

DESCRIPTION

LIGHT DIFFUSION FILM, METHOD FOR PRODUCING LIGHT DIFFUSION FILM, OPTICAL MEMBER, IMAGE DISPLAY DEVICE DISPLAY PANEL, AND IMAGE DISPLAY DEVICE

TECHNICAL FIELD

[0001] The present invention relates to a light diffusion film, a method for producing a light diffusion film, an optical member, a display panel for image display device, and an image display device.

BACKGROUND ART

[0002] In an image display device or the like using a back light, a light diffusion film is sometimes used in order to uniformize the amount of light throughout the entire screen to reduce display unevenness.

Citation List

Patent Literature

[0003] Patent Literature 1: JP H10(1998)-096922 A

SUMMARY OF INVENTION

Technical Problem

[0004] The light diffusion film has a problem that the light transmittance tends to be lowered when light diffusion property is to be increased.

[0005] With the foregoing in mind, it is an object of the present invention to provide a light diffusion film that can achieve both high light diffusion property and high light transmittance, a method for producing the light diffusion film, an optical member, a display panel for image display device, and an image display device.

Solution to Problem

[0006] In order to achieve the above object, the present invention provides a light diffusion film, including: a transparent base (A); and a light diffusion layer (B), wherein the light diffusion layer (B) is laminated on at least one side of the transparent base (A), asperities are formed on an outermost surface of the light diffusion film on a side of the light diffusion layer (B), and the asperities satisfy the following mathematical equations (1) and (2):

$$0.110 \leq S_m \quad (1)$$

$$R_{sk} \leq 0.200 \quad (2)$$

where in the mathematical equation (1), S_m is an average convex-to-convex distance (mm) of the asperities measured according to JIS B0601 (1994 edition), and in the mathematical equation (2), R_{sk} is a skewness of the asperities measured according to JIS B0601 (1994 edition).

5 [0007] The present invention also provides a method for producing the light diffusion film according to the present invention, including the steps of: forming a light diffusion layer (B) on a transparent base (A), and forming asperities on an outermost surface of the light diffusion film on a side of the light diffusion layer (B) so as to satisfy the mathematical equations (1) and (2), wherein the light diffusion layer (B) forming includes the steps of: coating a coating liquid on the
10 transparent base (A); and forming a coating film by drying the coated coating liquid, and the coating liquid contains a resin and a solvent.

[0008] The present invention also provides an optical member including the light diffusion film according to the present invention.

[0009] The present invention also provides a display panel for image display device including
15 the light diffusion film according to the present invention for use on a side opposite to a visual side of the display panel for image display device.

[0010] The present invention also provides an image display device, including: the light diffusion film according to the present invention; the optical member according to the present invention; or the display panel for image display device according to the present invention.

20 Advantageous Effects of Invention

[0011] The present invention can provide a light diffusion film that can achieve both high light diffusion property and high light transmittance, a method for producing the light diffusion film, an optical member, a display panel for image display device, and an image display device.

BRIEF DESCRIPTION OF DRAWINGS

25 [0012] [FIG. 1] FIG. 1 is a cross-sectional view showing an example of a configuration of a light diffusion film of the present invention.

DESCRIPTION OF EMBODIMENTS

[0013] Next, the present invention is described in detail with reference to examples. The present invention, however, is not limited thereto.

30 [0014] The light diffusion film of the present invention may have a luminous transmittance loss factor of 3.0% or less at a wavelength of 380 nm to 780 nm, for example.

[0015] In the light diffusion film of the present invention, for example, other layer may be further laminated on the surface of the light diffusion layer (B) on a side facing away from the transparent base (A).

[0016] The light diffusion film of the present invention may be, for example, a light diffusion film, including: a transparent base (A); a light diffusion layer (B); and other layer, wherein the light diffusion layer (B) and the other layer are laminated on at least one side of the transparent base (A), asperities are formed on an outermost surface of the other layer, and the asperities satisfy the following mathematical equations (1) and (2):

$$0.110 \leq S_m \quad (1)$$

$$R_{sk} \leq 0.200 \quad (2)$$

where in the mathematical equation (1), S_m is an average convex-to-convex distance (mm) of the asperities measured according to JIS B0601 (1994 edition), and

in the mathematical equation (2), R_{sk} is a skewness of the asperities measured according to JIS B0601 (1994 edition).

[0017] In the light diffusion film of the present invention, for example, the transparent base (A) may contain an acrylic resin.

[0018] In the light diffusion film of the present invention, for example, the transparent base (A) may be an acrylic film.

[0019] In the light diffusion film of the present invention, for example, the light diffusion layer (B) may contain a binder resin and a filler. The filler may be, for example, a particle. Further, a refractive index difference between the particle and the binder resin may be 0.200 or less, for example.

[0020] The light diffusion film of the present invention may include, for example, an intermediate layer containing a resin derived from the transparent base (A) and a resin derived from the light diffusion layer (B) between the transparent base (A) and the light diffusion layer (B).

[0021] The light diffusion film of the present invention may be, for example, a light diffusion film for use on a side opposite to a visual side of the display panel for image display device.

[0022] In the light diffusion film production method of the present invention, for example, the light diffusion layer (B) forming may further include the step of curing the coating film.

[0023] In the light diffusion film production method of the present invention, for example, the solvent may contain toluene and cyclopentanone.

[0024] In the light diffusion film production method of the present invention, for example, the light diffusion film may be a light diffusion film including the other layer and the asperities forming may include the step of forming the other layer on the light diffusion layer (B).

[0025] The image display device of the present invention may be, for example, an image display device including the display panel for image display device according to the present

invention and a backlight for the image display device.

[0026] [1. Light diffusion film]

As described above, the light diffusion film of the present invention is a light diffusion film, including: a transparent base (A); and a light diffusion layer (B), wherein the light diffusion layer (B) is laminated on at least one side of the transparent base (A), asperities are formed on an outermost surface of the light diffusion film on a side of the light diffusion layer (B), and the asperities satisfy the following mathematical equations (1) and (2):

$$0.110 \leq S_m \quad (1)$$

$$R_{sk} \leq 0.200 \quad (2)$$

where in the mathematical equation (1), S_m is an average convex-to-convex distance (mm) of the asperities measured according to JIS B0601 (1994 edition), and in the mathematical equation (2), R_{sk} is a skewness of the asperities measured according to JIS B0601 (1994 edition).

[0027] The light diffusion film of the present invention has a large S_m and a small R_{sk} . That is, the light diffusion film has asperities with gradual convex portions on the outermost surface on the side of the light diffusion layer (B). As a result, the light diffusion film of the present invention can achieve both high light diffusion property and high light transmittance.

[0028] A common light diffusion film has, for example, a short convex-to-convex spacing, a large valley component relative to the centerline of the surface level, and high convex portions and deep valleys in asperities of the surface in order to achieve light diffusion. This increases the loss of light and lowers the light transmittance. In this regard, the inventors of the present invention have found that by setting the S_m to be within the range of the mathematical equation (1) and setting the R_{sk} to be within the range of the mathematical equation (2), both high light diffusion and high light transmittance can be achieved. In the light diffusion film of the present invention, the S_m is as large as 0.110 or more, that is, the convex-to-convex spacing in asperities of the surface is long, and the R_{sk} is as small as 0.200 or less, which means that the components of the convex and valley in asperities of the surfaces are nearly equal, as will be described below. It is considered that since the light diffusion film has asperities with gradual convex portions on the outermost surface on the side of the light diffusion layer (B) as described above, the back surface reflection can be suppressed by reducing the surface area of asperities, thereby reducing the light loss and increasing the light transmittance.

[0029] FIG. 1 is a cross-sectional view showing an example of the configuration of a light diffusion film of the present invention. As shown in FIG. 1, in this light diffusion film 10, a light diffusion layer (B) 12 is laminated on one side of a transparent base (A) 11. In the light diffusion

layer (B) 12, particles 12b and a thixotropy-imparting agent 12c are contained in a resin layer 12a. The resin layer 12a is formed of a binder resin. The particles 12b and the thixotropy-imparting agent 12c serve as a filler. The light diffusion layer (B) 12 has asperities formed on the surface facing away from the transparent base layer (A) 11. The asperities satisfy the

5 mathematical equation (1) ($0.110 \leq S_m$) and the mathematical equation (2) ($R_{sk} \leq 0.200$).

