than 1.15, more preferably from 1.03 to 1.1.

[0053] The retardation film has an in-plane retardation as described above, and hence has a relationship of $n_x > n_y$. The retardation film shows any appropriate refractive index ellipsoid as long as the film has the relationship of $n_x > n_y$. The refractive index ellipsoid of the retardation film typically shows a relationship of $n_x > n_y \geq n_z$. Herein, " $n_y = n_z$ " encompasses not only a case in which n_y and n_z are exactly equal to each other, but also a case in which n_y and n_z are substantially equal to each other. Accordingly, a relationship of $n_y < n_z$ may be satisfied without impairing the effect of the present invention. The N_z coefficient of the retardation film is preferably from 0.9 to 2.0, more preferably from 0.9 to 1.5, still more preferably from 0.9 to 1.2. When such relationship is satisfied, in the case of using the circularly polarizing plate including a retardation film for an image display apparatus, an extremely excellent reflection hue can be achieved.

[0054] The thickness of the retardation film may be set so that the retardation film can most appropriately function as a $\lambda/4$ plate. In other words, the thickness may be set so that a desired in-plane retardation may be obtained. Specifically, the thickness is preferably from 15 μm to 60 μm , more preferably from 20 μm to 55 μm , most preferably from 20 μm to 45 μm . According to the embodiment of the present invention, a retardation film excellent in retardation developability is

obtained, and hence the thickness of the retardation film can be remarkably reduced as compared to a general $\lambda/4$ plate.

[0055] The haze value of the retardation film is preferably 1.5% or less, more preferably 1.0% or less, still more preferably 0.5% or less. According to the embodiment of the present invention, a reverse dispersion retardation film excellent in both retardation developability and haze value can be achieved. The haze value is preferably as small as possible. The lower limit of the haze value may be, for example, 0.1%.

[0056] The elongation at break of the retardation film is preferably 200% or more, more preferably 210% or more, still more preferably 220% or more, particularly preferably 245% or more. The upper limit of the elongation at break may be, for example, 500%. The retardation film according to the embodiment of the present invention is, in addition to being excellent in retardation developability, also excellent in expansibility as just described, and hence, by virtue of a synergistic effect thereof, a desired in-plane retardation can be achieved with an extremely small thickness. The term "elongation at break" as used herein means an elongation ratio at the time when the film is broken in fixed-end uniaxial stretching at a predetermined stretching temperature (e.g., $T_g - 2^\circ\text{C}$).

[0057] The limiting birefringence Δn of the retardation film is preferably 0.0039 or more, more preferably 0.0040 or more, still more preferably 0.0041 or more, particularly preferably 0.0044 or more. The upper limit of the limiting birefringence Δn may be, for example, 0.0070. The retardation film according to the embodiment of the present invention has extremely high birefringence as just described, and hence can achieve a desired in-plane retardation with an extremely small thickness. The term "limiting birefringence" as used herein means birefringence at the maximum stretching ratio without break in the case where the stretching ratio is increased at a predetermined stretching temperature. The birefringence may be determined by dividing the in-plane retardation R_e of the film at the maximum stretching ratio without break by the film thickness "d".

[0058] The absolute value of the photoelastic coefficient of the retardation film is preferably 20×10^{-12} (m^2/N) or less, more preferably from 1.0×10^{-12} (m^2/N) to 15×10^{-12} (m^2/N), still more preferably from 2.0×10^{-12} (m^2/N) to 12×10^{-12} (m^2/N). When the absolute value of the photoelastic coefficient falls within such ranges, in the case of applying the retardation film to an image display apparatus, display unevenness can be suppressed.

[0059] A-3. Method of Producing Retardation Film

The retardation film described in the section A-1 and the section A-2 is obtained by forming a film from the resin composition described in the section A-1, and stretching the film. Any appropriate forming method may be adopted as a method of forming a film from the resin composition. Specific examples thereof include a compression molding method, a transfer molding method, an injection molding method, an extrusion molding method, a blow molding method, a powder forming method, a FRP molding method, a cast coating method (e.g., a casting method), a calendar molding method, and a hot-press method. Of those, an extrusion molding method or a cast coating method is preferred because the extrusion molding method or the cast coating method can increase the smoothness of the film to be obtained and provide satisfactory optical uniformity. The cast coating method may cause a problem due to a residual solvent, and hence the extrusion molding method is particularly preferred, and in particular, a melt-extrusion molding method using a T-die is preferred from the viewpoints of the productivity of the film and the ease with which subsequent stretching treatment is performed. Forming conditions may be appropriately set depending on, for example, the composition and kinds of the resins to be used, and the characteristics desired of the retardation film. Thus, a resin film containing the polycarbonate-based resin or the like and the acrylic resin may be obtained.

[0060] The thickness of the resin film (unstretched film) may be set to any appropriate value depending on, for example, the desired thickness and desired optical characteristics of the retardation film to be obtained, and stretching conditions to be described later. The thickness is preferably from 50 μm to 300 μm .

[0061] Any appropriate stretching method and stretching conditions (e.g., a stretching temperature, a stretching ratio, and a stretching direction) may be adopted for the stretching. Specifically, one kind of various stretching methods, such as free-end stretching, fixed-end stretching, free-end shrinkage, and fixed-end shrinkage, may be employed alone, or two or more kinds thereof may be employed simultaneously or sequentially. With regard to the stretching direction, the stretching may be performed in various directions or dimensions, such as a lengthwise direction, a widthwise direction, a thickness direction, and an oblique direction.

[0062] A retardation film having the desired optical characteristics (e.g., a refractive index characteristic, an in-plane retardation, and an N_z coefficient) can be obtained by appropriately selecting the stretching method and stretching conditions.

[0063] In one embodiment, the retardation film is produced by subjecting a resin film to uniaxial stretching or fixed-end uniaxial stretching. As a specific example of the uniaxial stretching, there is given a method involving stretching the resin film in a running direction (elongate direction) while running the resin film in the elongate direction. As a specific example of the fixed-end uniaxial stretching, there is given a method involving stretching the resin film in a widthwise direction (lateral direction) while running the resin film in the elongate direction. The stretching ratio is preferably from 1.1 times to 3.5 times.

