

DESCRIPTION

TITLE OF THE INVENTION: RUBBER-BASED PRESSURE-SENSITIVE-ADHESIVE COMPOSITION, RUBBER-BASED PRESSURE-SENSITIVE-ADHESIVE LAYER, PRESSURE-SENSITIVE-ADHESIVE FILM, RUBBER-BASED PRESSURE-SENSITIVE-ADHESIVE LAYER ATTACHED OPTICAL FILM, OPTICAL MEMBER, AND IMAGE DISPLAY DEVICE

TECHNICAL FIELD

[0001]

The present invention relates to a rubber-based pressure-sensitive-adhesive composition, and a rubber-based pressure-sensitive-adhesive layer formed using this rubber-based pressure-sensitive-adhesive composition. The invention also relates to a rubber-based pressure-sensitive-adhesive layer attached optical film, in which the rubber-based pressure-sensitive-adhesive layer is laid on/over an optical film, and an optical member, in which this rubber-based pressure-sensitive-adhesive layer is laid on/over a low moisture permeability film. The invention also relates to a pressure-sensitive-adhesive film including the rubber-based pressure-sensitive-adhesive layer. The invention further relates to an image display device including the pressure-sensitive-adhesive layer attached optical film and/or the optical member.

BACKGROUND ART

[0002]

In recent years, an image display device such as a liquid crystal display device has been strongly required to be made lighter and thinner. A polarizing film and other various optical members used in the image display device have also been required to be made thinner and lighter.

[0003]

As a polarizing film, known is, for example, a single-side protected polarizing film having a polarizer and a protective film only on a single surface of the polarizer. Such a single-side protected polarizing film can be made thinner and lighter; however, the other single surface of the polarizer is not protected by any protective film, so that the polarizer of the single-side protected polarizing film has a problem of being easily deteriorated by water or others. In the same manner, even a double-side protected polarizing film, the polarizer thereof may be deteriorated by water or others when its protective films are made thin.

[0004]

An organic electroluminescence (EL) panel mounted on an organic electroluminescence display device is very weak against water and oxygen in the atmospheric air. Thus, usually, a barrier layer, or an optical film having a

barrier function is laid on the outer surface of the organic electroluminescence panel. The pressure-sensitive-adhesive layer for bonding thereof is required not to permeate water or others (low moisture permeability).

[0005]

Various optical members used in such an image display device are easily deteriorated by water or others in accordance with the raw material thereof. Thus, a pressure-sensitive-adhesive layer for bonding the optical members to an adherend has been required not to permeate water or others (low moisture permeability).

[0006]

As a material for forming such a low moisture permeability pressure-sensitive-adhesive layer, a rubber-based pressure-sensitive-adhesives are known. For example, the following are known: an adhesive composition for sealing which includes a hydrogenated cyclic olefin-based polymer, and a polyisobutylene resin having a weight-average molecular weight of 500,000 or more (see, for example, Patent Document 1); a pressure-sensitive-adhesive composition including a polyisobutylene-based resin having a weight-average molecular weight of from 270,000 to 480,000, a polyisobutylene resin having a weight-average molecular weight of from 100,000 to 250,000, and a hydrogenated

petroleum resin having a softening point of from 90 to 135°C (see, for example, Patent Document 2).

PRIOR ART DOCUMENTS

PATENT DOCUMENTS

[0007]

Patent Document 1: JP-A-2009-524705

Patent Document 2: JP-B-5416316

SUMMARY OF THE INVENTION

PROBLEMS TO BE SOLVED BY THE INVENTION

[0008]

The use of a rubber-based pressure-sensitive-adhesive makes it possible to lower the resultant pressure-sensitive adhesive layer in moisture permeability; however, this pressure-sensitive adhesive may cause the layer to be more largely peeled off and foamed in a high-temperature environment than any conventional acrylic pressure-sensitive adhesive used for optical articles. The peeling, the foaming, and such other inconveniences are caused by a shortage in the cohesive power of the rubber-based pressure-sensitive-adhesive layer near an adhesive interface of this layer. It has been understood that this shortage in the cohesive power near the adhesive interface is caused by the following: near the interface of the

pressure-sensitive adhesive layer, there is present a large quantity of a rubber-based polymer which is contained in the rubber-based pressure-sensitive adhesive, and which is small in molecular weight so that molecules thereof are not very entangled with each other; thus, a layer low in cohesive power (brittle layer) is generated.

[0009]

According to Patent Documents 1 and 2, trials are made for overcoming various problems by adding an additive, such as a tackifier, to a rubber-based polymer. However, no improvement is made in the rubber-based polymer, which is a root cause for the problems. Thus, the trials are not sufficient from the viewpoint of the endurance of the resultant pressure-sensitive adhesive layer.

[0010]

Thus, an object of the present invention is to provide a rubber-based pressure-sensitive-adhesive composition capable of forming a rubber-based pressure-sensitive-adhesive layer which is low in moisture permeability and has such a high endurance that even in a high-temperature environment, inconveniences that the layer is partially raised and separated, peeled off or damaged into some other form can be restrained from being caused. Another object of the invention is to provide a rubber-based pressure-sensitive-adhesive layer formed, using this

pressure-sensitive-adhesive composition, a pressure-sensitive-adhesive film, in which this rubber-based pressure-sensitive-adhesive layer is laid, a rubber-based pressure-sensitive-adhesive layer attached optical film, and an optical member. Still another object of the invention is to provide an image display device including the rubber-based pressure-sensitive-adhesive layer attached optical film and/or the optical member.

MEANS FOR SOLVING THE PROBLEMS

[0011]

In order to solve the above-mentioned problems, the inventors have repeatedly made eager investigations to find out a rubber-based pressure-sensitive-adhesive composition described below, and then have achieved the present invention.

[0012]

The present invention relates to a rubber-based pressure-sensitive-adhesive composition, comprising a rubber-based base polymer; wherein

the rubber-based base polymer comprises an isobutylene-based polymer having a polydispersity ("weight-average molecular weight"/"number-average molecular weight") of 4 or less; and

a rubber-based pressure-sensitive-adhesive layer

which is made from the rubber-based pressure-sensitive-adhesive composition and which has a thickness of 50 μm has a moisture permeability of 50 $\text{g}/(\text{m}^2\cdot\text{day})$ or less at 40°C and 92% R.H.

[0013]

The rubber-based pressure-sensitive-adhesive composition of the invention preferably comprises a tackifier.

[0014]

In the rubber-based pressure-sensitive-adhesive composition of the invention, the tackifier is preferably at least one tackifier selected from the group consisting of a tackifier containing a terpene skeleton, a tackifier containing a rosin skeleton, and hydrogenated products of these tackifiers.

[0015]

In the rubber-based pressure-sensitive-adhesive composition of the invention, the tackifier preferably has a softening point of 90°C or higher.

[0016]

The rubber-based pressure-sensitive-adhesive composition of the invention preferably comprises a hydrogen-abstraction type photopolymerization initiator.

[0017]

The present invention relates to a rubber-based

pressure-sensitive-adhesive layer, made from a rubber-based pressure-sensitive-adhesive composition of the invention.

[0018]

The present invention relates to a pressure-sensitive adhesive film, comprising a support comprising a plastic substrate, and a rubber-based pressure-sensitive-adhesive layer of the invention that is on/over at least one surface of the support.

[0019]

The present invention relates to a rubber-based pressure-sensitive-adhesive layer attached optical film, comprising an optical film, and a rubber-based pressure-sensitive-adhesive layer of the invention that is on/over at least one surface of the optical film.

[0020]

In the rubber-based pressure-sensitive-adhesive layer attached optical film of the invention, the optical film is preferably a polarizing film having a polarizer and a protective film on/over at least one surface of the polarizer.

[0021]

In the rubber-based pressure-sensitive-adhesive layer attached optical film of the invention, the polarizing film is preferably a single-side protected polarizing film having the polarizer and the protective film only on/over

the one surface of the polarizer, and

the rubber-based pressure-sensitive-adhesive layer, the polarizer, and the protective film are preferably laminated in this order. The rubber-based pressure-sensitive-adhesive layer attached optical film preferably further comprises a retardation film, and

the rubber-based pressure-sensitive-adhesive layer, the retardation film, the polarizer, and the protective film are preferably laminated in this order.

[0022]

The present invention also relates to an optical member, comprising a film having a moisture permeability of 1 g/(m²·day) or less at 40°C and 92% R.H., and a rubber-based pressure-sensitive-adhesive layer of the invention that is on/over at least one surface of the film.

[0023]

The present invention further relates to an image display device, comprising at least one rubber-based pressure-sensitive-adhesive layer attached optical film of the invention, or at least one optical member of the invention.

EFFECT OF THE INVENTION

[0024]

In the rubber-based pressure-sensitive-adhesive

composition of the present invention, the use of a rubber-based polymer small in low molecular weight, that is, a polymer small in polydispersity (M_w/M_n) makes it possible to provide a rubber-based pressure-sensitive-adhesive layer which can restrain the generation of inconveniences (such as a partial raise and peel of this layer) (i.e., which has a high endurance) in a high-temperature environment also while keeping a low moisture permeability.

[0025]

The present invention can also provide a rubber-based pressure-sensitive-adhesive layer attached optical film, an optical member, and pressure-sensitive adhesive film which are remarkably good in endurance in a high-temperature environment and further in low moisture permeability; and an image display device remarkably good in optical reliabilities.

BRIEF DESCRIPTION OF THE DRAWINGS

[0026]

Fig. 1 is a sectional view that schematically illustrates an embodiment of the pressure-sensitive adhesive layer attached polarizing film of the present invention.

Fig. 2 is a sectional view that schematically illustrates an embodiment of the pressure-sensitive

adhesive layer attached polarizing film of the present invention.

MODE FOR CARRYING OUT THE INVENTION

[0027]

1. Rubber-Based Pressure-Sensitive-Adhesive Composition

The rubber-based pressure-sensitive-adhesive composition of the present invention includes a rubber-based base polymer, wherein

the rubber-based base polymer includes an isobutylene-based polymer having a polydispersity ("weight-average molecular weight"/"number-average molecular weight") of 4 or less, and

a moisture permeability of the rubber-based pressure-sensitive-adhesive layer which is formed using the rubber-based pressure-sensitive-adhesive composition and which has a thickness of 50 μm is 50 $\text{g}/(\text{m}^2 \cdot \text{day})$ or less.

[0028]

(1) Rubber-based Base Polymer

The rubber-based base polymer used in the present invention is a polymer showing rubber elasticity in the range of temperatures near room temperature and includes an isobutylene-based polymer having a polydispersity ("weight-average molecular weight"/"number-average molecular weight") of 4 or less.