However, the light diffusion film of the present invention is not limited thereto, and the light diffusion film may or may not contain the particles 12b and the thixotropy imparting agent 12c.

[0030] In the light diffusion film of the present invention, as described above, other layer may be laminated on the surface of the light diffusion layer (B) on the side facing away from the transparent base (A). However, the light diffusion film may or may not include the other layer.

10 When the light diffusion film includes the other layer, examples of the other layer include a pressure-sensitive adhesive layer, an adhesive layer, a low refractive index layer, a high refractive index layer, a conductive layer, a UV absorbing layer, an antifouling layer, a high hardness layer, a stress relaxation layer, and a primer layer. The other layer may be a single layer or the other layer may include a plurality of layers, and in the case of a plurality of layers, one
15 kind of the layers or two or more kinds of the same may be used. For example, the other layer may be a thin optical film whose thickness and refractive index are controlled strictly or the one including two or more of the thin optical films laminated together.

[0031] In the light diffusion film of the present invention, the "outermost surface on the side of the light diffusion layer (B)" is the outermost surface of the light diffusion film on the side of the
20 light diffusion layer (B). Specifically, the "outermost surface on the side of the light diffusion layer (B)" is a surface of the light diffusion layer (B) on the side facing away from the transparent base (A) when the light diffusion film includes no other layer (e.g., FIG. 1). The "outermost surface on the side of the light diffusion layer (B)" is the outermost surface of the
25 other layer on the side facing away from the transparent base (A) when the light diffusion film includes the other layer (not shown).

[0032] In the present invention, the S_m in the mathematical equation (1) is a quantity representing the average of the lengths of the contour curve elements in the reference length. The S_m in the mathematical equation (1) is a quantity measured according to JIS B0601 (1994
30 edition) as described above, and can be measured, for example, by the methods described in Examples below.

[0033] In the light diffusion film of the present invention, the S_m of the asperities on the outermost surface on the side of the light diffusion layer (B) is 0.110 or more as shown in the mathematical equation (1), and may be, for example, 0.120 or more, 0.130 or more, or 0.140 or

more. The upper limit value of the S_m is not particularly limited, and is, for example, 0.200 or less.

[0034] In the present invention, the R_{sk} (skewness) of the mathematical equation (2) represents the cube-mean of $Z(x)$ in the reference length which is non-dimensionalized by cubed root-mean-square height R_q . The skewness means the degree of distortion, and represents the symmetry of a convex portion and a valley portion when the mean line is taken as a center. $R_{sk} = 0$ indicates that the convex portion and the valley portion are symmetric (normal distribution) with respect to the mean line, $R_{sk} > 0$ indicates that the symmetry is biased downward with respect to the mean line, and $R_{sk} < 0$ indicates that the symmetry is biased upward with respect to the mean line. The R_{sk} in the mathematical equation (2) is a quantity measured according to JIS B0601 (1994 edition) as described above, and can be measured by, for example, the methods described in Examples below.

[0035] The R_{sk} of the asperities on the outermost surface of the light diffusion film of the present invention on the side of the light diffusion layer (B) is, as indicated in the mathematical equation (2), 0.200 or less, and may be, for example, 0.180 or less, 0.160 or less, or 0.120 or less. The lower limit value of the R_{sk} is not particularly limited, and is, for example, -0.200 or more.

[0036] The ten-point average surface roughness (also referred to as ten-point average height) R_z of the asperities on the outermost surface of the light diffusion film of the present invention on the side of the light diffusion layer (B) may be, for example, 1.700 or less, 1.200 or less, 1.000 or less, or 0.900 or less. The lower limit value of the R_z is not particularly limited, and may be, for example, 0.200 or more. The small R_z facilitates obtaining a higher light transmittance. The R_z can be measured by, for example, the measurement methods described in Examples below. The R_z can be represented, for example, by the sum of the average from the highest peak to the fifth highest peak of the contour curve and the average from the deepest valley to the fifth deepest valley in the reference length.

[0037] In the present invention, the light transmittance of the light diffusion film can be expressed, for example, by the luminous transmittance loss factor (luminous transmittance loss factor at wavelengths of 380 nm to 780 nm). The luminous transmittance loss factor may be expressed as a luminous transmittance loss factor with respect to a translucent base. The translucent base is, for example, a transparent plastic film base, and is a transparent base (A) in the light diffusion film of the present invention. The luminous transmittance loss factor can be calculated based on the following mathematical equation, assuming that the luminous transmittance Y of only the translucent base is Y_1 , and the luminous transmittance Y of the light diffusion film is Y_2 . The luminous transmittance loss factor can be measured and calculated by,

for example, the measurement methods and the calculation methods described in Examples below. Further, the luminous transmittance loss factor is not particularly limited, and may be, for example, 3.0% or less as described above, and may be 2.5% or less or 2.0% or less. The lower limit value of the luminous transmittance loss factor is not particularly limited, and may be, for example, 0% or a numerical value more than 0%.

Luminous transmittance loss factor (%) = $(Y1 - Y2) / Y1 \times 100$

[0038] In the light diffusion film of the present invention, the total haze value is not particularly limited, and may be, for example, 10% or more, 15% or more, 18% or more, or 20% or more, and may be, for example, 40% or less, 35% or less, 32% or less, or 28% or less. When the total haze value is high, the light diffusion tends to be high. When the total haze value is low, the light transmittance tends to be high. The haze value is an indicator relating to transparency of an optical film or the like, and indicates the turbidity (haze). Further, the haze value can be calculated from the proportion of the transmitted and diffused light with respect to the total transmitted light, and is affected by the roughness of the surface or the like. In the light diffusion film of the present invention, the total haze value can be defined, for example, by the following mathematical equation, and can be measured, for example, by the measurement methods described in Examples below.

Total haze value(%) = $Td / Tt \times 100$

Td: diffuse transmittance

Tt: total light transmittance

[0039] The transparent base (A), the light diffusion layer (B), and the other layer will be described below with further examples.

[0040] The transparent base (A) is not particularly limited, and may be, for example, a transparent plastic film base. The transparent plastic film base is not particularly limited and preferably has superior light transmittance of visible light (preferably, light transmittance of 90% or more) and superior transparency (preferably, haze value of 1% or less), and may be, for example, a transparent plastic film base described in JP 2008-90263 A. Specific examples of the material for forming the transparent plastic film base include polyester-based polymers such as polyethylene terephthalate (PET) and polyethylene naphthalate (PEN); cellulose-based polymers such as diacetyl cellulose (DAC) and triacetyl cellulose (TAC); polycarbonate-based polymers; and acrylic polymers such as polymethyl methacrylate. Examples of the material for forming the

transparent plastic film base include styrene-based polymers such as polystyrene and acrylonitrile-styrene copolymers; olefin-based polymers such as polyethylene, polypropylene, polyolefin having a cyclic or norbornene structure, and ethylen-propylene copolymers; vinyl chloride-based polymers; and amide-based polymers such as nylon and aromatic polyamides.

5 Further, examples of the material for forming the transparent plastic film base include imide-based polymers; sulfone-based polymers; polyether sulfone-based polymers; polyether ether ketone-based polymers, polyphenylene sulfide-based polymers; vinyl alcohol-based polymers; vinylidene chloride-based polymers, vinyl butyral-based polymers, allylate-based polymers; polyoxymethylene-based polymers; epoxy-based polymers, and blends of the above-mentioned
10 polymers. As the transparent plastic film base, a base having optically low birefringence is preferably used. The light diffusion film of the present invention can be used, for example, as a protective film in a polarizing plate, and in this case, a film formed of polyethylene terephthalate (PET), triacetyl cellulose (TAC), polycarbonate, an acrylic polymer, polyolefin having a cyclic or norbornene structure, or the like is preferred as the transparent plastic film base. In the present
15 invention, the transparent plastic film base may be a polarizer itself as described below. With such a configuration, it is possible to simplify the structure of the polarizing plate without the need for a protective layer made of TAC or the like, to reduce the number of steps of producing the polarizing plate or the image display device, and to improve the production efficiency. Further, with such a configuration, the polarizing plate can be thinner. In the case where the
20 transparent plastic film base is a polarizer, the light diffusion layer (B) and the low reflection layer (C) function as a protective layer. Further, with such a configuration, for example, the light diffusion film also functions as a cover plate in the case where the light diffusion film is attached to the surface of the liquid crystal cell.