[0064] In another embodiment, the retardation film may be produced by continuously subjecting a resin film having an elongate shape to oblique stretching in the direction of a predetermined angle with respect to an elongate direction. When the oblique stretching is adopted, a stretched film having an elongate shape and having an alignment angle that is a predetermined angle with respect to the elongate direction of the film (having a slow axis in the direction of the predetermined angle) is obtained, and for example, its lamination with the polarizer can be performed by a roll-to-roll process. As a result, the manufacturing process can be simplified. The predetermined angle may be an angle formed

between the absorption axis of the polarizer and the slow axis of the retardation film in the circularly polarizing plate (to be described later). As described later, the angle is preferably from 40° to 50° , more preferably from 42° to 48° , still more preferably from 44° to 46° , particularly preferably about 45° , or preferably from 130° to 140° , more preferably from 132° to 138° , still more preferably from 134° to 136° , particularly preferably about 135° .

[0065] As a stretching machine to be used for the oblique stretching, for example, there is given a tenter stretching machine capable of applying feeding forces, or tensile forces or take-up forces, having different speeds on left and right sides in a lateral direction and/or a longitudinal direction. Examples of the tenter stretching machine include a lateral uniaxial stretching machine and a simultaneous biaxial stretching machine, and any appropriate stretching machine may be used as long as the resin film having an elongate shape can be continuously subjected to the oblique stretching.

[0066] Through appropriate control of each of the speeds on the left and right sides in the stretching machine, a retardation film (substantially a retardation film having an elongate shape) having the desired in-plane retardation and having a slow axis in the desired direction can be obtained.

[0067] As a method for the oblique stretching, there are given, for example, methods described in JP 50-83482 A, JP 02-113920 A, JP 03-182701 A, JP 2000-9912 A, JP 2002-86554 A, JP 2002-22944 A, and the like.

[0068] In one embodiment, the stretching temperature of the film is a temperature equal to or lower than the glass transition temperature (T_g) of the polycarbonate-based resin or the like. In general, in the case of the stretching of a film of the polycarbonate-based resin or the like, the film is in a glassy state at a temperature equal to or lower than T_g , and hence the stretching is substantially impossible. According to the embodiment of the present invention, a small amount of the acrylic resin (typically polymethyl methacrylate) is blended to enable stretching at or below T_g without substantially changing T_g of the polycarbonate-based resin or the like. Further, through the stretching at or below T_g , there can be achieved a reverse dispersion retardation film that is excellent in expansibility and retardation developability, and that has a small haze, though the reason therefor is not theoretically clear. Specifically, the stretching temperature is preferably from T_g to $T_g-10^{\circ}\text{C}$, more preferably from T_g to $T_g-8^{\circ}\text{C}$, still more preferably from T_g to $T_g-5^{\circ}\text{C}$. The film can be appropriately stretched even at a temperature higher than T_g , up to, for

example, about $T_g+5^{\circ}\text{C}$, or for example, about $T_g+2^{\circ}\text{C}$.

[0069] [Reason why Effect is Achieved]

The reason why the film formed of the resin composition of the present invention expresses excellent characteristics is presumed to be as described below. As demonstrated in Examples to be described later, a resin composition having an acrylic resin of appropriate composition blended therewith at a limited ratio is clearly improved in limiting ratio at break at the time of stretching while maintaining transparency nearly equal to that of the polycarbonate-based resin alone. The polycarbonate-based resin and the acrylic resin are presumed to be completely compatible with each other, and it is conceived that polymer chains of the acrylic resin blended in the polycarbonate-based resin enhance the entanglement of polymer chains of the polycarbonate-based resin to improve the breaking strength of the film. The intrinsic birefringence of the acrylic resin alone is nearly zero, and hence the blending of the acrylic resin is predicted to basically reduce the intrinsic birefringence of the resin composition to reduce alignment birefringence to be expressed through stretching. However, in the present invention, the blending amount of the acrylic resin is very small, and hence it is conceived that the stretching strength of the resin composition is successfully improved while the intrinsic birefringence-reducing influence of the acrylic resin is

restricted to nearly zero, and thus the alignment birefringence is improved.

[0070] B. Circularly Polarizing Plate

The retardation film according to the embodiment of the present invention described in the section A may be suitably used for a circularly polarizing plate. Accordingly, the embodiments of the present invention also encompass a circularly polarizing plate. FIG. 1 is a schematic sectional view of a circularly polarizing plate according to one embodiment of the present invention. A circularly polarizing plate **100** of the illustrated example includes a polarizing plate **10** and a retardation film **20**. The retardation film **20** is the retardation film according to the embodiment of the present invention described in the section A. The polarizing plate **10** includes a polarizer **11**, a first protective layer **12** arranged on one side of the polarizer **11**, and a second protective layer **13** arranged on the other side of the polarizer **11**. Depending on purposes, one of the first protective layer **12** and the second protective layer **13** may be omitted. For example, the retardation film **20** according to the embodiment of the present invention may also function as a protective layer for the polarizer **11**, and hence the second protective layer **13** may be omitted. An angle formed between the slow axis of the retardation film **20** and the absorption axis of the polarizer **11** is preferably from 40° to

50°, more preferably from 42° to 48°, still more preferably from 44° to 46°, particularly preferably about 45°; or preferably from 130° to 140°, more preferably from 132° to 138°, still more preferably from 134° to 136°, particularly preferably about 135°.