[0029]

The isobutylene-based polymer may be a polymer containing, as its constituent monomer, isobutylene. The isobutylene-based polymer may be a homopolymer made from isobutylene (polyisobutylene: PIB), or may be a copolymer made from isobutylene as a main monomer (that is, a copolymer obtained by the copolymerization of isobutylene in a proportion more than 50% by mole). Examples of such a copolymer include copolymers each made from isobutylene and n-butylene, and copolymers each made from isobutylene and isoprene (such as regular butyl rubber, chlorinated butyl rubber, brominated butyl rubber, partially crosslinked butyl rubber, and other butyl rubbers); and vulcanized products and modified products of these copolymers (such as the copolymers that have been modified with functional groups such as hydroxyl groups, carboxyl groups, amino groups, or epoxy groups). Among these examples, polyisobutylene (PIB) is preferred since this polymer has, at its main chain, no double bonds to be excellent in weather resistance.

[0030]

The polydispersity of the isobutylene-based polymer can be calculated out according to the ratio (M_w/M_n) of the weight-average molecular weight (M_w) of the isobutylene-based polymer to the number-average molecular weight (M_n)

thereof. In the present invention, the polydispersity (M_w/M_n) of the isobutylene-based polymer is 4 or less, and is preferably 3.5 or less, more preferably 3 or less. The lower limit of the polydispersity is not particularly limited, and is sufficient to be 1 or more. In the present invention, the matter that the polydispersity of the isobutylene-based polymer is 4 or less makes good the endurance of a rubber-based pressure-sensitive-adhesive layer yielded from the rubber-based pressure-sensitive-adhesive composition. This would be based on the following: the use of the isobutylene-based polymer, the polydispersity of which is 4 or less, decreases a quantity of low-molecular components in the rubber-based pressure-sensitive-adhesive composition to restrain the formation of a brittle layer made from the low-molecular components in the rubber-based pressure-sensitive-adhesive layer made from the pressure-sensitive adhesive composition.

[0031]

The isobutylene-based polymer having a polydispersity of 4 or less may be a commercially available product, examples thereof including OPPANOL N series manufactured by the BASF. Specific examples thereof include OPPANOL N50 (M_w/M_n : 2.3), OPPANPL N80 (M_w/M_n : 2.4), and OPPANPL N100 (M_w/M_n : 2.9) manufactured by the BASF.

[0032]

The weight-average molecular weight (M_w) of the isobutylene-based polymer is preferably 500000 or more, more preferably 550000 or more, even more preferably 700000 or more, in particular preferably 1000000 or more. The upper limit of the weight-average molecular weight is not particularly limited, and is preferably 5000000 or less, more preferably 3000000 or less, even more preferably 2000000 or less. When the weight-average molecular weight of the isobutylene-based polymer is adjusted to 500000 or more, the composition favorably tends to be rendered a rubber-based pressure-sensitive-adhesive composition more remarkably good in endurance when the resultant layer is stored at a high temperature.

[0033]

The number-average molecular weight (M_n) of the isobutylene-based polymer is preferably 200000 or more, more preferably 300000 or more, even more preferably 400000 or more. The upper limit value of the number-average molecular weight is not particularly limited, and is preferably 3000000 or less, more preferably 1000000 or less, even more preferably 700000 or less. By setting the number-average molecular weight of the isobutylene-based polymer into 200000 or more, the polymer can be improved in cohesive power to restrain inconveniences, such as peeling, when stored at high temperature. Thus, this case is

preferred.

[0034]

The content of the isobutylene-based polymer in the rubber-based base polymer is preferably 60% or more by weight, more preferably 80% or more by weight, even more preferably 90% or more by weight. The content is in particular preferably 100% by weight (specifically, the rubber-based base polymer is made only of the isobutylene-based polymer, the polydispersity of which is 4 or less). The upper limit thereof is not particularly limited, and is sufficient to be, for example, 100% or less by weight.

[0035]

The rubber-based pressure-sensitive-adhesive composition of the present invention may include, for example, a rubber-based polymer besides the isobutylene-based polymer. Specific examples thereof include styrene-based thermoplastic elastomers such as styrene-ethylene-butylene-styrene block copolymer (SEBS), styrene-isoprene-styrene block copolymer (SIS), styrene-butadiene-styrene block copolymer (SBS), styrene-ethylene-propylene-styrene block copolymer (SEPS: hydrogenated product of SIS), styrene-ethylene-propylene block copolymer (SEP: hydrogenated product of styrene-isoprene block copolymer), styrene-isobutylene-styrene block copolymer (SIBS), styrene-butadiene rubber (SBR), and other styrene-based

block copolymer; butyl rubber (IIR), butadiene rubber (BR), acrylonitrile-butadiene rubber (NBR), EPR (binary ethylene-propylene rubber), EPT (ternary ethylene-propylene rubber), acrylic rubber, and urethane rubber; polyurethane-based thermoplastic elastomers; polyester-based thermoplastic elastomers; blended thermoplastic elastomers such as a polymer blend of polypropylene and EPT (ternary ethylene-propylene rubber). These rubber-based polymers may be added to the composition as far as the advantageous effects of the present invention are not damaged. The amount thereof is preferably 40% or less by weight, more preferably 20% or less by weight, further preferably 10% or less by weight, for rubber-based base polymers. The composition may contain none of the rubber-based polymers (in other words, the amount thereof is 0% by weight).

[0036]

The content of the rubber-based base polymer is not particularly limited, and is preferably 40% or more by weight, more preferably 50% or more by weight, even more preferably 70% or more by weight, in particular preferably 80% or more by weight of the whole of solids in the rubber-based pressure-sensitive-adhesive composition. The upper limit of the content of the rubber-based base polymer is not particularly limited, and is preferably 100% or less by weight, more preferably 90% or less by weight.

[0037]

The moisture permeability of the rubber-based pressure-sensitive-adhesive layer which is formed using the rubber-based pressure-sensitive-adhesive composition and which has a thickness of 50 μm is 50 $\text{g}/(\text{m}^2\cdot\text{day})$ or less, preferably 30 $\text{g}/(\text{m}^2\cdot\text{day})$ or less, more preferably 20 $\text{g}/(\text{m}^2\cdot\text{day})$ or less, even more preferably 15 $\text{g}/(\text{m}^2\cdot\text{day})$ or less. The lower limit value of the moisture permeability is not particularly limited. Ideally, this layer does not transmit water vapor at all (in other words, the moisture permeability is 0 $\text{g}/(\text{m}^2\cdot\text{day})$). When the moisture permeability of the rubber-based pressure-sensitive-adhesive layer is in any one of the ranges, the following can be favorably attained: when the pressure-sensitive-adhesive layer is applied to an optical film such as a polarizing film, water is restrained from being shifted to the optical film; consequently, the optical film is restrained from being deteriorated or damaged in any other manner by water. The moisture permeability is the water-vapor transmissibility (moisture permeability) of a rubber-based pressure-sensitive-adhesive layer under conditions of 40°C temperature and 92% R.H. when the thickness of this layer is 50 μm , and is measurable by a method in the item EXAMPLES.

[0038]

(2) Tackifier

A tackifier may be added to the rubber-based pressure-sensitive-adhesive composition of the present invention. As the tackifier, the rubber-based pressure-sensitive-adhesive composition may include at least one tackifier selected from the group consisting of tackifiers each containing a terpene skeleton and tackifiers each containing a rosin skeleton, and hydrogenated products of these tackifiers. The matter that the rubber-based pressure-sensitive-adhesive composition contains the tackifier(s) favorably allows to form a rubber-based pressure-sensitive-adhesive layer having a high adhesion to various adherends, and a high endurance even in a high-temperature environment.

[0039]

Examples of the tackifiers each containing a terpene skeleton include terpene polymers such as α -pinene polymer, β -pinene polymer, and dipentene polymer; and modified terpene resins in each of which the terpene polymers is modified (with, for example, phenol modified, styrene modified, an aromatic modified, added hydrogenation modified or a hydrocarbon modified). Examples of the modified terpene resins include terpene phenol resin, styrene modified terpene resin, aromatically modified terpene resin, and hydrogen-added terpene resin

(hydrogenated terpene resin). Examples of the hydrogenated terpene resin referred to herein include a hydrogenated product of terpene polymer, and hydrogenated products of other modified terpene resins or terpene phenol resin. Thereamong, hydrogenated products of terpene phenol resins are preferred from the viewpoint of compatibility with the rubber-based pressure-sensitive-adhesive composition and pressure-sensitive-adhesive properties.

[0040]

Examples of the tackifiers each containing a rosin skeleton include rosin resin, polymerized rosin resin, hydrogenated rosin resin, rosin ester resin, hydrogenated rosin ester resin, and rosin phenol resin. Specifically, the following may be used: gum rosin, wood rosin, tall oil rosin and other unmodified rosins (raw rosins); modified rosins each yielded by modifying one of these raw rosins by hydrogenation, disproportionation, polymerization, or any other chemical modification; and derivatives of these raw rosins or modified rosins.

[0041]

The tackifier may be a commercially available product, examples thereof including CLEARON series, and POLYESTER series manufactured by Yasuhara Chemical Co., Ltd.; and SUPER ESTER series, PENSEL series, and PINECRYSTAL series manufactured by Arakawa Chemical

Industries, Ltd.

[0042]

When the tackifier is a hydrogenated product, the hydrogenation may be a partially hydrogenated product, in which a compound is partially hydrogenated, or a completely hydrogenated product, in which all double bonds of a compound are hydrogenated. In the present invention, the completely hydrogenated product is preferred from the viewpoint of pressure-sensitive-adhesive properties, weather resistance and hue thereof.

[0043]

The tackifier preferably has a cyclohexanol skeleton from the viewpoint of pressure-sensitive-adhesive properties thereof. Details of a principle thereof are unclear; however, the principle would be based on the matter that the cyclohexanol skeleton results in a better balance of compatibility between the tackifier and the isobutylene-based polymer, which is a base polymer, than a phenol skeleton. The tackifier containing a cyclohexanol skeleton is preferably, for example, a hydrogenated product of terpene phenol resin, rosin phenol resin or the like, more preferably a completely hydrogenated product of terpene phenol resin, rosin phenol resin or the like.

[0044]

The softening point (softening temperature) of the

tackifier is not particularly limited, and is, for example, preferably about 90°C or higher, more preferably about 100°C or higher. When the softening point of the tackifier is 90°C or higher, the tackifier does not soften even at a high temperature, so that this tackifier can favorably keep pressure-sensitive-adhesive properties. The upper limit value of the softening point of the tackifier is not particularly limited. However, if the softening point becomes too high, the tackifier may become higher in molecular weight to be deteriorated in the compatibility to cause inconveniences, such as whitening, unfavorably. The upper limit value of the softening point of the tackifier is, for example, preferably about 200°C or lower, more preferably about 180°C or lower. The softening point of the tackifier that is referred to herein is defined as a value measured by a softening point testing method (ring and ball method) prescribed in any one of JIS K5902 and JIS K2207.

[0045]

The weight-average molecular weight (M_w) of the tackifier is not particularly limited, and is preferably 50000 or less, preferably 30000 or less, more preferably 10000 or less, even more preferably 8000 or less, in particular preferably 5000 or less. The lower limit value of the weight-average molecular weight of the tackifier is

not particularly limited, and is preferably 500 or more, more preferably 1000 or more, even more preferably 2000 or more. When the weight-average molecular weight of the tackifier is in any one of these ranges, the tackifier is favorably good in compatibility with the isobutylene-based polymer not to cause inconveniences such as whitening.