[0041] In the present invention, the thickness of the transparent base (A) is not particularly
25 limited, and is, for example, in the range from 10 to 500 μm , from 20 to 300 μm , or from 30 to 200 μm from the viewpoint of strength, workability such as handleability, and film thinness, for example. The refractive index of the transparent base (A) is not particularly limited, and is in the range from 1.30 to 1.80 or from 1.40 to 1.70, for example.

[0042] In the light diffusion film of the present invention, for example, the transparent base (A)
30 may contain an acrylic resin, as described above.

[0043] In the light diffusion film of the present invention, for example, the transparent base (A) may be an acrylic film, as described above. In this case, the acrylic film forming the transparent base (A) may contain a resin other than an acrylic resin. The content of the acrylic resin contained in the transparent base (A) is not particularly limited, and may be, for example, 80%

by mass or more, 85% by mass or more, or 90% by mass or more, and the upper limit value is not particularly limited, and may be, for example, 100% by mass or less or 95% by mass or less.

[0044] In the light diffusion film of the present invention, for example, the light diffusion layer (B) may contain a resin (binder resin) and a filler. The filler may contain at least one of particles and a thixotropy-imparting agent (thixotropic agent).

[0045] For example, when the light diffusion layer (B) contains a thixotropy imparting agent without containing particles, it is possible to obtain a light diffusion film of the present invention whose outermost surface has asperities with gradual convex portions having small S_m and R_{sk} . Further, when the light diffusion layer (B) contains a thixotropy imparting agent and particles having a small particle size, it is also possible to obtain a light diffusion film of the present invention whose outermost surface has asperities with gradual convex portions having small S_m and R_{sk} .

[0046] In the light diffusion film of the present invention, for example, the resin contained in the light diffusion layer (B) may contain an acrylate resin (also referred to as an acrylic resin).

[0047] In the light diffusion film of the present invention, for example, the resin contained in the light diffusion layer (B) may contain a urethane acrylate resin.

[0048] In the light diffusion film of the present invention, for example, the resin contained in the light diffusion layer (B) may be a copolymer of a curable urethane acrylate resin and a polyfunctional acrylate.

[0049] In the light diffusion film of the present invention, for example, the light diffusion layer (B) is formed by using a light diffusion layer-forming material containing a resin and a filler, and the light diffusion layer (B) may have a flocculated portion forming a convex portion on the surface of the light diffusion layer (B) by flocculating the fillers. In addition, in the flocculated portion forming the convex portion, the fillers may be present in the state of being gathered in one direction in an in-plane direction of the light diffusion layer (B). In the image display device of the present invention, for example, the light diffusion film of the present invention may be disposed such that the one direction in which the fillers are gathered coincides with the long side direction of the black matrix pattern.

[0050] In the light diffusion film of the present invention, the thixotropy-imparting agent may be at least one selected from the group consisting of, for example, organoclay, oxidized polyolefin, and denatured urea. Further, the thixotropy-imparting agent may be, for example, a thickener.

[0051] The light diffusion film of the present invention may contain the thixotropy-imparting agent in the range from 0.2 to 5 parts by weight relative to 100 parts by weight (mass) of the

resin of the light diffusion layer (B), for example.

[0052] The light diffusion film of the present invention may contain the particles in the range from 0.2 to 12 parts by weight or 0.5 to 12 parts by weight relative to 100 parts by weight of the resin of the light diffusion layer (B), for example.

5 [0053] In the method for producing a light diffusion film of the present invention, further, the surface profile of the light diffusion film may be adjusted by adjusting the number of parts by weight of the particles relative to 100 parts by weight of the resin in the light diffusion layer-forming material.

[0054] By having a flocculated portion in which particles are flocculated, for example, the light
10 diffusion film of the present invention having asperities with gradual convex portions can be obtained. In addition, for example, by having the flocculated portion, the average convex-to-convex distance S_m (mm) of the surface of the light diffusion layer (B) becomes large. The light diffusion film having such a surface profile can effectively prevent reflected glare of a fluorescent lamp or the like. However, the light diffusion film of the present invention is not
15 limited thereto.

[0055] The light diffusion layer (B) is formed, for example, by coating a coating liquid containing the resin, the filler, and a solvent on at least one side of the transparent base (A) to form a coating film, and then removing the solvent from the coating film, as described below. Examples of the resin include a heat-curable resin and an ionizing radiation-curable resin which
20 is cured by ultraviolet rays and/or light. As the resin, a commercially available heat-curable resin and/or an ultraviolet-curable resin can also be used.

[0056] As the heat-curable resin and/or the ultraviolet-curable resin, a curable compound having at least one of an acrylate group and a methacrylate group cured by, for example, heat, light (ultraviolet or the like) and/or an electron beam can be used, and examples thereof include a
25 silicone resin, a polyester resin, a polyether resin, an epoxy resin, an urethane resin, an alkyd resin, a spiroacetal resin, a polybutadiene resin, a polythiol polyene resin, and an oligomer and/or a prepolymer of acrylate and/or methacrylate of a polyfunctional compound such as a polyhydric alcohol. One kind of them may be used alone or two or more kinds of them may be used in combination.

30 [0057] As the resin, a reactive diluent having at least one of an acrylate group and a methacrylate group can be used, for example. As the reactive diluent, reactive diluents described in JP 2008-88309 A can be used, and examples thereof include monofunctional acrylate, monofunctional methacrylate, polyfunctional acrylate, and polyfunctional methacrylate. As the reactive diluent, acrylate having a trifunctional group or more or methacrylate having a

trifunctional group or more is preferable because the hardness of the light diffusion layer (B) can be superior. Examples of the reactive diluent also include butanediol glycerin ether diacrylate, acrylate of isocyanuric acid, and methacrylate of isocyanuric acid. One kind of them may be used alone or two or more kinds of them may be used in combination.

5 [0058] The main function of the particles for forming the light diffusion layer (B) is to impart light diffusion properties by forming asperities on the surface of the light diffusion layer (B) and control the haze value of the light diffusion layer (B). The haze value of the light diffusion layer (B) can be designed by controlling the refractive index difference between the particle and the resin. The refractive index difference between the particle and the resin is not particularly
10 limited, and may be, for example, 0.200 or less as described above, and may be 0.150 or less, 0.100 or less, or 0.050 or less, and may be, for example, 0 or more, and may be a numerical value of more than 0, and may be 0.010 or more, 0.020 or more, or 0.030 or more. Examples of the particles include inorganic particles and organic particles. The inorganic particles are not particularly limited, and examples thereof include silicon oxide particles, titanium oxide
15 particles, aluminium oxide particles, zinc oxide particles, tin oxide particles, calcium carbonate particles, barium sulfate particles, talc particles, kaolin particles, and calcium sulfate particles. The organic particles are not particularly limited, and examples thereof include a polymethyl methacrylate resin powder (PMMA particles), a silicone resin powder, a polystyrene resin powder, a polycarbonate resin powder, an acrylic styrene resin powder, a benzoguanamine resin
20 powder, a melamine resin powder, a polyolefin resin powder, a polyester resin powder, a polyamide resin powder, a polyimide resin powder, and a polyfluoroethylene resin powder. One kind of the inorganic particles and organic particles may be used alone, or two or more kinds of the same may be used in combination.