[0071] As illustrated in FIG. 2, a circularly polarizing plate **101** according to another embodiment may include another retardation layer **50** and/or a conductive layer or conductive layer-equipped isotropic substrate **60**. The other retardation layer **50** and the conductive layer or conductive layer-equipped isotropic substrate **60** are typically arranged on the outer side of the retardation film **20** (opposite side to the polarizing plate **10**). The other retardation layer typically has a refractive index characteristic of showing a relationship of $n_z > n_x = n_y$. When such other retardation layer is arranged, reflection in an oblique direction can be satisfactorily prevented, and an antireflection function can be exhibited over a wide viewing angle. The other retardation layer **50** and the conductive layer or conductive layer-equipped isotropic substrate **60** are typically arranged in the stated order from the retardation film **20** side. The other retardation layer **50** and the conductive layer or conductive layer-equipped isotropic substrate **60** are typically optional layers to be arranged as required, any one or both thereof may be omitted. When the conductive layer or conductive layer-equipped isotropic substrate is arranged, the

circularly polarizing plate may be applied to a so-called inner touch panel-type input display apparatus, which includes a built-in touch sensor between an image display cell (e.g., organic EL cell) and a polarizing plate.

[0072] The circularly polarizing plate may include an additional retardation layer. The additional retardation layer may be arranged in combination with the other retardation layer **50**, or may be arranged alone (i.e., without the arrangement of the other retardation layer **50**). The optical characteristics (e.g., refractive index characteristic, in-plane retardation, Nz coefficient, and photoelastic coefficient), thickness, arrangement position, and the like of the additional retardation layer may be appropriately set depending on purposes.

[0073] The circularly polarizing plate may have a sheet shape, or may have an elongate shape. The term "elongate shape" as used herein means an elongated shape in which a length is sufficiently long as compared to a width, and includes, for example, an elongated shape in which a length is 10 or more times, preferably 20 or more times as long as a width. The circularly polarizing plate having an elongate shape may be rolled into a roll shape. When the circularly polarizing plate has an elongate shape, the polarizing plate and the retardation film each also have an elongate shape. In this case, the

polarizer preferably has an absorption axis in its elongate direction. The retardation film is preferably an obliquely stretched film having, as described above, a slow axis in a direction at an angle of from 40° to 50° or from 130° to 140° with respect to the elongate direction. When the polarizer and the retardation film are configured as just described, the circularly polarizing plate can be produced by a roll-to-roll process.

[0074] In practical use, a pressure-sensitive adhesive layer (not shown) is arranged on the opposite side of the retardation film to the polarizing plate to enable the circularly polarizing plate to be bonded to an image display cell. Further, it is preferred that a release film be temporarily bonded to the surface of the pressure-sensitive adhesive layer until the circularly polarizing plate is used. The temporary bonding of the release film protects the pressure-sensitive adhesive layer and enables the formation of a roll of the circularly polarizing plate.

[0075] Now, the constituent elements of the circularly polarizing plate are described.

[0076] B-1. Polarizer

Any appropriate polarizer may be adopted as the polarizer

11. 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.

[0077] 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.

[0078] 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.

[0079] 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 or JP 6470455 B. The entire description of the laid-open publications is incorporated herein by reference.

[0080] The thickness of the polarizer is preferably 15 μm or less, more preferably from 1 μm to 12 μm , still more preferably from 3 μm to 10 μm , particularly preferably from 3 μm to 8 μm . When the thickness of the polarizer falls within such ranges, curling at the time of heating can be satisfactorily suppressed, and satisfactory appearance durability at the time of heating is obtained. Further, when the thickness of the polarizer falls within such ranges, a contribution can be made to the thinning of the circularly polarizing plate (consequently of an organic EL display apparatus).

[0081] The polarizer preferably shows absorption dichroism at any wavelength in the wavelength range of from 380 nm to 780 nm. The single layer transmittance of the polarizer is preferably from 43.0% to 46.0%, more 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.

[0082] B-2. Protective Layer

The first protective layer **12** and the second protective layer **13** are each formed of any appropriate film that may be used as a protective layer for a polarizer. A material serving as a main component of the film is specifically, for example: a cellulose-based resin, such as triacetylcellulose (TAC); a transparent resin, such as a polyester-based, polyvinyl alcohol-based, polycarbonate-based, polyamide-based, polyimide-based, polyether sulfone-based, polysulfone-based, polystyrene-based, polynorbornene-based, polyolefin-based, (meth)acrylic, or acetate-based transparent resin; or a thermosetting resin or a UV-curable resin, such as a (meth)acrylic, urethane-based, (meth)acrylic urethane-based, epoxy-based, or silicone-based thermosetting resin or UV-curable resin. A further example thereof is a glassy polymer, 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 the 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.

[0083] As described later, the circularly polarizing plate according to the embodiment of the present invention is typically arranged on the viewer side of an image display apparatus, and the first protective layer **12** is typically arranged on its viewer side. Accordingly, the first protective layer **12** may be subjected to surface treatment, such as hard coat treatment, antireflection treatment, anti-sticking treatment, or antiglare treatment, as required. Further/alternatively, the first protective layer **12** 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. Accordingly, the circularly polarizing plate is suitably applicable even to an image display apparatus that may be used outdoors.

[0084] The thickness of the first protective layer is typically 300 μm or less, preferably 100 μm or less, more preferably from 5 μm to 80 μm , still more preferably from 10 μm to 60 μm . When the first protective layer is subjected to surface treatment, its thickness is a thickness including the thickness of its surface-treated layer.

[0085] In one embodiment, it is preferred that the second protective layer **13** be optically isotropic. The phrase "optically isotropic" as used herein refers to having an in-plane retardation $\text{Re}(550)$ of from 0 nm to 10 nm and a thickness direction retardation $\text{Rth}(550)$ of from -10 nm to +10 nm.

[0086] C. Image Display Apparatus

The circularly polarizing plate described in the section B may be applied to an image display apparatus. Accordingly, the embodiments of the present invention also encompass an image display apparatus using such circularly polarizing plate. Typical examples of the image display apparatus include a liquid crystal display apparatus and an organic EL display apparatus. An image display apparatus according to an embodiment of the

present invention includes the circularly polarizing plate described in the section B on the viewer side thereof. The circularly polarizing plate is arranged so that the polarizer may be on the viewer side.

Examples

[0087] Now, the present invention is specifically described by way of Examples. However, the present invention is not limited to these Examples. Measurement methods for characteristics are as described below.