[0046]

The addition amount of the tackifier is preferably 40 parts or less by weight, more preferably 30 parts or less by weight, even more preferably 20 parts or less by weight for 100 parts by weight of the solid weight of the rubber-based base polymer. The lower limit value of the addition amount of the tackifier is not particularly limited, and is preferably 0.1 part or more by weight, more preferably 1 part or more by weight, even more preferably 5 parts or more by weight. It is preferred to set the use amount of the tackifier into any one of the ranges in order that the composition can improve the pressure-sensitive-adhesive properties. If the use amount of the tackifier is over these ranges to result in a large-amount addition thereof, the pressure-sensitive adhesive unfavorably tends to be lowered in cohesive power.

[0047]

A tackifier other than the tackifiers each containing a terpene skeleton and the tackifiers each containing a

rosin skeleton may be added to the rubber-based pressure-sensitive-adhesive composition of the present invention. This tackifier may be a petroleum-based resin tackifier. Examples of the petroleum-based resin tackifier include aromatic petroleum resins, aliphatic petroleum resins, alicyclic petroleum resins (aliphatic cyclic petroleum resins), aliphatic/aromatic petroleum resins, aliphatic/alicyclic petroleum resins, hydrogenated petroleum resins, coumarone-based resins, and coumarone indene-based resins.

[0048]

The petroleum-based resin tackifier may be used as far as the advantageous effects of the present invention are not damaged. The tackifier may be used, for example, in an amount of about 30 parts or less by weight for 100 parts by weight of the solid weight of the rubber-based base polymer.

[0049]

(3) Hydrogen-Abstraction Type Photopolymerization Initiator

A hydrogen-abstraction type photopolymerization initiator may be added to the rubber-based pressure-sensitive-adhesive composition of the present invention. The hydrogen-abstraction type photopolymerization initiator is a material which is irradiated with an active energy ray to withdraw hydrogen from the isobutylene-based polymer

such as polyisobutylene without being cleaved so as to allow to form reaction points in the polymer. By the formation of the reaction points, a crosslinking reaction of the polymer can be started.

[0050]

Besides the hydrogen-abstraction type photopolymerization initiator used in the present invention, as the photopolymerization initiator, known is also a cleavage type photopolymerization initiator which is irradiated with an active energy ray to be cleaved and decomposed so as to generate radicals. However, when the cleavage type photopolymerization initiator is used for the isobutylene-based polymer used in the present invention, the main chain of the isobutylene-based polymer is unfavorably cut with the radical-generated photopolymerization initiator, so that the isobutylene-based polymer cannot be crosslinked. In the present invention, the use of the hydrogen-abstraction type photopolymerization initiator allows to crosslink the isobutylene-based polymer as described above.

[0051]

Examples of the hydrogen-abstraction type photopolymerization initiator include acetophenone, benzophenone-based compounds such as benzophenone, methyl o-benzoylbenzoate-4-phenylbenzophenone, 4,4'-

dichlorobenzophenone, hydroxybenzophenone, 4,4'-dimethoxybenzophenone, 4,4'-dichlorobenzophenone, 4,4'-dimethylbenzophenone, 4-benzoyl-4'-methyl-diphenyl sulfide, acrylated benzophenone, 3,3',4,4'-tetra(t-butylperoxycarbonyl)benzophenone, and 3,3'-dimethyl-4-methoxybenzophenone; thioxanthone-based compounds such as 2-isopropylthioxanthone, 2,4-dimethylthioxanthone, 2,4-diethylthioxanthone, and 2,4-dichlorothioxanthone; aminobenzophenone-based compounds such as 4,4'-bis(dimethylamino)benzophenone, and 4,4'-diethylaminobenzophenone; 10-butyl-2-chloroacridone, 2-ethylanthraquinone, 9,10-phenanthrenequinone, and camphorquinone; aromatic ketone compounds such as acetophenone, and 1-hydroxycyclohexyl phenyl ketone; aromatic aldehydes such as terephthalic aldehyde, and quinone-based aromatic compounds such as methyl anthraquinone. These compounds may be used singly or in the form of a mixture of two or more thereof. Thereamong, preferred are benzophenone-based compounds, and more preferred is benzophenone from the viewpoint of the reactivity thereof.

[0052]

The content of the hydrogen-abstraction type photopolymerization initiator is preferably from 0.001 to 10 parts by weight, more preferably from 0.005 to 10 parts

by weight, even more preferably from 0.01 to 10 parts by weight for 100 parts by weight of the rubber-based base polymer. When the composition includes the hydrogen-abstraction type photopolymerization initiator in an amount in any one of these ranges, the crosslinking reaction can be favorably advanced to cause the resultant crosslinked product to have a desired density.

[0053]

In the present invention, a cleavage type photopolymerization initiator may be used together with the hydrogen-abstraction type photopolymerization initiator as far as the advantageous effects of the present invention are not damaged. However, it is preferred not to use any cleavage type photopolymerization initiator for the same reason as described above.

[0054]

(4) Polyfunctional Radical Polymerizable Compound

The rubber-based pressure-sensitive-adhesive composition of the present invention may further include a polyfunctional radical polymerizable compound. In the invention, the polyfunctional radical polymerizable compound functions as a crosslinking agent for the isobutylene-based polymer.

[0055]

The polyfunctional radical polymerizable compound is

a compound having at least two radical-polymerizable functional groups each having an unsaturated double bond, such as (meth)acryloyl groups or vinyl groups. Specific examples of the polyfunctional radical polymerizable compound include esterified products each made from (meth)acrylic acid and a polyhydric alcohol such as tripropylene glycol di(meth)acrylate, tetraethylene glycol di(meth)acrylate, 1,6-hexanediol di(meth)acrylate, 1,9-nonanediol di(meth)acrylate, 1,10-decanediol di(meth)acrylate, 2-ethyl-2-butylpropanediol di(meth)acrylate, bisphenol A di(meth)acrylate, bisphenol A ethylene oxide adduct di(meth)acrylate, bisphenol A propylene oxide adduct di(meth)acrylate, bisphenol A diglycidyl ether di(meth)acrylate, neopentyl glycol di(meth)acrylate, tricyclodecanedimethanol di(meth)acrylate, dioxane glycol di(meth)acrylate, trimethylolpropane tri(meth)acrylate, pentaerythritol tri(meth)acrylate, pentaerythritol tetra(meth)acrylate, dipentaerythritol penta(meth)acrylate, dipentaerythritol hexa(meth)acrylate, EO-modified diglycerin tetra(meth)acrylate; and 9,9-bis [4-(2-(meth)acryloyloxyethoxy)phenyl]fluorene. These compounds may be used singly or in the form of a mixture of two or more thereof. From the viewpoint of compatibility with the isobutylene-based polymer, thereamong, preferred are

esterified products each made from (meth)acrylic acid and a polyhydric alcohol. More preferred are bifunctional (meth)acrylates each having two (meth)acryloyl groups, and trifunctional (meth)acrylates each having three or more (meth)acryloyl groups. Particularly preferred are tricyclodecanedimethanol di(meth)acrylate, and trimethylolpropane tri(meth)acrylate.

[0056]

The content of the polyfunctional radical polymerizable compound is preferably 20 parts or less by weight, more preferably 15 parts or less by weight, even more preferably 10 parts or less by weight for 100 parts by weight of the rubber-based base polymer. The lower limit value of the content of the polyfunctional radical polymerizable compound is not particularly limited, and is, for example, preferably 0.1 part or more by weight, more preferably 0.5 part or more by weight, even more preferably 1 part or more by weight for 100 parts by weight of the rubber-based base polymer. When the content of the polyfunctional radical polymerizable compound is in any one of these ranges, the resultant rubber-based pressure-sensitive-adhesive layer is favorable from the viewpoint of the endurance thereof.

[0057]

The molecular weight of the polyfunctional radical

polymerizable compound is not particularly limited, and is, for example, preferably about 1000 or less, more preferably about 500 or less.

[0058]

(5) Other Additives

An organic solvent may be added as a diluent to the rubber-based pressure-sensitive-adhesive composition. The diluent is not particularly limited. Examples thereof include toluene, xylene, n-heptane, and dimethyl ether. These may be used singly or in the form of a mixture of two or more thereof. Thereamong, toluene is preferred.

[0059]

The addition amount of the diluent is not particularly limited, and is preferably from about 50 to 95 % by weight, more preferably from about 70 to 90 % by weight in the rubber-based pressure-sensitive-adhesive composition. From the viewpoint of the paintability of the composition onto a support and others, the addition amount of the diluent in the ranges is preferred.

[0060]

An additive other than the above-mentioned additives may be added to the rubber-based pressure-sensitive-adhesive composition of the present invention as far as the advantageous effects of the invention are not damaged. Examples of the additive(s) include a softener, a

crosslinking agent (such as polyisocyanate, epoxy compounds, and alkyl etherized melamine compounds), a filler, an antiaging agent and an ultraviolet absorbent. The species, the combination, the addition amount, and other factors of the additive(s) added in the rubber-based pressure-sensitive-adhesive composition may be appropriately set in accordance with a purpose thereof. The content amount (total amount) of the additive(s) in the rubber-based pressure-sensitive-adhesive composition is preferably 30% or less by weight, more preferably 20% or less by weight, even more preferably 10% or less by weight. [0061]

2. Rubber-Based Pressure-Sensitive-Adhesive Layer

The rubber-based pressure-sensitive-adhesive layer of the present invention is a layer formed, using the rubber-based pressure-sensitive-adhesive composition. The method of the present invention for producing the rubber-based pressure-sensitive-adhesive layer will be described later. [0062]

The thickness of the rubber-based pressure-sensitive-adhesive layer of the present invention is not particularly limited, and may be appropriately set in accordance with the usage thereof. The thickness is preferably 250 μm or less, more preferably 100 μm or less, more preferably 50 μm or less. The lower limit value of the thickness of the

pressure-sensitive-adhesive layer is not particularly limited, and is preferably 1 μm or more, more preferably 5 μm or more from the viewpoint of the endurance of the layer.

[0063]

The moisture permeability of the rubber-based pressure-sensitive-adhesive layer is as described above.

[0064]

3. Method for Producing Rubber-Based Pressure-Sensitive-Adhesive Layer

The method for producing the rubber-based pressure-sensitive-adhesive layer of the present invention is not particularly limited. This layer can be formed, for example, by applying the rubber-based pressure-sensitive-adhesive composition onto, for example, a support that may be of various types, and then subjecting the resultant to, for example, heating and drying to remove a solvent and the like therein (producing method 1). When the rubber-based pressure-sensitive-adhesive composition of the present invention contains the above-mentioned hydrogen-abstraction type photopolymerization initiator, the rubber-based pressure-sensitive-adhesive layer can be produced by radiating an active energy ray to the rubber-based pressure-sensitive-adhesive composition to crosslink the isobutylene-based polymer (producing method 2).