[0059] The particle size (D) (weight-average particle size) of the particles is not particularly
25 limited, and is, for example, in the range from 2 to 10 μm . By setting the weight-average particle size of the particles within the above range, for example, it is possible to obtain a light diffusion film which is more excellent in light diffusion properties and suppressed from reflected glare. From the viewpoint of suppressing reflected glare from an oblique direction, it is preferable that the weight-average particle size of the particles be not too small. From the viewpoint of
30 suppressing reflected glare from the front direction, it is preferable that the weight-average particle size of the particles be not too large. The weight-average particulate size of the particles may be, for example, 2.2 μm or more, 2.3 μm or more, 2.5 μm or more, or 3.0 μm or more, and may be, for example, 9.0 μm or less, 8.0 μm or less, 7.0 μm or less, or 6.0 μm or less. The weight-average particle size of the particles may be, for example, 2.2 μm to 9.0 μm , 2.2 μm to

8.0 μm , 2.2 μm to 7.0 μm , 2.2 μm to 6.0 μm , 2.3 μm to 9.0 μm , 2.3 μm to 8.0 μm , 2.3 μm to 7.0 μm , 2.3 μm to 6.0 μm , 2.5 μm to 9.0 μm , 2.5 μm to 8.0 μm , 2.5 μm to 7.0 μm , 2.5 μm to 6.0 μm , 3.0 μm to 9.0 μm , 3.0 μm to 8.0 μm , 3.0 μm to 7.0 μm , or 3.0 μm to 6.0 μm . The weight-average particle size of the particles can be measured by the Coulter counter method, for example. For
5 example, a particle size distribution measurement apparatus (trade name: COULTER MULTISIZER, produced by Beckman Coulter, Inc.) using a pore electrical resistance method is employed to measure an electrical resistance of an electrolyte corresponding to the volume of the particles when the particles pass through the pores. Thus, the number and volume of fine particles are measured and then the weight-average particle size is calculated.

10 [0060] The shape of the particles is not particularly limited and may be, for example, an approximately spherical shape in the form of a bead or an indefinite shape such as a powder, and is preferably an approximately spherical shape, more preferably an approximately spherical shape with an aspect ratio of 1.5 or less. Most preferably, the particles are spherical particles.

[0061] The proportion of the particles in the light diffusion layer (B) may be, for example, 0.1
15 parts by weight or more, 0.2 parts by weight or more, 0.3 parts by weight or more, or 0.5 parts by weight or more, and may be 10 parts by weight or less, 8 parts by weight or less, 7 parts by weight or less, or 6 parts by weight or less, relative to 100 parts by weight of the resin. The proportion of the particles may be, for example, 0.1 to 10 parts by weight, 0.1 to 8 parts by weight, 0.1 to 7 parts by weight, 0.1 to 6 parts by weight, 0.2 to 10 parts by weight, 0.2 to 8 parts
20 by weight, 0.2 to 7 parts by weight, 0.2 to 6 parts by weight, 0.3 to 10 parts by weight, 0.3 to 8 parts by weight, 0.3 to 7 parts by weight, 0.3 to 6 parts by weight, 0.5 to 10 parts by weight, 0.5 to 8 parts by weight, 0.5 to 7 parts by weight, or 0.5 to 6 parts by weight, relative to 100 parts by weight of the resin. By setting the proportion of the particles within the above range, for example, the flocculated portion can be suitably formed, and a light diffusion film having more
25 excellent light diffusion properties and suppressed from reflected glare can be obtained, for example.

[0062] In the light diffusion layer (B), the filler may be particles and a thixotropy-imparting agent. The thixotropy-imparting agent may be contained alone or the thixotropy-imparting agent may be contained in addition to the particles. By containing the thixotropy-imparting agent, the
30 flocculated state of the particles can be easily controlled. Examples of the thixotropy-imparting agent include organoclay, oxidized polyolefin, and denatured urea.

[0063] The organoclay is preferably layered clay which has been subjected to an organification treatment in order to improve affinity with the resin. The organoclay may be prepared in-house or a commercially available product. Examples of the commercially available product include

LUCENTITE SAN, LUCENTITE STN, LUCENTITE SEN, LUCENTITE SPN, SOMASIF ME-100, SOMASIF MAE, SOMASIF MTE, SOMASIF MEE, and SOMASIF MPE (trade names, produced by CO-OP CHEMICAL Co. Ltd.); S-BEN, S-BEN C, S-BEN E, S-BEN W, S-BEN P, S-BEN WX, S-BEN N-400, S-BEN NX, S-BEN NX80, S-BEN NO12S, S-BEN NEZ, S-BEN NO12, S-BEN NE, S-BEN NZ, S-BEN NZ70, ORGANAIT, ORGANAIT D, and ORGANAIT T (trade names, produced by HOJUN Co., Ltd.); KUNIPIA F, KUNIPIA G, and KUNIPIA G4 (trade names, produced by Kunimine Industries, Co. Ltd.); and TIXOGEL VZ, CLAYTONE HT, and CLAYTONE 40 (trade names, produced by Rockwood Additives Limited).

[0064] The organoclay may be prepared in-house or a commercially available product. Examples of the commercially available product include DISPARON 4200-20 (trade name, produced by Kusumoto Chemicals, Ltd.) and FLOWNON SA300 (trade name, produced by KYOEISHA CHEMICAL Co., LTD).

[0065] The denatured urea is a reactant of an isocyanate monomer or an adduct thereof and organic amine. The denatured urea may be prepared in-house or a commercially available product. The commercially available product can be, for example, BYK410 (produced by BYK-Chemie Corporation).

[0066] One kind of the thixotropy-imparting agents may be used alone, or two or more kinds of the same may be used in combination.

[0067] The proportion of the thixotropy-imparting agent in the light diffusion layer (B) is preferably in the range from 0.2 to 5 parts by weight and more preferably from 0.4 to 4 parts by weight relative to 100 parts by weight of the resin.

[0068] The maximum thickness (d') of the light diffusion layer (B) is not particularly limited, and is preferably in the range from 3 to 12 μm . By setting the maximum thickness (d') of the light diffusion layer (B) within the above range, for example, generation of curling in the light diffusion film can be prevented, and a problem of lowering productivity such as poor conveyability can be avoided. In addition, when the thickness (d) is within the above range, it is preferable that the weight-average particle size (D) of the particles be within the range from 2 to 10 μm as described above. When the maximum thickness (d') of the light diffusion layer (B) and the weight-average particle size (D) of the particles are in the combination described above, a light diffusion film excellent in light diffusion properties can be obtained. The maximum thickness (d') of the light diffusion layer (B) is more preferably in the range from 3 to 8 μm .

[0069] The ratio D/d between the thickness (d') of the light diffusion layer (B) and the weight-average particle size (D) of the particles may be, for example, 1 or less, 0.9 or less, 0.8 or less,

0.7 or less, or 0.6 or less, and may be 0.1 or more, 0.2 or more, 0.3 or more, or 0.4 or more. The D/d may be, for example, 0.1 to 1, 0.2 to 1, 0.3 to 1, 0.4 to 1, 0.1 to 0.9, 0.2 to 0.9, 0.3 to 0.9, 0.4 to 0.9, 0.1 to 0.8, 0.2 to 0.8, 0.3 to 0.8, 0.4 to 0.8, 0.1 to 0.7, 0.2 to 0.7, 0.3 to 0.7, 0.4 to 0.7, 0.1 to 0.6, 0.2 to 0.6, 0.3 to 0.6, or 0.4 to 0.6. With such a relationship, it is possible to obtain a light diffusion film which is more excellent in light diffusion properties and suppressed from reflected glare.

[0070] In the light diffusion film according to the present invention, for example, the light diffusion layer (B) may have a flocculated portion forming a convex portion on the surface of the light diffusion layer (B) by flocculating the fillers, and in the flocculated portion forming the convex portion, the fillers may be present in the state of being gathered in one direction in an in-plane direction of the light diffusion layer (B). As a result, for example, the reflected glare of the fluorescent lamp can be prevented. The light diffusion film of the present invention is, however, not limited thereto.