[0088] (1) Reduced Viscosity

A resin sample was dissolved in methylene chloride to prepare a resin solution having a concentration of 0.6 g/dL. Measurement was performed at a temperature of 20.0°C±0.1°C with an Ubbelohde-type viscometer manufactured by Moritomo Rika Kogyo, and the flow-through time t_0 of the solvent and the flow-through time "t" of the solution were measured. A relative viscosity η_{rel} was determined by the following equation (i) using the resultant values for t_0 and "t", and a specific viscosity η_{sp} was determined by the following equation (ii) using the resultant relative viscosity η_{rel} .

$$\eta_{rel}=t/t_0 \quad \cdots (i)$$

$$\eta_{sp}=(\eta-\eta_0)/\eta_0=\eta_{rel}-1 \quad \cdots (ii)$$

Then, a reduced viscosity η_{sp}/c was determined by dividing the resultant specific viscosity η_{sp} by the concentration "c" [g/dL]. A higher value thereof indicates a larger molecular weight.

[0089] (2) Melt Viscosity

A pelletized resin was dried by being placed in a hot-air dryer at 100°C for 6 hours or more. Measurement was performed with a capillary rheometer manufactured by Toyo Seiki Seisakusho, Ltd. using the dried pellet. A melt viscosity was measured at a measurement temperature of 240°C and shear rates between 6.08 sec⁻¹ to 1,824 sec⁻¹, and the value of the melt viscosity at 91.2 sec⁻¹ was used. An orifice used was one having a die diameter of 1 mm and a length of 10 mm.

[0090] (3) Glass Transition Temperature

The glass transition temperature of a resin was measured using a differential scanning calorimeter DSC6220 manufactured by SII NanoTechnology Inc. About 10 mg of a resin sample was placed in an aluminum pan manufactured by SII NanoTechnology Inc., and the aluminum pan was sealed. Under a nitrogen stream at 50 mL/min, the temperature was increased from 30°C to 200°C at a temperature increase rate of 20°C/min. The temperature was kept at 200°C for 3 minutes, and then lowered to 30°C at a rate

of 20°C/min. The temperature was kept at 30°C for 3 minutes, and increased again to 200°C at a rate of 20°C/min. On the basis of DSC data obtained in the second temperature increase, an extrapolated glass transition starting temperature, which was a temperature at a point of intersection of a straight line created by extending the baseline at lower temperatures to higher temperatures and a tangent drawn at a point at which a curve gradient in a portion showing a stepwise change of glass transition became maximum, was determined, and adopted as a glass transition temperature.

[0091] (4) GPC

About 0.1 g of a resin sample was dissolved in 2 mL of methylene chloride, and the solution was filtered through a 0.2 µm disc filter, followed by GPC measurement. Standard polystyrene was similarly subjected to GPC measurement, and a number-average molecular weight (Mn) and a weight-average molecular weight (Mw) in terms of polystyrene were calculated. Apparatus and conditions are as described below.

- Pump: LC-20AD (manufactured by Shimadzu Corporation)
- Degasser: DGU-20A5 (manufactured by Shimadzu Corporation)
- Column oven: CTO-20AC (manufactured by Shimadzu Corporation)
- Detector: differential refractive index detector RID-10A (manufactured by Shimadzu Corporation)

- Column: PLgel 10 μ m Guard, PLgel 10 μ m MIXED-B 2 columns
(manufactured by Agilent)
- Oven temperature: 40°C
- Eluent: chloroform
- Flow rate: 1 mL/min
- Injection amount: 10 μ L

[0092] (5) Refractive Index

About 4 g of resin pellets dried in a hot-air dryer at 100°C for 6 hours or more were used as a sample. Polyimide films were laid above and below the sample with spacers each measuring 14 cm long by 14 cm wide by 0.1 mm thick. The whole was preheated at a temperature of from 200°C to 230°C for 3 minutes, and pressurized at a pressure of 7 MPa for 5 minutes. After that, the sample was removed together with the spacers, and cooled to produce a film. A rectangular test piece having a width of 8 mm and a length of 40 mm was cut out of the resultant film, and used as a measurement sample. Through use of interference filters for wavelengths of 656 nm (C-line), 589 nm (D-line), and 486 nm (F-line), refractive indices n_C , n_D , and n_F at the respective wavelengths were measured with a multi-wavelength Abbe refractometer DR-M4/1550 manufactured by Atago Co., Ltd. The measurement was performed at 20°C using monobromonaphthalene as an interfacial liquid.

[0093] (6) Photoelastic Coefficient

Measurement was performed using an apparatus obtained by combining a birefringence measuring apparatus formed of a He-Ne laser, a polarizer, a compensator, an analyzer, and a photodetector with a vibration-type viscoelasticity measuring apparatus (DVE-3 manufactured by Rheology Co., Ltd.) (for details, see Journal of the Society of Rheology, Japan, Vol. 19, pp. 93-97 (1991)). A sample having a width of 5 mm and a length of 20 mm was cut out of a film produced by the same method as in (5) described above, and was fixed in the viscoelasticity measuring apparatus, and a storage elastic modulus E' at a room temperature of 25°C was measured at a frequency of 96 Hz. Simultaneously, emitted laser light was passed through the polarizer, the sample, the compensator, and the analyzer in the stated order, picked up by the photodetector (photodiode), and passed through a lock-in amplifier, and with respect to a waveform at an angular frequency ω or 2ω , a retardation relative to its amplitude and strain was determined, and a strain-optic coefficient O' was determined. At this time, the directions of the absorption axes of the polarizer and the analyzer were adjusted so as to be perpendicular to each other, and to each form an angle of $\pi/4$ with respect to the extension direction of the sample. A photoelastic coefficient C was determined from the following equation using the storage elastic modulus E' and the strain-optic coefficient O' .

$$C=O'/E'$$

[0094] (7) Thickness of Film

Measurement was performed using a dial gauge.