Hereinafter, a description will be made about each of the producing methods.

[0065]

(1) Producing Method 1

The method for applying the pressure-sensitive-adhesive composition may be a method of various types. Specific examples thereof include roll coating, kiss roll coating, gravure coating, reverse coating, roll brushing, spray coating, dip roll coating, bar coating, knife coating, air knife coating, curtain coating, lip coating, and an extrusion coating method through, for example, a die coater.

[0066]

The heating and drying temperature is preferably from about 30 to 200°C, more preferably from 40 to 180°C, further preferably from 80 to 150°C. When the heating and drying temperature is in any one of above ranges, the pressure-sensitive-adhesive layer having an excellent pressure-sensitive-adhesive properties can be obtained. About the drying period, a suitable period may be appropriately adopted. The drying period is preferably from about 5 seconds to 20 minutes, more preferably from 30 seconds to 10 minutes, even more preferably from 1 to 8 minutes.

[0067]

The support may be, for example, a release-treated sheet (separator).

[0068]

The constituent material of the separator is, for example, a plastic film such as polyethylene, polypropylene, polyethylene terephthalate or polyester film, a porous material such as paper, cloth or nonwoven fabric, a net, a foamed sheet or a metal foil piece; a laminate composed of two or more of these examples; or any other appropriate thin sheet piece. The plastic film is preferred since the film is excellent in surface smoothness.

[0069]

Examples of the plastic film include a polyethylene film, a polypropylene film, a polybutene film, a polybutadiene film, a polymethylpentene film, a polyvinyl chloride film, a vinyl chloride copolymer film, a polyethylene terephthalate film, a polybutylene terephthalate film, a polyurethane film, and an ethylene-vinyl acetate copolymer film.

[0070]

The thickness of the separator is usually from about 5 to 200 μm , preferably from about 5 to 100 μm . As required, the separator may be subjected to release treatment with a silicone-based, fluorine-containing

compound-based, long-chain alkyl-based or aliphatic acid amide-based release agent, or with silica powder; or to antifouling treatment or antistatic treatment of, for example, a applying type, a material-kneading-in type or a vapor deposition type. When a surface of the separator is appropriately subjected, particularly, to release treatment such as silicone treatment, long-chain alkyl treatment or fluorine treatment, the separator can be made higher in releasability from the pressure-sensitive adhesive layer.

[0071]

The thickness of a rubber-based pressure-sensitive-adhesive layer of the present invention is as described above.

[0072]

(2) Producing Method 2

In the radiation of the active energy ray, usually, the rubber-based pressure-sensitive-adhesive composition is applied onto, for example, a support that may be of various types, and the ray is radiated onto the resultant applied layer. About the radiation of the active energy ray, the ray may be radiated directly to the applied layer (without bonding any other member or others thereto). Alternatively, after optical films, such as a separator, and various members, such as a glass piece, are bonded to the applied layer, the ray may be radiated to the

resultant. In the case of the radiation after the bonding of the optical films and the various members, it is allowable to radiate the active energy ray to the applied layer across the optical films and the various members, or peel off the optical films and the various members, and then radiate the active energy ray to the applied layer through the peel-off surface thereof.

[0073]

The method for the applying of the rubber-based pressure-sensitive-adhesive composition may be the same method as in the producing method 1.

[0074]

In the case that the active energy ray is radiated onto the applied layer of the rubber-based pressure-sensitive-adhesive composition; when the rubber-based pressure-sensitive-adhesive composition contains an organic solvent as a diluting agent, it is preferred to remove the solvent and others by, for example, heating and drying after the application and before the radiation of the active energy ray.

[0075]

The heating and drying temperature is not particularly limited, and is preferably from about 30 to 90°C, more preferably from about 60 to 80°C to reduce the quantity of the remaining solvent. About the drying

period, a suitable period may be appropriately adopted. The drying period is preferably from about 5 seconds to 20 minutes, more preferably from 30 seconds to 10 minutes, even more preferably from 1 to 8 minutes.

[0076]

Examples of the active energy ray include visible rays, ultraviolet rays, and an electron beam. Thereamong, ultraviolet rays are preferred.

[0077]

Conditions for the ultraviolet ray radiation are not particularly limited. Thus, arbitrary appropriate conditions may be set in accordance with the composition of the rubber-based pressure-sensitive-adhesive composition to be crosslinked. For example, the integrated quantity of the radiated ray is preferably from 100 to 2000 mJ/cm².

[0078]

The support may be the support describe above.

[0079]

The thickness and the moisture permeability of a rubber-based pressure-sensitive-adhesive layer yielded by the producing method are as described above.

[0080]

4. Pressure-Sensitive Adhesive Film

The pressure-sensitive adhesive film of the present invention has a support including a plastic substrate, and

the above-defined rubber-based pressure-sensitive-adhesive layer on/over at least one surface of the support.

[0081]

In a method for forming the rubber-based pressure-sensitive-adhesive layer on/over the support, the rubber-based pressure-sensitive-adhesive layer can be formed on/over the support by applying the rubber-based pressure-sensitive-adhesive composition on/over the support, and then subjecting the resultant to, for example, heating and drying to remove a solvent and the like therein or then radiating an active energy ray to the resultant.

[0082]

The rubber-based pressure-sensitive-adhesive composition, the rubber-based pressure-sensitive-adhesive layer, and the producing method of the layer are as described above.

[0083]

The plastic substrate is not particularly limited as far as it can be formed into a sheet or a film, and examples include a polyolefin film such as polyethylene, polypropylene, poly-1-butene, poly-4-methyl-1-pentene, an ethylene-propylene copolymer, an ethylene 1-butene copolymer, an ethylene-vinyl acetate copolymer, an ethylene-ethyl acrylate copolymer, and an ethylene-vinyl alcohol copolymer, a polyester film such as polyethylene

terephthalate, polyethylene naphthalate, and polybutylene terephthalate, a polyacrylate film, a polystyrene film, a polyamide film such as nylon 6, nylon 6,6, and partially aromatic polyamide, a polyvinyl chloride film, a polyvinylidene chloride film, and a polycarbonate film.

[0084]

A thickness of the film is usually about 5 to 200 μm , preferably about 10 to 100 μm .

[0085]

The plastic substrate may be subjected to releasing, or anti-staining treatment with silicone, fluorine, long chain alkyl-based or fatty acid amide-based releasing agent, or a silica powder, easy adhesion treatment such as acid treatment, alkali treatment, primer treatment, corona treatment, plasma treatment, and ultraviolet ray treatment, or coating-type, kneading-type, or deposition-type antistatic treatment, if necessary.

[0086]

The pressure-sensitive adhesive film of the present invention is usable as a surface protective sheet that may be of various types, or is usable also as a re-release sheet which is not easily contaminated. When such a re-release sheet is used for an anti-reflection film, an anti-reflection glass piece or the like that is easily contaminated, this sheet is favorably usable as a re-

release sheet which is not extremely contaminated. When the rubber-based base polymer small in polydispersity is used to attain a further crosslinking, the pressure-sensitive adhesive film is more favorably usable.

[0087]

5. Pressure-Sensitive-Adhesive Layer Attached Optical Film

The rubber-based pressure-sensitive-adhesive layer attached optical film of the present invention has an optical film, and the above-defined rubber-based pressure-sensitive-adhesive layer laid on/over the optical film.

[0088]

In a method for forming the rubber-based pressure-sensitive-adhesive layer on/over the optical film, the rubber-based pressure-sensitive-adhesive layer can be formed on/over the optical film by applying the rubber-based pressure-sensitive-adhesive composition on/over the optical film, and then subjecting the resultant to, for example, heating and drying to remove a solvent and the like therein or then radiating an active energy ray to the resultant. As described above, the rubber-based pressure-sensitive-adhesive layer is formed on a support or the like, and the rubber-based pressure-sensitive-adhesive layer is transferred onto the optical film, so that a rubber-based pressure-sensitive-adhesive layer attached optical film can also be formed. In this case, the

release-treated sheet, which is used to produce the rubber-based pressure-sensitive-adhesive layer attached optical film, is usable, as it is, as the separator of the rubber-based pressure-sensitive-adhesive layer attached optical film, so that the process can be simplified.

[0089]

The rubber-based pressure-sensitive-adhesive composition, the rubber-based pressure-sensitive-adhesive layer and the producing method thereof are as described above.

[0090]

The optical film may be an optical film used to form various image display devices, such as a liquid crystal display device. The species thereof is not particularly limited. The optical film is, for example, a polarizing film. In general, a polarizing film is a product which has a polarizer and a protective film on a single or each surface of the polarizer. In the present invention, however, the optical film is preferably a single-side protected polarizing film from the viewpoint of making the image display device thinner.

[0091]

The polarizer is not particularly limited, and may be a polarizer of various types. For example, the polarizer may be a product produced by a process including adsorbing

a dichroic material such as iodine or a dichroic dye to a hydrophilic polymer film such as a polyvinyl alcohol-based film, a partially-formalized polyvinyl alcohol-based film, or a partially-saponified, ethylene-vinyl acetate copolymer-based film and uniaxially stretching the film, or may be a polyene-based oriented film such as a film of a dehydration product of polyvinyl alcohol or a dehydrochlorination product of polyvinyl chloride. Among these polarizers, a polarizer including a polyvinyl alcohol-based film and a dichroic material such as iodine is preferred. The thickness of these polarizers is not particularly limited, and is generally from about 5 to 80 μm .

[0092]

The polarizer yielded by dyeing a polyvinyl alcohol based film with iodine, and then stretching the resultant uniaxially may be produced, for example, by immersing a polyvinyl alcohol into an aqueous solution of iodine to dye the polyvinyl alcohol, and then stretching the resultant into a length 3 to 7 times the original length. If necessary, the film may also be immersed in an aqueous solution of potassium iodide or the like optionally containing boric acid, zinc sulfate, zinc chloride, or other materials. If necessary, the polyvinyl alcohol-based film may be further immersed in water for washing before it

is dyed. If the polyvinyl alcohol-based film is washed with water, dirt and any anti-blocking agent can be cleaned from the surface of the polyvinyl alcohol-based film, and the polyvinyl alcohol-based film can also be allowed to swell so that unevenness such as uneven dyeing can be effectively prevented. The film may be stretched before, while, or after it is dyed with iodine. The film may also be stretched in an aqueous solution of boric acid, potassium iodide, or the like or in a water bath.

[0093]

In the present invention, a thin polarizer of 10 μm or less thickness is preferably used for making the polarizing film thinner. For making the polarizing film thinner, the thickness is preferably from 1 to 7 μm . Such a thin polarizer is preferred in the point that the polarizer is small in thickness unevenness, excellent in visibility, and small in dimension change to be excellent in endurance and further the thickness of the polarizing film is also made smaller.