[0071] The light diffusion film of the present invention may include, for example, an intermediate layer containing a resin derived from the transparent base (A) and a resin derived from the light diffusion layer (B) between the transparent base (A) and the light diffusion layer (B). By controlling the thickness of the intermediate layer, it is possible to control the surface profile of the light diffusion layer (B). For example, increasing the thickness of the intermediate layer tends to increase the S_m and R_{sk} , and decreasing the thickness of the intermediate layer tends to decrease the S_m and R_{sk} . The presence of the intermediate layer can be checked, for example, by observing the cross-section of the light diffusion film using a microscope. The thickness of the intermediate layer, the transparent base (A), and the light diffusion layer (B) can be measured by, for example, observing the cross-section of the light diffusion film using a microscope to specify the interface between the transparent base (A), the intermediate layer, and the light diffusion layer (B). The microscope may be, for example, a transmission electron microscope (TEM). The time-of-flight secondary ion mass spectrometry or the like may be used for specifying the interface, for example. Such a method can be used, for example, when the interface is difficult to be specified using a microscope.

[0072] In the present invention, the mechanism by which the intermediate layer (also referred to as a permeation layer and a compatibility layer) is formed is not particularly limited, and the intermediate layer is formed, for example, in the drying in the light diffusion film production method of the present invention. Specifically, for example, in the drying, a coating liquid for forming the light diffusion layer (B) penetrates into the transparent base (A), and the intermediate layer containing a resin derived from the transparent base (A) and a resin derived

from the light diffusion layer (B) is formed. The resin contained in the intermediate layer is not particularly limited, and for example, a resin contained in the transparent base (A) and a resin contained in the light diffusion layer (B) may be simply mixed (compatible). In addition, in the resin contained in the intermediate layer, for example, at least one of a resin contained in the transparent base (A) and a resin contained in the light diffusion layer (B) may be chemically changed by heating, light irradiation, or the like.

[0073] The thickness ratio R of the intermediate layer defined by the mathematical equation (5) below is not particularly limited, and may be, for example, in the range from 0.10 to 0.80, for example, and may be 0.15 or more, 0.20 or more, 0.25 or more, 0.30 or more, 0.40 or more, or 0.45 or more, and may be, for example, 0.75 or less, 0.70 or less, 0.65 or less, 0.60 or less, 0.50 or less, 0.40 or less, 0.45 or less, or 0.30 or less. The intermediate layer can be checked, and the thickness thereof can be measured, by observing the cross-section of the light diffusion film using a transmission electron microscope (TEM), for example.

$$R=[D_C/(D_C+D_B)] \quad (5)$$

In the mathematical equation (5), D_B is the thickness of the light diffusion layer (B), and D_C is the thickness of the intermediate layer.

[0074] As described above, in the light diffusion film according to the present invention, for example, the light diffusion layer (B) may have a flocculated portion forming a convex portion on the surface of the light diffusion layer (B) by flocculating the fillers, and in the flocculated portion forming the convex portion, the fillers may be present in the state of being gathered in one direction in an in-plane direction of the light diffusion layer (B). Thus, the convex portions become gradual convex portions having anisotropy. However, the light diffusion film of the present invention is not limited thereto.

[0075] The surface profile of the light diffusion layer (B) can also be designed freely by controlling the flocculated state of the fillers contained in the light diffusion layer-forming material. The flocculated state of the fillers can be controlled by, for example, the material of the filler (e.g., a chemical modification state of the surfaces of particles, an affinity for a solvent or a resin), the type, combination, or the like of a resin (binder) or a solvent. Further, the flocculated state of the particles can be precisely controlled by the thixotropy-imparting agent. As a result, in the present invention, the surface profile of the light diffusion film can be controlled (adjusted) in a wide range, for example, the flocculated state of the filler can be made as described above, and the convex portions can be made to be gradual convex portions. Further, as described above, it is

also possible to control (adjust) the surface profile of the light diffusion film in a wider range also by adjusting the number of parts by weight of the particles relative to 100 parts by weight of the resin in the light diffusion layer-forming material.

[0076] While the convex portions in the light diffusion film of the present invention may be gradual convex portions which can prevent the generation of a projection as a defect in outward appearance on the surface of the light diffusion layer (B), the present invention is not limited thereto. In addition, in the light diffusion film of the present invention, for example, some of the particles may be present in positions in which the particles directly or indirectly overlap in the thickness direction of the light diffusion layer (B), for example.

[0077] The other layer is not particularly limited, and examples thereof include a pressure-sensitive adhesive layer, an adhesive layer, a low refractive index layer, a high refractive index layer, a conductive layer, a UV absorbing layer, an antifouling layer, a high hardness layer, a stress relaxation layer, and a primer layer as described above. The other layer may be a single layer or the other layer may include a plurality of layers, and in the case of a plurality of layers, one kind of the layers or two or more kinds of the same may be used. For example, the other layer may be a thin optical film whose thickness and refractive index are controlled strictly or the one including two or more of the thin optical films laminated together.

[0078] [2. Light diffusion film production method]

The method for producing the light diffusion film of the present invention is not particularly limited and may be produced by any method, and is preferably produced by the light diffusion film production method of the present invention.

[0079] The light diffusion film production method can be performed, for example, as follows.

[0080] First, the light diffusion layer (B) is formed on the transparent base (A) so as to satisfy the mathematical equations (1) and (2) (light diffusion layer (B) forming). Thereby, a laminate of the transparent base (A) and the light diffusion layer (B) is produced. The light diffusion layer (B) forming includes the steps of: coating a coating liquid on the transparent base (A); and forming a coating film by drying the coated coating liquid as described above. Further, for example, as described above, the light diffusion layer (B) forming may further include the step of: curing the coating film. While the curing may be carried out, for example, after the drying, the present invention is not limited thereto. The curing can be performed, for example, by heating, light irradiation, or the like. The light is not particularly limited, and may be, for example, ultraviolet rays or the like. The light source of the light irradiation is not particularly limited, and may be, for example, a high-pressure mercury lamp or the like.

[0081] The coating liquid includes a resin and a solvent as described above. The coating liquid

may be, for example, a light diffusion layer-forming material (coating liquid) containing the resin, particles, thixotropy-imparting agent, and solvent.

[0082] The coating liquid preferably exhibits thixotropic properties, and the T_i value defined by the following mathematical equation is preferably in the range from 1.3 to 3.5, more preferably in the range from 1.4 to 3.2, and still more preferably in the range from 1.5 to 3.

$$T_i \text{ value} = \beta_1/\beta_2$$

In the above mathematical equation, β_1 is a viscosity at the shear rate of 20 (1/s) measured using RHEOSTRESS RS6000 produced by HAAKE, and β_2 is a viscosity at the shear rate of 200 (1/s) measured using RHEOSTRESS RS6000 produced by HAAKE.

[0083] When the T_i value is 1.3 or more, problems of a defect in outward appearance and deterioration in characteristics of light diffusion properties and white blur are unlikely to occur. When the T_i value is 3.5 or less, a problem that the particles are in the dispersed state in which the particles are not flocculated or the like is unlikely to occur.

[0084] Further, while the coating liquid may or may not contain a thixotropy-imparting agent, it is preferable to contain a thixotropy-imparting agent because it tends to exhibit thixotropy.

Further, as described above, when the coating liquid contains the thixotropy-imparting agent, an effect (thixotropy effect) of preventing sedimentation of the particles can be obtained. Further, it is also possible to freely control the surface profile of the light diffusion film in a wider range by shear flocculation of the thixotropy-imparting agent itself. As described above, for example, when the coating liquid contains a thixotropy imparting agent without containing particles, it is possible to obtain a light diffusion film of the present invention whose outermost surface has asperities with gradual convex portions having small S_m and R_{sk} . Further, when the coating liquid contains a thixotropy imparting agent and particles having a small particle size, it is also possible to obtain a light diffusion film of the present invention whose outermost surface has asperities with gradual convex portions having small S_m and R_{sk} .