[0095] (8) Retardation Value of Retardation Film

A 50 mm×50 mm sample was cut out of a retardation film obtained in each of Examples and Comparative Examples, and was used as a measurement sample. The measurement sample was measured for its Re(450) and Re(550) using Axoscan manufactured by Axometrics, Inc. A measurement temperature was 23°C.

[0096] (9) Haze Value

Measurement was performed in accordance with JIS K 7136 through use of a haze meter (manufactured by Murakami Color Research Laboratory Co., Ltd., product name: "HN-150"). A haze value of 1.5% or less was judged to be acceptable. When pellets after extrusion and kneading were already cloudy, it was judged that a transparent retardation film was impossible to obtain through use of the pellets, and the evaluation of a retardation film was not performed.

[0097] (10) Elongation at Break and Limiting Birefringence

Δn

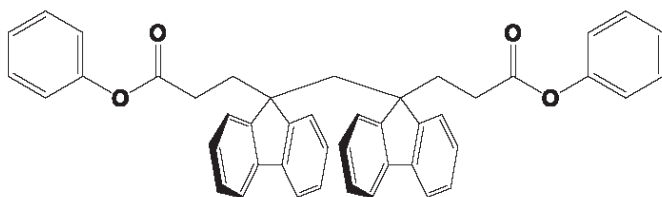
A sample measuring 120 mm (conveying direction of film at the time of production: MD) by 150 mm (direction perpendicular to the conveying direction: TD) was cut out of an unstretched film having an elongate shape used in each of Examples and Comparative Examples. The sample was subjected to fixed-end uniaxial stretching in its TD direction at varying stretching ratios through use of a lab stretcher "Bruckner KARO IV" with a stretching temperature being set to "T_g-2°C" of the resin sample, and the maximum elongation at break immediately before the sample broke was measured with a metal ruler. Further, the in-plane retardation R_e of the film at the maximum stretching ratio without break and the film thickness "d" were measured, and a limiting birefringence Δn was determined by dividing the in-plane retardation R_e by the film thickness "d". As described above, the film thickness was measured with a dial gauge. The in-plane retardation R_e was measured using "Axoscan" manufactured by Axometrics, Inc. A measurement wavelength was 590 nm.

[0098] [Abbreviations for Compounds]

Abbreviations for compounds used in the following synthesis examples, Examples, and Comparative Examples are as described below.

•BPFM: bis[9-(2-phenoxy-carbonyl-ethyl)fluoren-9-yl]methane

The compound was synthesized by a method described in JP 2015-25111 A.



- ISB: isosorbide [manufactured by Roquette Frères]
- SPG: spiroglycol [manufactured by Mitsubishi Gas Chemical Company, Inc.]
- DPC: diphenyl carbonate [manufactured by Mitsubishi Chemical Corporation]
- BPEF: 9,9-bis(4-(2-hydroxyethoxy)phenyl)fluorene [manufactured by Osaka Gas Chemical Co., Ltd.]
- PEG1000: polyethylene glycol, number-average molecular weight: 1,000 [manufactured by Sanyo Chemical Industries, Ltd.]

[0099] [Modifier Resin]

- DIANAL BR80 (manufactured by Mitsubishi Chemical Corporation)
- DIANAL BR85 (manufactured by Mitsubishi Chemical Corporation)
- KURALITY LA4285 (manufactured by Kuraray Co., Ltd.)
- METABLEN P570A (manufactured by Mitsubishi Chemical Corporation)

•ESTYRENE MS-600 (manufactured by Nippon Steel & Sumikin Chemical Co., Ltd.)

•ESTYRENE MS-200 (manufactured by Nippon Steel & Sumikin Chemical Co., Ltd.)

•G9504 (manufactured by Japan PolyStyrene Inc.)

The composition and physical properties of each resin are shown in Table 1.

[0100] [Example 1]

Polymerization was performed with a batch polymerization apparatus formed of two vertical stirring reactors each including a stirring blade and a reflux condenser. 30.31 Parts by mass (0.047 mol) of BPFM, 39.94 parts by mass (0.273 mol) of ISB, 30.20 parts by mass (0.099 mol) of SPG, 69.67 parts by mass (0.325 mol) of DPC, and 7.88×10^{-4} parts by mass (4.47×10^{-6} mol) of calcium acetate monohydrate serving as a catalyst were loaded. The inside of a first reactor was purged with nitrogen under reduced pressure, and 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. 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 110°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 20 kPa, respectively in 40 minutes. After that, while the pressure was further lowered, 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. This resin is referred to as "PC1". A ratio among structural units derived from the respective monomers is as follows: BPFM/ISB/SPG/DPC=21.5/39.4/30.0/9.1 mass%. PC1 had a reduced viscosity of 0.46 dL/g, an M_w of 48,000, a refractive index n_D of 1.526, a melt viscosity of 2,480 Pa·s, a glass transition temperature of 139°C, a photoelastic coefficient of 9×10^{-12} [m²/N], and a wavelength dispersion $Re(450)/Re(550)$ of 0.85.

[0101] BR80 was used as an acrylic resin, and subjected to extrusion and kneading with the resultant polyester carbonate. A mixture of the pellets of the polycarbonate (99.5 parts by mass) and powder of BR80 (0.5 part by mass) was fed into a twin-screw extruder TEX30HSS manufactured by The Japan Steel Works, Ltd. through use of a metering feeder. The cylinder temperature of the extruder was set to 250°C, and extrusion was performed at a treatment amount of 12 kg/hr and a screw revolution number of 120 rpm. In addition, the extruder included a vacuum vent, and molten resins were extruded while devolatilization was performed under reduced pressure. The pellets of the resin composition thus obtained were vacuum-dried at 100°C for 6 hours or more, and then an elongate unstretched film having a length of 3 m, a width of 200 mm, and a thickness of 100 μm was produced using a film-forming apparatus including a single-screw extruder (manufactured by Isuzu Kakoki, screw diameter: 25 mm, cylinder preset temperature: 250°C), a T-die (width: 300 mm, preset temperature: 220°C), a chill roll (preset temperature: 120°C to 130°C), and a take-up unit. Then, the elongate unstretched film was used in the determination of elongation at break and limiting birefringence Δn by the procedure described in (10) above. In addition, separately from the film subjected to the above-mentioned evaluation, a retardation film obtained at a stretching temperature equal to T_g and a stretching ratio of 2.4

times showed a refractive index characteristic of $n_x > n_y > n_z$. Further, the resultant retardation film had an $\text{Re}(550)$ of 145 nm, an $\text{Re}(450)/\text{Re}(550)$ of 0.85, and a haze of 0.3%. The results are shown in Table 1.