[0094]

Typical examples of the thin polarizer include thin polarizing membranes described in JP-A-S51-069644, JP-A-2000-338329, WO2010/100917 pamphlet, JP-A-2014-59328 and JP-A-2012-73563. These thin polarizing membranes can each be yielded by a producing method including the step of

stretching a polyvinyl alcohol-based resin (hereinafter referred to as a PVA-based resin) and a resin substrate for stretching in a laminated state, and the step of dyeing the laminate. This producing method makes it possible to stretch the laminate, even when the PVA-based resin layer is thin, without causing any inconvenience, such as breaking, by the stretching based on the supporting of the PVA-based resin layer on the resin substrate for stretching.

[0095]

The thin polarizing membranes are preferably polarizing membranes each yielded by the following producing method, among producing methods including the step of stretching the members concerned in the laminate state and the step of dyeing the laminate, since the laminate can be stretched into a large stretch ratio to improve the resultant in polarizing performance: a producing method including the step of stretching the laminating in an aqueous solution of boric acid, as is described in a pamphlet of WO 2010/100917, or JP-A-2014-059328 or JP-A-2012-073563; and the membranes are in particular preferably membranes each yielded by a producing method including the step of stretching the laminate supplementally in the air before the stretching in the aqueous solution of boric acid, as is described in JP-A-

2014-059328, or JP-A-2012-073563.

[0096]

The material for forming the protective film laid on the single or each side of the polarizer is preferably a material excellent in transparency, mechanical strength, thermal stability, water blocking performance, isotropy, and others. Examples thereof include polyester-based polymers such as polyethylene terephthalate, and polyethylene naphthalate; cellulose-based polymers such as diacetylcellulose, and triacetylcellulose; acryl-based polymers such as polymethyl methacrylate; styrene-based polymers such as polystyrene, and acrylonitrile/styrene copolymer (AS resin); and polycarbonate-based polymers. Other examples of the material for forming the protective film include polyethylene, polypropylene, cyclic or norbornene-structure-containing polyolefins, polyolefin-based polymers such as ethylene/propylene copolymer, vinyl chloride-based polymers, amide-based polymers such as nylon and aromatic polyamides, imide-based polymers, sulfone-based polymers, polyethersulfone-based polymers, polyetheretherketone-based polymers, polyphenylene sulfide-based polymers, vinyl alcohol-based polymers, vinylidene chloride-based polymers, vinylbutyral-based polymers, arylate-based polymers, polyoxymethylene-based polymers, and epoxy-based polymers; and blends of two or more of

these polymers. The protective film may also be formed in the form of a cured layer of a thermosetting resin or an ultraviolet curable resin of, for example, acryl-based, urethane-based, acrylic urethane-based, epoxy-based or silicone-based resin. When protective films are laid, respectively, on both sides of the polarizer, protective films made of the same polymeric material may be used on the front and rear sides, or protective films made of, for example, different polymeric materials may be used on the two sides.

[0097]

The thickness of the protective film may be appropriately determined, and is generally from about 1 to 500 μm from the viewpoint of the strength, the handleability and other workabilities, the thin film property, and other properties of the film.

[0098]

The polarizer and the protective film are usually bonded to each other through, for example, a water-based adhesive. Examples of the water-based adhesive include isocyanate-based adhesives, polyvinyl alcohol-based adhesives, gelatin-based adhesives, vinyl-containing latex-based adhesives, water-based polyurethanes, and water-based polyesters. The adhesive for the polarizer and the protective film is, besides these adhesives, an

ultraviolet-ray curing-type adhesive, or an electron-beam curing-type adhesive. The electron-beam curing-type adhesive for polarizing films shows an adhesion suitable for the above-mentioned various protective films. A metal compound filler may be incorporated into the adhesive used in the present invention.

[0099]

A hard coat layer or a treatment may be applied onto the surface of the protective film onto which no polarizer is bonded, examples of the treatment including an anti-reflection treatment, or a treatment for sticking-prevention, diffusion or anti-glaring.

[0100]

In a case as illustrated in Fig. 1, where a polarizing film 2 is, for example, a single-side protected polarizing film having a protective film 5 on only a single surface of a polarizer 4, a pressure-sensitive adhesive layer attached polarizing film 1 of the present invention is preferably a film in which a rubber-based pressure-sensitive-adhesive layer 3 as described above is formed on a side of the polarizer 4 that does not have the protective film 5 (that is, a polarizer-4-side thereof) (in other words, the rubber-based pressure-sensitive-adhesive layer 3, the polarizer 4 and the protective film 5 are laminated in this order). In this case, it is not necessarily

essential that the polarizer 4 and the pressure-sensitive-adhesive layer 3 contact each other. In order that the advantageous effects of the present invention can be remarkably produced, these members preferably contact each other. This structure allows to restrain water and others from being shifted to the polarizer to restrain the polarizer of the single-side protected polarizing film from being deteriorated.

[0101]

Moreover, in the pressure-sensitive adhesive layer attached polarizing film, a retardation film is further usable. In the case of using, as its polarizing film, for example, a single-side protected polarizing film, it is preferred that as illustrated in Fig. 2, a rubber-based pressure-sensitive-adhesive layer 3, a retardation film 6, a polarizer 4 and a protective film 5 are laminated in this order.

[0102]

The retardation film is preferably a film which can function as a $\lambda/4$ plate. About this retardation film, the in-plane retardation $Re(550)$, which is measured using a light ray having a wavelength of 550 nm at 23°C, is preferably from 100 to 180 nm, more preferably from 110 to 170 nm, even more preferably from 120 to 160 nm, in particular preferably from 135 to 155 nm. The in-plane

retardation R_e can be gained by the following: $R_e = (n_x - n_y) \times d$ wherein "d" is the thickness (nm) of the film. The retardation film, which can function as a $\lambda/4$ plate as described above, can be laminated onto the polarizer to set the slow axis of this film into a direction oblique (for example, a 45° direction) to the absorption axis of the polarizer.

[0103]

The retardation film typically has a refractive index ellipse of $n_x > n_y = n_z$ or $n_x > n_y > n_z$. The symbol n_x is the refractive index of the film in a direction in which the in-plane retardation is the largest (that is, a slow axis direction of the film); n_y is the refractive index in an in-plane direction orthogonal to the slow axis direction of the film (that is, a fast axis direction thereof); and n_z is the refractive index in a thickness direction of the film. In the document DESCRIPTION, the case of $n_y = n_z$ includes not only a case where n_y is strictly equal to n_z but also a case where n_y is substantially equal to n_z .

[0104]

The N_z coefficient of the retardation film is, for example, preferably from 0.9 to 2, more preferably from 1 to 1.5, more preferably from 1 to 1.3. The N_z coefficient is gained by the following: $N_z = R_{th}/R_e$. The symbol R_{th} is the retardation of the film in the thickness direction

thereof, and is gained by the following: $R_{th} = (n_x - n_z) \times d$ wherein "d" is the thickness (nm) of the film.

[0105]

The retardation film may be a known retardation film, and is preferably a retardation film making use of a polymer or liquid crystal compound having reverse wavelength dispersion property, or a retardation film in which a $\lambda/2$ plate and a $\lambda/4$ plate are laminated onto each other. The use of any one of these retardation films makes it possible to give circular polarized light in a wide wavelength range, and realize an excellent color tone.

[0106]

A material that constitutes the retardation film in which a $\lambda/2$ plate and a $\lambda/4$ plate are laminated onto each other may be any one of polymers and liquid crystal compounds, and is preferably a liquid crystal compound in order to make the retardation film thin.

[0107]

In the present invention, together with the retardation film (referred to also as the first retardation film), a second retardation film having a refractive index property showing a relationship of $n_z > n_x \geq n_y$ is usable. The laying of the second retardation film makes it possible that the function of the $\lambda/4$ plate (first retardation film) is sufficiently maintained also about light rays radiated

into the pressure-sensitive adhesive layer attached polarizing film from directions oblique thereto, so that this polarizing film can realize a very good reflective hue in the oblique directions. The retardation value $R_{th}(550)$ of the second retardation film in the thickness direction thereof is preferably from -260 to -10 nm, more preferably from -200 to -20 nm, even more preferably from -180 to -30 nm, in particular preferably from -180 to -60 nm.

[0108]

In one embodiment, the second retardation film has a refractive index showing a relationship of $n_x = n_y$. Herein, the case of " $n_x = n_y$ " includes not only a case where n_x is strictly equal to n_y but also a case where n_x is substantially equal to n_y . Specifically, it is meant that $R_e(550)$ is less than 10 nm. In another embodiment, the second retardation film has a refractive index showing a relationship of $n_x > n_y$. In this case, the in-plane retardation $R_e(550)$ of the second retardation film is preferably from 10 to 150 nm, more preferably from 10 to 80 nm. Preferably, the second retardation film has a refractive index showing a relationship of $n_x > n_y$. The use of such a retardation film makes it possible to compensate favorably for a geometric axial shift of the slow axis of the first retardation film when the pressure-sensitive adhesive layer attached polarizing film is viewed

in a direction oblique thereto, so as to improve the pressure-sensitive adhesive layer attached polarizing film greatly in anti-reflecting function in the oblique direction. For reference, as described above, when n_x is substantially equal to n_y or when n_x is larger than n_y , a slow axis may be generated in the second retardation film. In this case, the second retardation film may be laminated to make the slow axis of this film parallel with or orthogonal to the absorption axis of the polarizer.

[0109]

The second retardation film may be made of any appropriate material. The retardation film is preferably a liquid crystal layer fixed to homeotropic alignment. A liquid crystal material (liquid crystal compound) that can be subjected to homeotropic alignment may be a liquid crystal monomer or may be a liquid crystal polymer. Specific examples of the liquid crystal compound and a method of forming the liquid crystal layer include a liquid crystal compound and forming method described in paragraphs [0020] to [0042] of JP 2002-333642 A. In this case, the thickness of the layer is preferably from 0.1 μm to 5 μm , more preferably from 0.2 μm to 3 μm . The liquid crystal layer can give a desired optical property even when very small in thickness; thus, this layer can attain the realization of making a circularly polarizing plate largely

thin.

[0110]

As another preferred specific example, the second retardation film may be a retardation film formed of a fumaric acid diester-based resin described in JP 2012-32784 A. In this case, the thickness of the layer is preferably from 5 μm to 50 μm , more preferably from 10 μm to 35 μm . The retardation film made of a phthalic diester resin has a wavelength dispersion property near to flat dispersion to have an advantage of giving a small hue change.

[0111]

Examples of an optical film other than the polarizing plate film include a reflector, an anti-transmissible plate, retardation films (examples thereof including a half wavelength plate and a quarter wavelength plate) other than the above described retardation films, a viewing angle compensation film, a brightness enhancement film, and any other optical film that becomes an optical layer that may be used to form a liquid crystal display device or the like. Thereamong, a brightness enhancement film is preferably usable as the optical film. These films may be used singly as the optical film. Alternatively, when put into practical use, one or more of these layers may be laminated onto the polarizing film, so as to be used.

[0112]

An anchor layer or a transparent resin layer may be formed on the surface of the optical film or polarizer, or the pressure-sensitive adhesive layer may be formed onto the surface after the surface is subjected to easy facilitating treatment such as corona treatment or plasma treatment. The surface of the pressure-sensitive adhesive layer may be subjected to easy facilitating treatment.