[0085] The solvent is not particularly limited, and various solvents can be used. One kind of the solvents may be used alone or two or more kinds of the same may be used in combination. In order to obtain the light diffusion film of the present invention in accordance with the composition of the resin, the types of the particles and the thixotropy-imparting agents, and the contents thereof, there are an optimum solvent type and an optimum solvent ratio. The solvent is not particularly limited, and examples thereof include alcohols such as methanol, ethanol, isopropyl alcohol, butanol, and 2-methoxyethanol; ketones such as acetone, methylethylketone,

methylisobutylketone, and cyclopentanone; esters such as methyl acetate, ethyl acetate, and butyl acetate; ethers such as diisopropyl ether and propyleneglycol monomethylether; glycols such as ethyleneglycol and propyleneglycol; cellosolves such as ethyl cellosolve and butyl cellosolve; aliphatic hydrocarbons such as hexane, heptane, and octane; and aromatic hydrocarbons such as benzene, toluene, and xylene. Further, for example, the solvent may contain a hydrocarbon solvent and a ketone solvent. The hydrocarbon solvent may be, for example, an aromatic hydrocarbon. The aromatic hydrocarbon may be, for example, at least one selected from the group consisting of toluene, o-xylene, m-xylene, p-xylene, ethylbenzene, and benzene. The ketone solvent may be, for example, at least one selected from the group consisting of cyclopentanone, acetone, methyl ethyl ketone, methyl isobutyl ketone, diethyl ketone, cyclohexanone, isophorone, and acetophenone. The solvent may be, for example, a solvent obtained by mixing the hydrocarbon solvent and the ketone solvent in a mass ratio of 90:10 to 10:90. The mass ratio of the hydrocarbon solvent to the ketone solvent may be, for example, 80:20 to 20:80, 70:30 to 30:70, or 40:60 to 60:40, and the like. In this case, for example, the hydrocarbon solvent may be toluene and the ketone solvent may be cyclopentanone.

[0086] In the case where an acrylic film is employed as the transparent base (A) to form an intermediate layer (permeation layer), a good solvent for an acrylic film (acrylic resin) can be suitably used, for example. As a solvent thereof, for example, a solvent containing a hydrocarbon solvent and a ketone solvent may be used as described above. The hydrocarbon solvent may be, for example, an aromatic hydrocarbon. The aromatic hydrocarbon may be, for example, at least one selected from the group consisting of toluene, o-xylene, m-xylene, p-xylene, ethylbenzene, and benzene. The ketone solvent may be, for example, at least one selected from the group consisting of cyclopentanone, acetone, methyl ethyl ketone, methyl isobutyl ketone, diethyl ketone, cyclohexanone, isophorone, and acetophenone. The solvent may be, for example, a solvent obtained by mixing the hydrocarbon solvent and the ketone solvent in a mass ratio of 90:10 to 10:90. The mass ratio of the hydrocarbon solvent to the ketone solvent may be, for example, 80:20 to 20:80, 70:30 to 30:70, or 40:60 to 60:40, and the like. In this case, for example, the hydrocarbon solvent may be toluene and the ketone solvent may be cyclopentanone.

[0087] In the case of containing a thixotropy-imparting agent, the light diffusion layer-forming material (coating liquid) can favorably have thixotropy by selecting a solvent as appropriate. For example, in the case of using organoclay, toluene and xylene can be suitably used alone or in combination. For example, in the case of using oxidized polyolefin, methyl ethyl ketone, ethyl acetate, and propylene glycol monomethyl ether can be suitably used alone or in combination.

For example, in the case of using denatured urea, butyl acetate and methyl isobutyl ketone can be suitably used alone or in combination.

[0088] Various leveling agents can be added to the light diffusion layer-forming material. For the purpose of preventing unevenness in coating (for the purpose of causing a surface to be evenly coated), a fluorine-based leveling agent or a silicone-based leveling agent can be used as the leveling agent, for example. In the present invention, a leveling agent can be selected as appropriate according to the case where the surface of the light diffusion layer (B) is required to have antifouling properties, the case where a low reflection layer (low refractive index layer) and/or a layer containing intermediate layer fillers is formed on the light diffusion layer (B) as described below. In the present invention, for example, the coating liquid can have thixotropic properties by causing the coating liquid to contain thixotropy-imparting agents. Therefore, the unevenness in coating is less prone to occur. In this case, for example, the present invention has an advantage of widening the choice of the leveling agents.

[0089] The amount of the leveling agent to be blended is not particularly limited, and is preferably in the range from 0.3 to 5 parts by weight, and more preferably 0.5 to 5 parts by weight with respect to 100 parts by weight of the resin.

[0090] A pigment, a filler, a dispersant, a plasticizer, a UV absorber, a surfactant, an antifouling agent, an antioxidant, or the like may be added to the light diffusion layer-forming material to the extent of not impairing functions of the coating liquid. One kind of the additives may be used alone or two or more kinds of the same may be used in combination.

[0091] Any of conventionally known photoinitiators described in JP 2008-88309 A can be used in the light diffusion layer-forming material, for example.

[0092] As a method for forming a coating film by coating the coating liquid on the transparent base (A), a coating method such as a fountain coating method, a die coating method, a spin coating method, a spray coating method, a gravure coating method, a roller coating method, or a bar coating method can be used, for example.

[0093] Next, as described above, the coating film is dried and cured to form a light diffusion layer (B). The drying may be, for example, natural drying, air drying by blowing air, heat drying, or a combination thereof.

[0094] The drying temperature of the coating liquid for forming the light diffusion layer (B) may be, for example, in a range from 30 to 200°C. The aforementioned drying temperature may be 40°C or more, 50°C or more, 60°C or more, 70°C or more, 80°C or more, 90°C or more, or 100°C or more, for example, and 190°C or less, 180°C or less, 170°C or less, 160°C or less, 150°C or less, 140°C or less, 135°C or less, 130°C or less, 120°C or less, or 110°C or less. The

drying time is not particularly limited, and may be, for example, 30 seconds or longer, 40 seconds or longer, 50 seconds or longer, or 60 seconds or longer, and may be 150 seconds or shorter, 130 seconds or shorter, 110 seconds or shorter, or 90 seconds or shorter.

[0095] The way of curing the coating film is not particularly limited and is preferably

5 ultraviolet curing. The amount of irradiation with the energy radiation source is preferably from 50 to 500 mJ/cm² in terms of accumulative exposure at the ultraviolet wavelength of 365 nm.

With the amount of irradiation of at least 50 mJ/cm², the coating film is cured more sufficiently, and the resultant light diffusion layer (B) has more sufficient hardness. Moreover, with the amount of irradiation of 500 mJ/cm² or less, the resultant light diffusion layer (B) can be
10 prevented from being colored.

[0096] As described above, a laminate of the transparent base (A) and the light diffusion layer (B) can be produced. This laminate may be used as it is as a light diffusion film of the present invention, or may be used as a light diffusion film of the present invention, for example, by forming the other layer on the light diffusion layer (B). The method for forming the other layer is
15 not particularly limited, and may be performed in the same manner as or according to a general method for forming an optical layer, or the like, for example.

[0097] As described above, the light diffusion film of the present invention in which the light diffusion layer (B) is laminated on at least one side of the transparent base (A) can be produced. Note that, as described above, the light diffusion film may include other layer other than the
20 transparent base (A) and the light diffusion layer (B).

[0098] In addition, in the step of producing the antireflection film of the present invention, it is preferable that at least one of the transparent base (A) and the light diffusion layer (B) be subjected to surface treatment. If the surface of the transparent base (A) is subjected to surface treatment, the adhesiveness to the light diffusion layer (B) or the polarizer or the polarizing plate
25 is further improved. In addition, if the surface of the light diffusion layer (B) is subjected to surface treatment, for example, the adhesiveness to the other layer is further improved.

[0099] [3. Optical member and image display device]

The optical member of the present invention is not particularly limited, and may be, for example, a polarizing plate. The polarizing plate is also not particularly limited, and may include,
30 for example, a light diffusion film of the present invention and a polarizer, or may further include other components. Each of the components of the polarizing plate may be bonded by, for example, an adhesive or a pressure-sensitive adhesive.

[0100] The image display device of the present invention is not particularly limited, and any image display device may be used, and examples thereof include a liquid crystal display device,

an organic EL display device, and a quantum dot display device.

[0101] For example, as described above, the light diffusion film of the present invention may be used on a side opposite to a visual side of a display panel for image display device.