[0102] [Example 2]

A retardation film was produced in the same manner as in Example 1 except that the blending ratio of BR80 was set to 0.7 mass%. The resultant retardation film was subjected to the same evaluations as those of Example 1. The results are shown in Table 1.

[0103] [Example 3]

A retardation film was produced in the same manner as in Example 1 except that the blending ratio of BR80 was set to 0.9 mass%. The resultant retardation film was subjected to the same evaluations as those of Example 1. The results are shown in Table 1.

[0104] [Example 4]

A retardation film was produced in the same manner as in Example 1 except that the blending ratio of BR80 was set to 1.5 mass%. The resultant retardation film was subjected to the same evaluations as those of Example 1. The results are shown in Table 1.

[0105] [Comparative Example 1]

A retardation film was produced in the same manner as in Example 1 except that: no acrylic resin was used (i.e., the content of the acrylic resin was set to zero); and the stretching temperature was set to $T_g+2^{\circ}\text{C}$. The resultant retardation film was subjected to the same evaluations as those of Example 1. The results are shown in Table 1.

[0106] [Comparative Example 2]

A retardation film was produced in the same manner as in Example 1 except that the blending ratio of BR80 was set to 0.3 mass%. The resultant retardation film was subjected to the same evaluations as those of Example 1. The results are shown in Table 1.

[0107] [Comparative Example 3]

A retardation film was produced in the same manner as in Example 1 except that the blending ratio of BR80 was set to 3.0 mass%. The resultant retardation film was subjected to the same evaluations as those of Example 1. The results are shown in Table 1.

[0108] [Comparative Example 4]

A retardation film was produced in the same manner as in

Example 1 except that: the blending ratio of BR80 was set to 10 mass%; and the stretching temperature was set to $T_g+2^{\circ}\text{C}$. The resultant retardation film was subjected to the same evaluations as those of Example 1. The results are shown in Table 1.

[0109] [Comparative Example 5]

Extrusion and kneading, and production of an unstretched film were performed in the same manner as in Example 1 except that: BR85 was used as the acrylic resin; and the blending ratio of BR85 was set to 1 mass%. The unstretched film was apparently transparent, but had a fine insoluble component generated therein.

[0110] [Comparative Example 6]

Extrusion and kneading were performed in the same manner as in Example 1 except that: LA4285 was used as the acrylic resin; and the blending ratio of LA4285 was set to 1 mass%. The pellets after the kneading were cloudy.

[0111] [Comparative Example 7]

Extrusion and kneading were performed in the same manner as in Example 1 except that: P570A was used as the acrylic resin; and the blending ratio of P570A was set to 1 mass%. The pellets after the kneading were cloudy.

[0112] [Comparative Example 8]

The same evaluations as those of Example 1 were performed except that: MS-600 was used as the acrylic resin; and the blending ratio of MS-600 was set to 1 mass%. The results are shown in Table 1.

[0113] [Comparative Example 9]

Extrusion and kneading were performed in the same manner as in Example 1 except that: MS-200 was used as the acrylic resin; and the blending ratio of MS-200 was set to 1 mass%. The pellets after the kneading were cloudy.

[0114] [Comparative Example 10]

Extrusion and kneading was performed in the same manner as in Example 1 except that: the non-acrylic resin G9504 was used as the modifier resin; and the blending ratio of G9504 was set to 1 mass%. The pellets after the kneading were cloudy.

[0115] [Comparative Example 11]

BPEF/ISB/PEG1000 copolymerized polycarbonate was synthesized by a method described in JP 2014-43570 A. This resin is referred to as "PC2". A ratio among structural units derived from the respective monomers is as follows: BPEF/ISB/PEG1000/DPC=63.7/26.1/1.0/9.2 mass%. PC2 had a reduced viscosity of 0.35 dL/g, an Mw of 36,000, a refractive index n_D

of 1.599, a melt viscosity of 3,100 Pa·s, a glass transition temperature of 145°C, a photoelastic coefficient of 30×10^{-12} [m²/N], and a wavelength dispersion $\text{Re}(450)/\text{Re}(550)$ of 0.89. Extrusion and kneading was performed in the same manner as in Example 1 except that: PC2 was used as the base resin; BR80 was used as the acrylic resin; and the blending ratio of BR80 was set to 1 mass%. The pellets after the kneading were cloudy.

[0116]