[0113]

6. Optical Member

The optical member of the present invention has a film having a moisture permeability of $1 \text{ g}/(\text{m}^2 \cdot \text{day})$ or less at 40°C and 92% R.H., and the above-defined rubber-based pressure-sensitive-adhesive layer on/over at least one surface of this film.

[0114]

The method of forming a rubber-based pressure-sensitive-adhesive layer on the film, a rubber-based pressure-sensitive-adhesive composition and rubber-based pressure-sensitive-adhesive layer are as described above.

[0115]

The film having a moisture permeability of $1 \text{ g}/(\text{m}^2 \cdot \text{day})$ or less at 40°C and 92% R.H. is, for example, a barrier layer used in an organic electroluminescence element. The barrier layer used in the organic electroluminescence element is, for example, a polymer

layer made of trifluoropolyethylene, polytrifluorochloroethylene (PCTFE), polyimide, polycarbonate, polyethylene terephthalate, an alicyclic polyolefin or an ethylene-vinyl alcohol copolymer; a laminated body made of two or more of these layers; or a product in which a film-forming method such as sputtering is used to coat the polymer layer with an inorganic thin film made of, for example, silicon oxide, silicon nitride, aluminum oxide, or diamond-like carbon. An optical member having such a low moisture permeability film is usable suitably for an organic electroluminescence device. Specifically, the optical member is usable as a sealing member for an organic electroluminescence element.

[0116]

7. Image Display Device

The image display device of the present invention includes one or more selected from the group consisting of the above-defined pressure-sensitive-adhesive layer attached polarizing film, and the above-defined optical member. Examples of the image display device include a liquid crystal display device, and an organic electroluminescence display device.

[0117]

The image display device of the present invention is sufficient to include the pressure-sensitive-adhesive layer

attached optical film or optical member of the invention. Other structures of this device may be the same as in any conventional image display device.

[0118]

The image display device of the present invention includes the above-defined pressure-sensitive-adhesive layer attached optical film or optical member; thus, this device has high optical reliabilities.

EXAMPLES

[0119]

Hereinafter, the present invention will be specifically described by way of working examples thereof. However, the invention is not limited to these examples. In each of the examples, the word "part(s)" and the symbol "%" are part(s) by weight and % by weight, respectively.

[0120]

Production Example 1 (Production of Polarizing Film (1))

In order to produce a thin polarizing membrane, supplemental stretching in the air at a stretching temperature of 130°C was initially used to stretch a laminate in which a polyvinyl alcohol (PVA) layer of 9 μm thickness was formed on an amorphous polyethylene terephthalate (PET) substrate, thereby producing a stretched laminate. Next, the stretched laminate was dyed

to produce a colored laminate. The colored laminate was further stretched into a total stretch ratio of 5.94 in an aqueous solution of boric acid at a stretching temperature of 65°C to produce an optical film laminate including the PVA layer of 4 μm thickness, which had been stretched in the state of being integrated with the amorphous PET substrate. This two-stage stretching resulted in the production of an optical film laminate including the PVA layer of 5 μm thickness. This laminate was a laminate in which PVA molecules in the PVA layer formed on the amorphous PET substrate was aligned to a high degree; and in which a highly functional polarizing membrane (polarizer) was configured in which iodine adsorbed by the dyeing was aligned, in the form of a polyiodide ion complex, to a high degree into one direction.

[0121]

While a polyvinyl alcohol-based adhesive was applied onto the outer surface of the polarizing membrane (polarizer, thickness: 5 μm) of the optical film laminate, which was related to the polarizer, to give an adhesive layer thickness of 0.1 μm , a transparent protective film (film yielded by applying corona treatment to a (meth)acryl-based resin film having a thickness of 20 μm and having a lactone ring structure) was bonded onto the polarizing membrane. The resultant was then dried at 50°C

for 5 minutes. Next, the amorphous PET substrate was peeled therefrom to produce a thin-polarizer-used single-side-protected polarizing film (polarizing film (1)).

[0122]

Production Example 2 (Production of Polarizing Film (2))

A polyvinyl alcohol film of 30 μm thickness was stretched three times between rolls different from each other in speed ratio while dyed in an iodine solution having a concentration of 0.3% at 30°C for one minute. Thereafter, while the film was immersed in an aqueous solution containing boric acid in a concentration of 4% and potassium iodide in a concentration of 10% at 60°C for 0.5 minute, the film was stretched into a total stretching ratio of 6 times. Next, the film was immersed in an aqueous solution containing potassium iodide in a concentration of 1.5% at 30°C for 10 seconds to be cleaned. The film was then dried at 50°C for 4 minutes to yield a polarizer of 12 μm thickness. A 25- μm thickness triacetylcellulose film was bonded onto one of the surfaces of the polarizer, and further a 13- μm thickness cycloolefin-based resin film was bonded onto the opposite surface of the polarizer, using a polyvinyl alcohol-based adhesive), to yield each double-surface protected film (polarizing film (2)). The one surface of the triacetylcellulose film was subjected to hard coat

treatment and the opposite surface thereof was subjected to saponified treatment. The polarizing film (2) had a structure of "hard coat layer/triacetylcellulose film/adhesive layer/polarizer/adhesive layer/cycloolefin-based resin film".

[0123]

Production Example 3 (Production of First Retardation Film)

37.5 Parts by mass of isosorbide (ISB), 91.5 parts by mass of 9,9-bis[4-(2-hydroxyethoxy)phenyl]fluorene (BHEPF), 8.4 parts by mass of polyethylene glycol (PEG) having an average molecular weight of 400, 105.7 parts by mass of diphenyl carbonate (DPC), and 0.594 part by mass of (a 0.2 mass % aqueous solution of) cesium carbonate as a catalyst were loaded into a reaction vessel. Under a nitrogen atmosphere, as a first step of a reaction, the heating medium temperature of the reaction vessel was set to 150°C, and the raw materials were dissolved while being stirred as required (for about 15 minutes).

[0124]

Next, a pressure in the reaction vessel was increased from normal pressure to 13.3 kPa, and produced phenol was extracted to the outside of the reaction vessel while the heating medium temperature of the reaction vessel was increased to 190°C in 1 hour. A temperature in the reaction vessel was held at 190°C for 15 minutes. After

that, as a second step, the pressure in the reaction vessel was set to 6.67 kPa, the heating medium temperature of the reaction vessel was increased to 230°C in 15 minutes, and the produced phenol was extracted to the outside of the reaction vessel. The temperature was increased to 250°C in 8 minutes because the stirring torque of a stirring machine increased. In order for the produced phenol to be further removed, the pressure in the reaction vessel was reduced to 0.200 kPa or less. After the stirring torque had reached a predetermined value, the reaction was completed, and a produced reaction product was extruded into water and then pelletized. Thus, a polycarbonate resin A including structural units derived from dihydroxy compounds at a ratio "BHEPF/ISB/PEG" of 42.9 mol%/52.8 mol%/4.3 mol% was obtained. The resultant polycarbonate resin A had a glass transition temperature of 126°C and a reduced viscosity of 0.372 dL/g. The resultant polycarbonate resin A was dried in a vacuum at 80°C for 5 hours. After that, a polycarbonate resin film having a length of 3 m, a width of 300 mm, and a thickness of 120 µm was produced by using a film-producing apparatus including a uniaxial extruder (manufactured by Isuzu Kakoki, screw diameter: 25 mm, cylinder preset temperature: 220°C), a T-die (width: 300 mm, preset temperature: 220°C), a chill roll (preset temperature: 120 to 130°C), and a rolling machine. The

resultant polycarbonate resin film had a water absorption rate of 1.2%.

[0125]

The resultant polycarbonate resin film was cut into a piece measuring 300 mm long by 300 mm wide, and the piece was subjected to longitudinal stretching with Lab Stretcher KARO IV (manufactured by Bruckner) at a temperature of 136°C and a ratio of 2 times to provide a retardation film. The resultant retardation film had an $\text{Re}(550)$ of 141 nm and an $\text{Rth}(550)$ of 141 nm (n_x : 1.5969, n_y : 1.5942, n_z : 1.5942), and showed a refractive index characteristic of $n_x > n_y = n_z$. In addition, the resultant retardation film had a ratio " $\text{Re}(450)/\text{Re}(550)$ " of 0.89. Further, the film showed a retardation fluctuation by an environmental test of 5 nm.

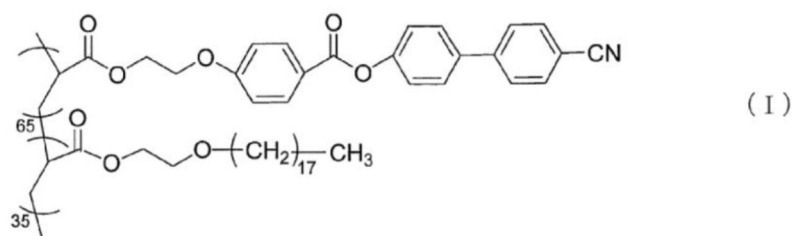
[0126]

Production Example 4 (Production of Second Retardation Layer (Second Retardation Film))

20 Parts by weight of a side chain-type liquid crystal polymer represented by the following chemical formula (I) (numerical values "65" and "35" in the formula each represent the mole percent of a monomer unit, which is represented in the form of a block polymer for convenience: weight-average molecular weight: 5,000), 80 parts by weight of a polymerizable liquid crystal showing a nematic liquid crystal phase (manufactured by BASF: trade name "Paliocolor

LC242"), and 5 parts by weight of a photopolymerization initiator (manufactured by Ciba Specialty Chemicals Inc.: trade name "IRGACURE 907") were dissolved in 200 parts by weight of cyclopentanone to prepare a liquid crystal application liquid. Then, the application liquid was applied to a base material film (norbornene-based resin film: manufactured by ZEON CORPORATION, trade name "ZEONEX") with a bar coater, and was then dried by heating at 80°C for 4 minutes to align the liquid crystal. The liquid crystal layer was cured by irradiating the liquid crystal layer with UV light. Thus, a cured liquid crystal layer (thickness: 0.58 μm) serving as a second retardation layer was formed on the base material. The layer had an $\text{Re}(550)$ of 0 nm and an $\text{Rth}(550)$ of -71 nm (n_x : 1.5326, n_y : 1.5326, n_z : 1.6550), and showed a refractive index characteristic of $n_z > n_x = n_y$.

[0127]



[0128]

Production Example 5 (Production of Retardation Film A)

The second retardation layer (cured liquid crystal

layer) yielded in Production Example 4 was bonded to the first retardation film yielded in Production Example 3 through an acryl-based pressure-sensitive adhesive, and then the base material film was removed therefrom to yield a laminate (retardation film A) in which the cured liquid crystal layer has been transferred on the first retardation film. The resultant retardation film A had a structure composed of the first retardation film/the acryl-based pressure-sensitive-adhesive layer/the second retardation layer. The resultant retardation film A had an $R_e(550)$ of 141 nm, and an $R_{th}(550)$ of 70 nm.