Specifically, for example, the light diffusion film of the present invention may be bonded to the side opposite to the visual side of the display panel for image display device with an adhesive, a pressure-sensitive adhesive, or the like. In this case, the light diffusion film of the present invention may be used alone, for example, or may be used as the optical member (e.g., the polarizing plate) of the present invention including other components. The image display device of the present invention may include, for example, the display panel for image display device and a backlight for the image display device. Specifically, for example, the light diffusion film of the present invention or the optical member of the present invention may be attached to the side opposite to the visual side of the display panel for image display device and the backlight for the image display device may be disposed on the side opposite to the visual side of the display panel for image display device. The light diffusion film has asperities with gradual convex portions on the outermost surface on the side of the light diffusion layer (B), as described above. Thus, the light diffusion film of the present invention can suppress or prevent damage to the back light surface for the image display device due to the asperities, for example. The image display device of the present invention, however, is not limited thereto.

[0102] The image display device of the present invention may be, for example, an image display device having the light diffusion film of the present invention on the viewing side surface, and the image display device may have a black matrix pattern.

[0103] Generally, the transparent base (A) side of the light diffusion film of the present invention can be attached to an optical member used in LCD via a pressure-sensitive adhesive or an adhesive, for example. In order to perform the attachment, the transparent base (A) may be subjected to any of the above-mentioned surface treatments. As described above, according to the light diffusion film production method of the present invention, the surface profile of the light diffusion film can be freely controlled in a wide range. Therefore, the optical characteristics that can be obtained by laminating the light diffusion film with other optical member using an adhesive, a pressure-sensitive adhesive, or the like are in a wide range corresponding to the surface profile of the light diffusion film.

[0104] The optical member can be, for example, a polarizer or a polarizing plate, for example. The polarizing plate is generally configured to include a transparent protective film on one or both sides of the polarizer. When a transparent protective film is provided on both sides of the polarizer, the front and back transparent protective films may be formed of the same material or

different materials. Polarizing plates are generally placed on both sides of a liquid crystal cell and is placed so that the absorption axes of two polarizing plates are substantially orthogonal to each other.

[0105] The configuration of the polarizing plate on which the light diffusion film has laminated is not particularly limited and may be, for example, a configuration obtained by laminating a transparent protective film, the polarizer, and the transparent protective film on the light diffusion film in this order or a configuration obtained by laminating the polarizer and the transparent protective film on the light diffusion film in this order.

[0106] The configuration of the image display device according to the present invention is the same as that of the conventional image display device except that the light diffusion film is disposed. For example, in the case of a LCD, the image display device can be produced by incorporating a driving circuit through appropriately assembling components such as a liquid crystal cell, an optical member such as a polarizing plate, and if necessary, a lighting system (backlight or the like).

[0107] The image display device of the present invention may be used for any suitable applications. Examples of the applications include office automation equipment such as a PC monitor, a notebook PC, and a copy machine, portable devices such as a mobile phone, a watch, a digital camera, a personal digital assistant (PDA), and a handheld game machine, home electric appliances such as a video camera, a television set, and a microwave oven, vehicle equipment such as a back monitor, a monitor for a car-navigation system, and a car audio device, display equipment such as an information monitor for stores, security equipment such as a surveillance monitor, and nursing and medical equipment such as a monitor for nursing care and a monitor for medical use.

Examples

[0108] Next, Examples of the present invention are described together with Comparative Examples. The present invention, however, is not limited by Examples and Comparative Examples.

[0109] Example 1

60 parts by weight of pentaerythritol triacrylate (PETA; trade name: "Viscoat #300", produced by OSAKA ORGANIC CHEMICAL INDUSTRY LTD) and 40 parts by weight of urethane acrylate prepolymer (trade name: "UA-53H-80BK", produced by SHIN-NAKAMURA CHEMICAL CO, LTD.) as a binder resin, 4 parts by weight of silicone particles (trade name: "Tospal 130", produced by Momentive Performance Materials Inc., weight-average particle size: 3 μ m, ID90-D50: 2.5 μ m), 2.5 parts by weight of synthetic smectite (trade name: "SUMECTON-

SAN", produced by Kunimine Industries, Co. Ltd.) which is an organoclay, 5 parts by weight of a photopolymerization initiator (trade name: "IRGACURE 907" produced by BASF Co., Ltd.), and 1.0 parts by weight of a leveling agent (trade name: "PC4100", produced by DIC

Corporation, solid content : 10%) were mixed and diluted with a toluene/cyclopentanone (CPN) mixed solvent (weight ratio toluene/cyclopentanone = 70/30) to prepare a light diffusion layer-forming composition I having a solid concentration of 31.5% by weight. Note that the organoclay was used by diluting with toluene so that the solid content became 6% by weight.

[0110] Further, the above-mentioned light diffusion layer-forming composition I was applied to a transparent plastic film base (acrylic film, trade name: "HX-40UC", produced by Toyo Kohan Co.,Ltd., thickness: 40 μm , refractive index: 1.50, luminous transmittance of a single base: 94.0%) using a wire bar, heated at 90°C for 1 minute, and then irradiated with ultraviolet having an accumulated light amount of 300 mJ/cm^2 using a high-pressure mercury lamp.

In this manner, a light diffusion film in which a light diffusion layer (B) (thickness: 5.7 μm) was laminated on one side of a transparent base (A), and an intermediate layer containing a resin derived from the transparent base (A) and a resin derived from the light diffusion layer (B) was formed between the transparent base (A) and the light diffusion layer (B) was obtained. Note that, the presence of the intermediate layer was checked by observing the cross-section of the light diffusion film using a transmission electron microscope (TEM) in the present example and in all of the following Examples and Comparative Examples.

[0111] Example 2

The light diffusion film was obtained in the same manner as in Example 1 except that the light diffusion layer was formed to have a thickness of 6.3 μm .

[0112] Example 3

The light diffusion film was obtained in the same manner as in Example 1 except that the light diffusion layer was formed to have a thickness of 6.9 μm .

[0113] Example 4

The light diffusion film was obtained in the same manner as in Example 1 except that the light diffusion layer was formed to have a thickness of 7.3 μm .

[0114] Example 5

The light diffusion film was obtained in the same manner as in Example 1 except that the heating time after coating of the light diffusion layer-forming composition I was changed from 1 minute to 30 seconds.

[0115] Example 6

The light diffusion film was obtained in the same manner as in Example 5 except that

the light diffusion layer was formed to have a thickness of 6.3 μm .

[0116] Example 7

The light diffusion film was obtained in the same manner as in Example 5 except that the light diffusion layer was formed to have a thickness of 6.9 μm .

5 [0117] Example 8

The light diffusion film was obtained in the same manner as in Example 5 except that the light diffusion layer was formed to have a thickness of 7.3 μm .

[0118] Example 9

The light diffusion film was obtained in the same manner as in Example 1 except that a
10 PET film (trade name: "ASTROLL CE900", produced by Kolon Industries Inc., thickness: 38 μm , refractive index: 1.64, luminous transmittance of a single base: 88.3%) was used as a transparent plastic film base (transparent base (A)) instead of the acrylic film of Example 1.

[0119] Example 10

The light diffusion film was obtained in the same manner as in Example 1 except that
15 TAC (trade name: "KC4UY", produced by KONICA MINOLTA, INC., thickness: 40 μm , refractive index: 1.50, luminous transmittance of a single base: 92.4%) was used as a transparent plastic film base (transparent base (A)) instead of the acrylic film of Example 1.

[0120] Comparative Example 1

60 parts by weight of pentaerythritol triacrylate (PETA; trade name: "Viscoat #300",
20 produced by OSAKA ORGANIC CHEMICAL INDUSTRY LTD) and 40 parts by weight of urethane acrylate prepolymer (trade name: "UA-53H-80BK", produced by SHIN-NAKAMURA CHEMICAL CO, LTD.) as a binder resin, 4 parts by weight of organic particles (trade name: "SSX1055QXE", produced by SEKISUI PLASTICS Co., Ltd., weight-average particle size: 5.5 μm), 2.5 parts by weight of synthetic smectite (trade name: "SUMECTON-SAN", produced by
25 Kunimine Industries, Co. Ltd.) which is an organoclay, 5 parts by weight of a photopolymerization initiator (trade name: "IRGACURE 907" produced by BASF Co., Ltd.), and 1.0 parts by weight of a leveling agent (trade name: "PC4100", produced by DIC Corporation, solid content : 10%) were mixed and diluted with a toluene/methyl ethyl ketone mixed solvent (weight ratio toluene/methyl ethyl ketone = 70/30) to prepare a light diffusion
30 layer-forming composition II having a solid concentration of 32% by weight. Note that the organoclay was used by diluting with toluene so that the solid content became 6% by weight.