Table 1

	Modifier resin				Blending formulation		Pellets after extrusion and kneading			Physical property evaluation of stretched film						
										Retardation film					Limiting stretching	
	Material name	Copolymerization composition	Mw	Refractive index	Base resin	Modifier resin	Appearance	Glass transition temperature (Tg)	Photoelastic coefficient	Stretching ratio	Str etc thin g temperature	Re(50)	Re(450)/Re(550)	Haze	Elongation at break	Limiting stretching
	-	-	-	-	-	Mass %	-	°C	×10 ⁻¹² m ² /N	%	°C	nm	-	%	%	-
Example 1	DIAN AL BR80	MMA 95 mass% or more	76,000	1.491	PC1	99.5	Transp arent	139	8	240	Tg	145	0.85	0.3	260	0.0042
Example 2	DIAN AL BR80	MMA 95 mass% or more	76,000	1.491	PC1	99.3	Transp arent	139	8	240	Tg	145	0.85	0.3	285	0.0046
Example 3	DIAN AL BR80	MMA 95 mass% or more	76,000	1.491	PC1	99.1	Transp arent	139	8	240	Tg	145	0.85	0.3	250	0.0042
Example 4	DIAN AL BR80	MMA 95 mass% or more	76,000	1.491	PC1	98.5	Transp arent	139	8	240	Tg	145	0.85	0.3	240	0.0041
Comparative Example 1	DIAN AL BR80	MMA 95 mass% or more	76,000	1.491	PC1	100.0	Transp arent	139	8	240	Tg+ 2°C	145	0.85	0.3	195	0.0038
Comparative Example 2	DIAN AL BR80	MMA 95 mass% or more	76,000	1.491	PC1	99.7	Transp arent	139	8	240	Tg	145	0.85	0.3	210	0.0038
Comparative Example 3	DIAN AL BR80	MMA 95 mass% or more	76,000	1.491	PC1	97.0	Transp arent	138	8	240	Tg	145	0.85	2.3	240	0.0041
Comparative Example 4	DIAN AL BR80	MMA 95 mass% or more	76,000	1.491	PC1	90.0	Transp arent	134	8	240	Tg+ 2°C	145	0.85	2.5	180	0.0032

Comparative Example 5	DIAN AL BR85	MMA 95 mass% or more	210,000	1.491	PC1	99.0	1.0	Transp arent, with insoluble component	139	8							
Comparative Example 6	KURA RITY LA42 85	MMA/BA 50/50 mass%	40,000	1.480	PC1	99.0	1.0	Cloudy	139								
Comparative Example 7	META BLEN P570 A	MMA/BA 50/50 mass%	170,000	1.479	PC1	99.0	1.0	Cloudy	139								
Comparative Example 8	ESTY RENE MS-600	MMA/styrene 60/40 mass%	150,000	1.532	PC1	99.0	1.0	Transp arent	139	8	240	Tg	145	0.85	7.0	190	0.0029
Comparative Example 9	ESTY RENE MS-200	MMA/styrene 20/80 mass%	190,000	1.570	PC1	99.0	1.0	Cloudy	139								
Comparative Example 10	G950 4	Styrene 95 mass% or more	230,000	1.589	PC1	99.0	1.0	Cloudy	139								
Comparative Example 11	DIAN AL BR80	MMA 95 mass% or more	76,000	1.491	PC2	99.0	1.0	Cloudy	145								

[0117] [Evaluation]

As apparent from Table 1, according to each of Examples of the present invention, a reverse dispersion retardation film having a large elongation at break (i.e., being excellent in expansibility), having a large limiting birefringence (i.e., being excellent in retardation developability), and having a small haze can be obtained through use of an acrylic resin having the optimal composition and molecular weight. In each of Comparative Examples 1 and 2, in which the addition amount of the acrylic resin is less than 0.5 mass%, it is found that the elongation at break is small (i.e., sufficient stretching cannot be performed), and the limiting birefringence Δn is remarkably small as compared to Examples. Meanwhile, in each of Comparative Examples 3 and 4, in which the addition amount of the acrylic resin is more than 2.0 mass%, the haze is high, and hence the transparency is insufficient, and further, it is found that, when the addition amount of the acrylic resin is excessively large, the limiting birefringence is reduced contrarily. It is found from Comparative Examples 6 to 10 that the acrylic resins each containing a large amount of a component other than methyl methacrylate, and the non-acrylic resin do not provide transparency of a resin required for an optical film because of lack of compatibility with the resin of the present invention. In Comparative Example 8, the resin composition after extrusion was transparent, but the haze was increased after stretching.

This is conceivably because, although the polyester carbonate resin and MS-600 had refractive indices close to each other, thereby giving an appearance of being transparent, the resins were substantially incompatible and phase-separated, and hence increased the haze by causing interphase peeling when subjected to a large deformation in the form of stretching.

[0118] [Example 5]
(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, whose iodine concentration had been adjusted so that the polarizer to be obtained had a single layer

transmittance of 45.0%. Further, two-stage cross-linking treatment was adopted as 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.

[0119] (Production of Polarizing Plate)

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. Thus, a polarizing plate having the configuration "protective

layer/polarizer" was obtained.

[0120] (Production of Circularly Polarizing Plate)

The polarizer surface of the polarizing plate obtained above and a retardation film produced in the same manner as in Example 1 except for adjusting the stretching ratio so as to give an $R_e(550)$ of 140 nm were bonded to each other via an acrylic pressure-sensitive adhesive. The retardation film was cut so that its slow axis and the absorption axis of the polarizer formed an angle of 45° at the time of their bonding. In addition, the absorption axis of the polarizer was arranged so as to be parallel to a lengthwise direction. Thus, a circularly polarizing plate having the configuration "protective layer/polarizer/retardation film" was obtained.

[0121] (Production of Image Display Apparatus)

An organic EL panel was removed from a commercially available organic EL display apparatus (manufactured by Samsung, product name: "Galaxy 5"), a polarizing film bonded to the organic EL panel was peeled off, and the circularly polarizing plate obtained above was bonded in place of the polarizing film. Thus, an image display apparatus (organic EL display apparatus) was obtained. The resultant organic EL display apparatus was caused to display a black image on its entire screen, and the image (black display screen) was visually observed. The image

was a satisfactory one with little reflection and showing no undesired coloring.

Industrial Applicability

[0122] The retardation film of the present invention can be suitably used for a circularly polarizing plate, and the circularly polarizing plate can be suitably used for an image display apparatus (typically a liquid crystal display apparatus or an organic EL display apparatus).