[0129]

Production Example 6 (Production of Each Retardation-Film-Attached Single-Side Protected Polarizing Film)

The first retardation film of the retardation film A yielded in Production Example 5 was bonded through a polyvinyl alcohol adhesive to the polarizing membrane (polarizer) side of the single-side protected polarizing film (polarizing film (1)) yielded in Production Example 1. The bonding was attained to set the angle of the slow axis of the retardation film A to 45° counterclockwise to the absorption axis of the polarizer. In this way, a retardation-film-attached single-side protected polarizing film (polarizing film (3)) was produced. The polarizing film (3) had the following structure: protective

film/adhesive layer/polarizer/adhesive layer/retardation film A.

[0130]

Example 1

(Production of Rubber-Based Composition)

A toluene solution (solid content:13%) of polyisobutylene (trade name: OPPANOL N50, manufactured by the BASF; Mw: 560000, Mn: 240000, Mw/Mn: 2.3) was prepared to obtain a rubber-based pressure-sensitive-adhesive composition (solution).

[0131]

(Production of Rubber-based Pressure-Sensitive Adhesive Sheet)

The pressure-sensitive adhesive composition (solution) produced above was applied onto a release-treated surface of a 38- μ m thickness polyester film (trade name: DIAFOIL MRF, manufactured by Mitsubishi Plastics, Inc.), this surface being a surface subjected to release treatment with silicone, to form an applied layer. Next, the applied layer was dried at 120°C for 3 minutes to form a pressure-sensitive adhesive layer. In this way, a pressure-sensitive adhesive sheet was produced in which the thickness of the pressure-sensitive adhesive layer was 50 μ m. The 38- μ m thickness polyester film (trade name: DIAFOIL MRF, manufactured by Mitsubishi Plastics, Inc.),

this surface being a surface subjected to release treatment with silicone, was bonded onto the pressure-sensitive adhesive surface of the pressure-sensitive adhesive sheet to bring the release-treated surface into contact with the pressure-sensitive adhesive layer. The polyester films, with which the two surfaces of the pressure-sensitive adhesive layer were coated, respectively, functioned as release liners (separators).

[0132]

Examples 2, 3

In each of the examples, a rubber-based pressure-sensitive adhesive sheet was produced in the same way as in Example 1 except that the polyisobutylene (OPPANOL N50) in Example 1 were changed to polyisobutylene described in Table 1.

[0133]

Example 4 (Production of Rubber-Based Composition)

A toluene solution (pressure-sensitive adhesive solution) into which the following were blended was prepared to give a solid content of 13% by weight: 100 parts by weight of a polyisobutylene (trade name: OPPANOL N50, manufactured by the BASF; Mw: 560000, Mn: 240000, Mw/Mn: 2.3) and 10 parts by weight of completely hydrogenated terpene phenol having a softening point of 135°C and a hydroxyl value of 160, as a tackifier. In this

way, a rubber-based pressure-sensitive-adhesive composition (solution) was prepared.

[0134]

A rubber-based pressure-sensitive adhesive sheet was produced in the same way as in Example 1 except that the rubber-based pressure-sensitive-adhesive composition produced above was used and a film thickness was 25 μm .

[0135]

Examples 5 to 7

In each of the examples, each rubber-based pressure-sensitive adhesive sheet was produced in the same way as in Example 4 except that a species of polyisobutylene, addition amount of the completely hydrogenated terpene phenol and a film thickness were changed those shown in Table 1.

[0136]

Example 8 (Production of Rubber-Based Composition)

A toluene solution (pressure-sensitive adhesive solution) into which the following were blended was prepared to give a solid content of 13% by weight: 100 parts by weight of a polyisobutylene (trade name: OPPANOL N80, manufactured by the BASF; Mw: 1050000, Mn: 440000, Mw/Mn: 2.4); 5 parts by weight of completely hydrogenated terpene phenol having a softening point of 135°C and a hydroxyl value of 160, as a tackifier; 5 parts by weight of

tricyclodecanedimethanol diacrylate (trade name: NK ESTER A-DCP, which is a bifunctional acrylate and is manufactured by Shin-Nakamura Chemical Co., Ltd.; molecular weight: 304) as a polyfunctional radical polymerizable compound; and 1 part by weight of benzophenone (manufactured by Wako Pure Chemical Industries, Ltd.) as a hydrogen-abstraction type photopolymerization initiator. In this way, a rubber-based pressure-sensitive-adhesive composition (solution) was prepared.

[0137]

(Production of Rubber-based Pressure-Sensitive Adhesive Sheet)

The rubber-based pressure-sensitive adhesive composition (solution) produced above was applied onto a release-treated surface of a 38- μ m thickness polyester film (trade name: DIAFOIL MRF, manufactured by Mitsubishi Plastics, Inc.), this surface being a surface subjected to release treatment with silicone, to form an applied layer. Next, the applied layer was dried at 80°C for 3 minutes to form a rubber-based pressure-sensitive-adhesive layer. In this way, a rubber-based pressure-sensitive adhesive sheet was produced in which the thickness of the pressure-sensitive adhesive layer was 50 μ m. The 38- μ m thickness polyester film (trade name: DIAFOIL MRF, manufactured by Mitsubishi Plastics, Inc.), this surface being a surface

subjected to release treatment with silicone, was bonded onto the pressure-sensitive adhesive surface of the pressure-sensitive adhesive sheet to bring the release-treated surface into contact with the rubber-based pressure-sensitive-adhesive layer. The polyester films, with which the two surfaces of the rubber-based pressure-sensitive-adhesive layer were coated, respectively, functioned as release liners (separators).

[0138]

Ultraviolet rays were radiated to the workpiece of the obtained rubber-based pressure-sensitive adhesive sheet at room temperature to yield a rubber-based pressure-sensitive adhesive sheet composed of the separator/the rubber-based pressure-sensitive-adhesive layer/the separator. About the ultraviolet ray radiation, the light quantity was 1000 mJ/cm² in a UVA band.

[0139]

Examples 9 to 13

In each of the examples, a rubber-based pressure-sensitive-adhesive sheet was produced in the same way as in Example 8 except that the composition was changed to a composition described in Table 1.

[0140]

Comparative Examples 1 to 3

In each of the examples, a rubber-based pressure-

sensitive-adhesive sheet was produced in the same way as in Example 1 except that the composition was changed to a composition described in Table 1.

[0141]

Comparative Example 4 (Production of Acryl-based Pressure-Sensitive Adhesive Sheet)

Into a separable flask equipped with a thermostat, a stirrer, a reflux condenser tube, and a nitrogen gas introducing tube were charged 99 parts by weight of butyl acrylate (BA), 1 part by weight of 4-hydroxybutyl acrylate (4HBA) as a monomer component, 0.2 part by weight of azobisisobutyronitrile as a polymerization initiator, and ethyl acetate as a polymerizing solvent to adjust the solid content therein to 20%. Nitrogen gas was then caused to flow into the flask to purge the inside of the flask with nitrogen for 1 hour while the component-system was stirred. Thereafter, the flask was heated to 60°C to cause the reactive components to react for 7 hours to yield an acryl-based polymer having a weight-average molecular weight (Mw) of 1100000. To the acryl-based polymer solution (solid content: 100 parts by weight) were added 0.8 part by weight of a trimethylolpropane tolylene diisocyanate (trade name: CORONATE L, manufactured by Nippon Polyurethane Industry Co., Ltd.) as an isocyanate-based crosslinking agent, and 0.1 part by weight of a silane coupling agent (trade name:

KBM-403, manufactured by Shin-Etsu Chemical Co., Ltd.) to prepare an acryl-based pressure-sensitive adhesive composition.

[0142]

The acryl-based pressure-sensitive adhesive composition produced above was applied onto a release-treated surface of a 38- μ m thickness polyester film (trade name: DIAFOIL MRF, manufactured by Mitsubishi Plastics, Inc.), this surface being a surface subjected to release treatment with silicone, to form an applied layer. Next, the applied layer was dried at 120°C for 3 minutes to form a pressure-sensitive-adhesive layer. In this way, a pressure-sensitive adhesive sheet was produced in which the thickness of the pressure-sensitive adhesive layer was 50 μ m. The 38- μ m thickness polyester film (trade name: DIAFOIL MRF, manufactured by Mitsubishi Plastics, Inc.), this surface being a surface subjected to release treatment with silicone, was bonded onto the pressure-sensitive adhesive surface of the pressure-sensitive adhesive sheet to bring the release-treated surface into contact with the pressure-sensitive-adhesive layer. In this way, an acryl-based pressure-sensitive-adhesive sheet was obtained. The polyester films, with which the two surfaces of the pressure-sensitive adhesive layer were coated, respectively, functioned as release liners (separators).

[0143]

About the pressure-sensitive adhesive composition and the pressure-sensitive adhesive sheets yielded in the working examples and the comparative examples, evaluations described below were made. Table 1 shows the results of the evaluation.

[0144]

<Endurance>

One of the release liners of any one of the pressure-sensitive adhesive sheets yielded in each of the working examples and the comparative examples was peeled off to make the pressure-sensitive adhesive surface thereof exposed. Through this pressure-sensitive adhesive surface, the pressure-sensitive adhesive sheet was bonded to the polarizer of any one of the polarizing films (1) yielded in Production Example 1. The other release liner was peeled off therefrom to yield a measuring sample 1 (single-side protected polarizing film).

[0145]

Moreover, one of the release liners of any one of the pressure-sensitive adhesive sheets yielded in each of the working examples and the comparative examples was peeled off to make the pressure-sensitive adhesive surface thereof exposed. Through this pressure-sensitive adhesive surface, the pressure-sensitive adhesive sheet was bonded to the

cycloolefin resin film of any one of the polarizing films (2). The other release liner was peeled off therefrom to yield a measuring sample 2 (double-side protected polarizing film).

[0146]

Furthermore, one of the release liners of any one of the pressure-sensitive adhesive sheets yielded in each of the working examples and the comparative examples was peeled off to make the pressure-sensitive adhesive surface thereof exposed. Through this pressure-sensitive adhesive surface, the pressure-sensitive adhesive sheet was bonded to the retardation film A of any one of the polarizing films (3). The other release liner was peeled off therefrom to yield a measuring sample 3 (retardation-film-attached single-side protected polarizing film).

[0147]

The obtained measuring samples 1 to 3 were bonded onto a glass plate respectively. This was put in an environment of 85°C temperature for 500 hours. Thereafter, the state thereof was observed with the naked eyes or through a loupe (x 20). The state was evaluated in accordance with the following evaluating criterion:

⊙: even when the sample is observed through the loupe, it is not found out that inconveniences (such as foaming and peel) are not caused.

○: such inconveniences cannot be verified with the naked eyes; however, an observation thereof with the loupe demonstrates the generation of slight inconveniences that do not cause any problem against the use of the sample.

×: inconveniences can be verified with the naked eyes.

[0148]

<Adhesive Displacement>

A loupe (x 20) was used to observe the state of the edge of each of the measuring samples 1 to 3 yielded in the endurance test after the sample was put in an environment of 85°C temperature for 500 hours. The sample was evaluated in accordance with the following evaluating criterion:

⊙: Adhesive displacement cannot be verified with the naked eyes; however, an observation thereof with the loupe demonstrates the generation of slight quantity of adhesive displacement that do not cause any problem against the use of the sample.

○: Adhesive displacement was verified with the naked eyes to such a degree that no inconvenience was caused.

×: Adhesive displacement was generated between the edge of the polarizing plate and the edge of the paste.

[0149]

<Moisture Permeability>

One of the release liners of the pressure-sensitive adhesive sheet yielded in each of the working examples and the comparative examples, was peeled off to make the pressure-sensitive adhesive surface exposed. By effect of this pressure-sensitive adhesive surface, the pressure-sensitive adhesive sheet was bonded onto a triacetylcellulose film (TAC film, manufactured by Konica Minolta, Ltd.; thickness: 25 μm). The other release liner was peeled off to yield a measuring sample.

[0150]

Next, this measuring sample was used to measure the moisture permeability (water vapor transmissibility) thereof in accordance with a moisture permeability testing method (cup method according to JIS Z 0208) under the following conditions:

Measuring temperature: 40°C,

Relative humidity: 92%, and

Measuring period: 24 hours.

In the measurement, a constant-temperature and constant-humidity chamber was used.

[0151]

[Table 1]

	Composition						Adhesive thickness (μm)	UV Radiation	Molecular weight of base polymer			Evaluation results																			
												Endurance (at 85°C for 500 h)			Generation of adhesive displacement (85°C x 500 h)																
	Polyisobutylene								Other polymer	Tackifier	Polyfunctional radical polymerizable compound		Photoinitiator	Moisture permeability (50 μm) at 40°C and 92% RH For 24 h (g/(m²·day))	Single-side protected polarizing film			Double-side protected polarizing film			Retardation-film-attached single-side protected polarizing film										
	OPANOL N50 (part(s) by weight)	OPANOL N80 (part(s) by weight)	OPANOL N100 (part(s) by weight)	OPANOL B50 (part(s) by weight)	OPANOL B80 (part(s) by weight)	OPANOL B100 (part(s) by weight)					A-DCP bifunctional (part(s) by weight)	DCP bifunctional (part(s) by weight)			Benzophenone hydrogen-attraction type (part(s) by weight)	Single-side protected polarizing film	Double-side protected polarizing film	Retardation-film-attached single-side protected polarizing film	Single-side protected polarizing film	Double-side protected polarizing film	Retardation-film-attached single-side protected polarizing film	Single-side protected polarizing film	Double-side protected polarizing film	Retardation-film-attached single-side protected polarizing film							
Example 1	100	-	-	-	-	-	-	-	-	-	-	50	Not done		560,000	240,000	2.3	○	○	○	○	○	○	○	○	○	○	○	○	○	
Example 2	-	100	-	-	-	-	-	-	-	-	-	50	Not done		1,050,000	440,000	2.4	9	○	○	○	○	○	○	○	○	○	○	○	○	○
Example 3	-	-	100	-	-	-	-	-	-	-	-	50	Not done	1,550,000	530,000	2.9	10	○	○	○	○	○	○	○	○	○	○	○	○	○	
Example 4	100	-	-	-	-	-	-	10	-	-	-	25	Not done	560,000	240,000	2.3	11	○	○	○	○	○	○	○	○	○	○	○	○	○	○
Example 5	-	-	100	-	-	-	-	1	-	-	-	50	Not done	1,550,000	530,000	2.9	10	○	○	○	○	○	○	○	○	○	○	○	○	○	○
Example 6	-	-	100	-	-	-	-	10	-	-	-	50	Not done	1,550,000	530,000	2.9	10	○	○	○	○	○	○	○	○	○	○	○	○	○	○
Example 7	-	-	100	-	-	-	-	20	-	-	-	50	Not done	1,550,000	530,000	2.9	10	○	○	○	○	○	○	○	○	○	○	○	○	○	○
Example 8	-	100	-	-	-	-	-	5	5	-	1	50	Done	1,050,000	440,000	2.4	11	○	○	○	○	○	○	○	○	○	○	○	○	○	○
Example 9	-	100	-	-	-	-	-	5	7.5	-	1	50	Done	1,050,000	440,000	2.4	11	○	○	○	○	○	○	○	○	○	○	○	○	○	○
Example 10	-	100	-	-	-	-	-	5	-	5	1	50	Done	1,050,000	440,000	2.4	12	○	○	○	○	○	○	○	○	○	○	○	○	○	○
Example 11	-	100	-	-	-	-	-	5	-	7.5	1	50	Done	1,050,000	440,000	2.4	11	○	○	○	○	○	○	○	○	○	○	○	○	○	○
Example 12	-	-	100	-	-	-	-	5	7.5	-	1	50	Done	1,550,000	530,000	2.9	11	○	○	○	○	○	○	○	○	○	○	○	○	○	○
Example 13	-	-	100	-	-	-	-	5	7.5	-	2	50	Done	1,550,000	530,000	2.9	11	○	○	○	○	○	○	○	○	○	○	○	○	○	○
Comparative Example 1	-	-	-	100	-	-	-	-	-	-	-	50	Not done	540,000	110,000	4.9	9	×	×	×	×	×	×	×	×	×	×	×	×	×	
Comparative Example 2	-	-	-	-	100	-	-	-	-	-	-	50	Not done	1,150,000	240,000	4.8	10	×	×	×	×	×	×	×	×	×	×	×	×	×	×
Comparative Example 3	-	-	-	-	-	100	-	-	-	-	-	50	Not done	1,700,000	370,000	4.6	10	×	×	×	×	×	×	×	×	×	×	×	×	×	×
Comparative Example 4	-	-	-	-	-	-	100	-	-	-	-	50	Not done	1,100,000	270,000	4	1000	○	○	○	○	○	○	○	○	○	○	○	○	○	○

[0152]

In Table 1, notations are as follows:

<Polyisobutylene>

OPPANOL N50 : polyisobutylene (Mw:560,000, Mn:240,000, Mw/Mn:2.3, manufactured by the BASF)

OPPANOL N80 : polyisobutylene (Mw:1,050,000, Mn:440,000, Mw/Mn:2.4, manufactured by the BASF)

OPPANOL N100 : polyisobutylene (Mw:1,550,000, Mn:530,000, Mw/Mn:2.9, manufactured by the BASF)

OPPANOL B50 : polyisobutylene (Mw:535,000, Mn:111,458, Mw/Mn:4.8, manufactured by the BASF)

OPPANOL B80 : polyisobutylene (Mw:1,150,000, Mn:239,583, Mw/Mn:4.8, manufactured by the BASF), and

OPPANOL B100 : polyisobutylene (Mw: 1,680,000, Mn:365,217, Mw/Mn:4.6, manufactured by the BASF).

<Other Polymer>

Acryl-based resin: acryl-based pressure-sensitive adhesive composition yielded in Comparative Example 4.

<Tackifier>

Completely hydrogenated terpene phenol:
completely hydrogenated terpene phenol having a softening point of 160°C and a hydroxyl value of 60.

<Polyfunctional Radical Polymerizable Compound>

A-DCP: tricyclodecanedimethanol diacrylate (trade name: NK ESTER A-DCP, manufactured by Shin-Nakamura

Chemical Co., Ltd.: a bifunctional acrylate; molecular weight: 304), and

DCP: tricyclodecanedimethanol diacrylate (trade name: NK ESTER DCP, manufactured by Shin-Nakamura Chemical Co., Ltd.: a bifunctional methacrylate; molecular weight: 332).

<Photopolymerization Initiator>

Benzophenone: hydrogen-abstraction type photopolymerization initiator.

DESCRIPTION OF REFERENCE SIGNS

[0153]

- 1 pressure-sensitive adhesive layer attached polarizing film
- 2 polarizing film
- 3 rubber-based pressure-sensitive-adhesive layer
- 4 polarizer
- 5 protective film
- 6 retardation film

CLAIMS

1. A rubber-based pressure-sensitive-adhesive composition, comprising a rubber-based base polymer; wherein

the rubber-based base polymer comprises an isobutylene-based polymer having a polydispersity ("weight-average molecular weight"/"number-average molecular weight") of 4 or less; and

a rubber-based pressure-sensitive-adhesive layer which is made from the rubber-based pressure-sensitive-adhesive composition and which has a thickness of 50 μm has a moisture permeability of 50 $\text{g}/(\text{m}^2\cdot\text{day})$ or less at 40°C and 92% R.H.

2. The rubber-based pressure-sensitive-adhesive composition according to claim 1, comprising a tackifier.

3. The rubber-based pressure-sensitive-adhesive composition according to claim 2, wherein the tackifier is at least one tackifier selected from the group consisting of a tackifier containing a terpene skeleton, a tackifier containing a rosin skeleton, and hydrogenated products of these tackifiers.

4. The rubber-based pressure-sensitive-adhesive composition according to claim 2 or 3, wherein the tackifier has a softening point of 90°C or higher.

5. The rubber-based pressure-sensitive-adhesive composition according to any one of claims 1 to 4, comprising a hydrogen-abstraction type photopolymerization initiator.

6. A rubber-based pressure-sensitive-adhesive layer, made from a rubber-based pressure-sensitive-adhesive composition according to any one of claims 1 to 5.

7. A pressure-sensitive adhesive film, comprising a support comprising a plastic substrate, and a rubber-based pressure-sensitive-adhesive layer as recited in claim 6 on at least one surface of the support.

8. A rubber-based pressure-sensitive-adhesive layer attached optical film, comprising an optical film, and a rubber-based pressure-sensitive-adhesive layer as recited in claim 6 on at least one surface of the optical film.

9. The rubber-based pressure-sensitive-adhesive layer attached optical film according to claim 8, wherein

the optical film is a polarizing film having a polarizer and a protective film on at least one surface of the polarizer.

10. The rubber-based pressure-sensitive-adhesive layer attached optical film according to claim 9, wherein the polarizing film is a single-side protected polarizing film having the polarizer and the protective film only on the one surface of the polarizer, and the rubber-based pressure-sensitive-adhesive layer, the polarizer, and the protective film are laminated in this order.

11. The rubber-based pressure-sensitive-adhesive layer attached optical film according to claim 10, wherein the rubber-based pressure-sensitive-adhesive layer attached optical film further comprises a retardation film, and

the rubber-based pressure-sensitive-adhesive layer, the retardation film, the polarizer, and the protective film are laminated in this order.

12. An optical member, comprising a film having a moisture permeability of $1 \text{ g}/(\text{m}^2\cdot\text{day})$ or less at 40°C and 92% R.H., and a rubber-based pressure-sensitive-adhesive

layer as recited in claim 6 on at least one surface of the film.

13. An image display device, comprising at least one rubber-based pressure-sensitive-adhesive layer attached optical film as recited in any one of claims 8 to 11, or at least one optical member as recited in claim 12.