Reference Signs List

- [0123] **10** polarizing plate
- 11** polarizer
- 12** first protective layer
- 13** second protective layer
- 20** retardation film
- 100** circularly polarizing plate
- 101** circularly polarizing plate

Claims

[Claim 1] A retardation film, comprising:

a resin having positive refractive index anisotropy, the resin containing:

at least one bonding group selected from the group consisting of a carbonate bond and an ester bond; and

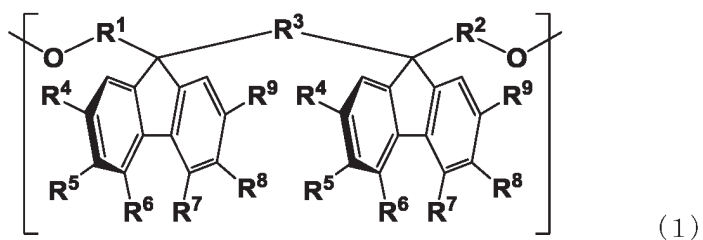
at least one structural unit selected from the group consisting of a structural unit represented by the following general formula (1) and a structural unit represented by the following general formula (2); and

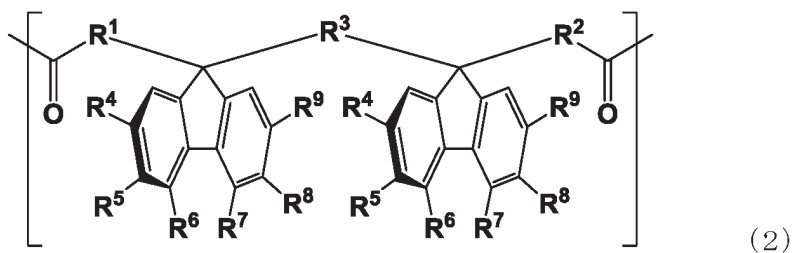
an acrylic resin,

wherein a content of the acrylic resin is from 0.5 mass% to 2.0 mass%,

wherein the acrylic resin contains 70 mass% or more of a structural unit derived from methyl methacrylate, and has a weight-average molecular weight Mw of from 10,000 to 200,000, and

wherein the retardation film has an Re(550) of from 100 nm to 200 nm, and an Re(450)/Re(550) of more than 0.5 and less than 1.0:





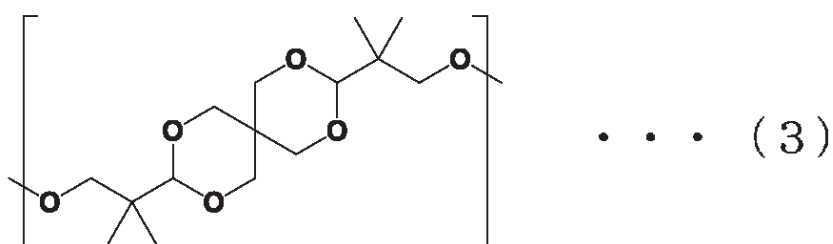
in the general formulae (1) and (2), R^1 to R^3 each independently represent a direct bond, or a substituted or unsubstituted alkylene group having 1 to 4 carbon atoms, and R^4 to R^9 each independently represent a hydrogen atom, a substituted or unsubstituted alkyl group having 1 to 10 carbon atoms, a substituted or unsubstituted aryl group having 4 to 10 carbon atoms, a substituted or unsubstituted acyl group having 1 to 10 carbon atoms, a substituted or unsubstituted alkoxy group having 1 to 10 carbon atoms, a substituted or unsubstituted aryloxy group having 1 to 10 carbon atoms, a substituted or unsubstituted amino group, a substituted or unsubstituted vinyl group having 1 to 10 carbon atoms, a substituted or unsubstituted ethynyl group having 1 to 10 carbon atoms, a sulfur atom having a substituent, a silicon atom having a substituent, a halogen atom, a nitro group, or a cyano group, provided that R^4 to R^9 may be identical to or different from each other, and at least two adjacent groups of R^4 to R^9 may be bonded to each other to form a ring,

where Re(550) represents an in-plane retardation of the

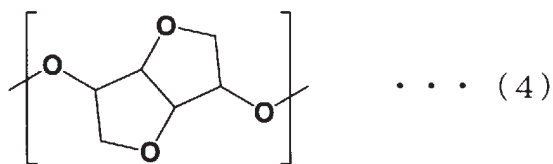
film measured at 23°C with light having a wavelength of 550 nm, and $\text{Re}(450)$ represents an in-plane retardation of the film measured at 23°C with light having a wavelength of 450 nm.

[Claim 2] The retardation film according to claim 1, wherein the resin having positive refractive index anisotropy contains 1 mass% to 40 mass% of the at least one structural unit selected from the group consisting of the structural unit represented by the general formula (1) and the structural unit represented by the general formula (2).

[Claim 3] The retardation film according to claim 1 or 2, wherein the resin having positive refractive index anisotropy further contains a structural unit represented by the following general formula (3).



[Claim 4] The retardation film according to any one of claims 1 to 3, wherein the resin having positive refractive index anisotropy further contains a structural unit represented by the following general formula (4).



[Claim 5] The retardation film according to any one of claims 1 to 4, wherein the retardation film has a haze value of 1.5% or less.

[Claim 6] The retardation film according to any one of claims 1 to 5, wherein the retardation film has an elongation at break of 200% or more.

[Claim 7] The retardation film according to any one of claims 1 to 6, wherein the retardation film has a limiting birefringence Δn of 0.0039 or more.

[Claim 8] A method of producing the retardation film of any one of claims 1 to 7,

comprising stretching a resin film containing the resin having positive refractive index anisotropy and the acrylic resin,

wherein the stretching is performed at a temperature equal to or lower than a glass transition temperature of the resin having positive refractive index anisotropy.

[Claim 9] The method according to claim 8,

wherein the stretching is performed while the resin film having an elongate shape is conveyed in an elongate direction, and

wherein a slow axis direction of the retardation film having an elongate shape to be obtained is a direction at from 40° to 50° or from 130° to 140° with respect to the elongate direction.

[Claim 10] A circularly polarizing plate, comprising:

a polarizer; and

the retardation film of any one of claims 1 to 7,

wherein an angle formed between an absorption axis of the polarizer and a slow axis of the retardation film is from 40° to 50° or from 130° to 140° .

[Claim 11] An image display apparatus, comprising the circularly polarizing plate of claim 10 on a viewer side, wherein the polarizer of the circularly polarizing plate is arranged on the viewer side.