[0121] Further, the above-mentioned light diffusion layer-forming composition II was applied to the same transparent plastic film base as Example 1 using a wire bar, heated at 90°C for 1 minute, and then irradiated with ultraviolet having an accumulated light amount of 300 mJ/cm^2

using a high-pressure mercury lamp. In this manner, a light diffusion film having a transparent base layer and a light diffusion layer (thickness: 5.7 μm) and an intermediate layer formed therebetween was obtained.

[0122] Comparative Example 2

5 The light diffusion film was obtained in the same manner as in Comparative Example 1 except that the light diffusion layer was formed to have a thickness of 5.9 μm .

[0123] Comparative Example 3

 The light diffusion film was obtained in the same manner as in Comparative Example 1 except that the light diffusion layer was formed to have a thickness of 6.2 μm .

10 [0124] Comparative Example 4

 The light diffusion film was obtained in the same manner as in Comparative Example 1 except that the light diffusion layer was formed to have a thickness of 6.3 μm .

[0125] Comparative Example 5

15 The light diffusion film was obtained in the same manner as in Comparative Example 1 except that the light diffusion layer was formed to have a thickness of 6.5 μm .

[0126] Comparative Example 6

 50 parts by weight of pentaerythritol triacrylate (PETA; trade name: "Viscoat #300", produced by OSAKA ORGANIC CHEMICAL INDUSTRY LTD) and 50 parts by weight of urethane acrylate prepolymer (trade name: "UA-53H-80BK", produced by SHIN-NAKAMURA
20 CHEMICAL CO, LTD.) as a binder resin, 3.5 parts by weight of silicone particles (trade name: "Tospal 130", produced by Momentive Performance Materials Inc., weight-average particle size: 3 μm , ID90-D50: 2.5 μm , refractive index: 1.42), 2 parts by weight of synthetic smectite (trade name: "LUCENTITE SAN ", produced by CO-OP CHEMICAL Co. Ltd.) which is an organoclay, 3 parts by weight of a photopolymerization initiator (trade name: "IRGACURE 907"
25 produced by BASF Co., Ltd.), and 0.2 parts by weight of a leveling agent (trade name: "PC4100", produced by DIC Corporation, solid content : 10%) were mixed and diluted with a toluene/cyclopentanone (CPN) mixed solvent (weight ratio toluene/cyclopentanone = 70/30) to prepare a light diffusion layer-forming composition III having a solid concentration of 33% by weight. Note that the organoclay was used by diluting with toluene so that the solid content
30 became 6% by weight.

[0127] Next, the above-mentioned light diffusion layer-forming composition III was applied to a triacetyl cellulose (TAC) film (trade name: "KC4UA", produced by Konica Minolta Opto, Inc., thickness: 40 μm) using a comma coater®, heated at 80°C for 1 minute, and then irradiated with ultraviolet having an accumulated light amount of 300 mJ/cm^2 using a high-pressure mercury

lamp. In this manner, a light diffusion film including a transparent base layer and a light diffusion layer (thickness: 6.3 μm) and an intermediate layer formed therebetween was obtained.

[0128] The characteristics of the light diffusion films of Examples and Comparative Examples prepared as described above were measured as follows.

5 [0129] [Asperities (Sm/Rsk/Rz) on surface of light diffusion layer]

In accordance with JIS B0601 (1994 edition), the average convex-to-convex distance Sm (mm), the skewness Rsk, and the ten-point average surface roughness Rz (μm) were measured. Specifically, first, a glass plate (produced by Matsunami Glass Ind., Ltd., MICRO SLIDE GLASS, Part No.: S, thickness: 1.3 mm, 45×50 mm) was bonded to the surface of the transparent base of the light diffusion film on the side facing away from the light diffusion layer to prepare a sample. Next, using a stylus-type surface roughness measuring instrument having a measuring needle having a radius of curvature R = 2 μm of the tip portion (diamond) (produced by Kosaka Laboratory Ltd., high-precision microfigure measuring instrument, trade name: "SURFCORDER ET4000"), under a scanning speed of 1 mm/sec, a cut-off value of 0.8 mm, and a measuring length of 12 mm, the surface profile of the light diffusion layer in the sample was measured in a constant direction, and the average convex-to-convex distance Sm (mm), the ten-point average surface roughness Rz (μm), and the skewness Rsk were measured. The high-precision microfigure measuring instrument automatically calculates each measured value.

15 [0130] [Luminous transmittance loss factor]

20 Using a spectrophotometer (trade name: "U-4100") produced by Hitachi High-Tech Corporation, the transmittance spectrum of each of the light diffusion films of Examples and Comparative Examples was measured at a wavelength in the range from 380 nm to 780 nm, and the luminous transmittance Y was automatically calculated. In addition, the transmittance spectrum was measured in the same manner for only the transparent plastic film base (without forming the light diffusion layer and the intermediate layer), and the luminous transmittance Y was automatically calculated. The luminous transmittance loss factor was calculated based on the following mathematical equation, assuming that the luminous transmittance Y of only the transparent plastic film base was Y1, and the luminous transmittance Y of each of the light diffusion films of Examples and Comparative Examples was Y2.

30

$$\text{Luminous transmittance loss factor (\%)} = (Y1 - Y2) / Y1 \times 100$$

[0131] [Total Haze]

The total haze was measured according to the haze (cloudiness) of JIS K 7136 (2000 edition) using a haze meter (trade name: "HM-150", produced by MURAKAMI COLOR

RESEARCH LABORATORY).

[0132] The characteristics of the light diffusion films of Examples and Comparative Examples measured as described above are summarized in Table 1 below. Incidentally, in Table 1 below, the unit of the average convex-to-convex distance S_m is mm, the skewness R_{sk} has no unit, the

5 unit of the ten-point average surface roughness R_z is μm , and the unit of the total haze is %.

[0133] Table 1

	Base	Sm	Rsk	Luminous transmittance loss factor	Rz	Total haze
Example 1	Acryl	0.141	0.161	1.60%	0.832	22.8
Example 2	Acryl	0.139	0.1819	2.20%	0.993	24.3
Example 3	Acryl	0.149	0.086	1.50%	0.980	25.1
Example 4	Acryl	0.159	0.050	1.80%	1.140	26.8
Example 5	Acryl	0.121	0.154	2.20%	0.806	23.9
Example 6	Acryl	0.128	0.160	2.70%	0.823	24.7
Example 7	Acryl	0.128	0.161	2.70%	0.853	25.4
Example 8	Acryl	0.139	0.126	2.80%	0.871	26.4
Example 9	PET	0.251	0.1263	0.00%	0.768	31.0
Example 10	TAC	0.198	0.1577	1.95%	0.674	24.2
Comparative Example 1	Acryl	0.095	0.488	4.20%	2.861	31.0
Comparative Example 2	Acryl	0.094	0.343	4.00%	2.418	28.4
Comparative Example 3	Acryl	0.098	0.306	3.70%	2.171	23.1
Comparative Example 4	Acryl	0.098	0.236	3.50%	1.969	20.9
Comparative Example 5	Acryl	0.102	0.148	3.40%	1.857	18.2
Comparative Example 6	TAC	0.247	0.390	3.60%	0.822	30.0

[0134] As shown in Table 1, the light diffusion films of Examples 1 to 10 satisfied both $0.110 \leq S_m$ and $R_{sk} \leq 0.200$. In contrast, the light diffusion films of Comparative Examples 1 to 5 did not satisfy $0.110 \leq S_m$. The light diffusion films of Comparative Examples 1 to 4 did not satisfy $R_{sk} \leq 0.200$. The light diffusion film of Comparative Examples 6 satisfied $0.110 \leq S_m$ but not satisfied $R_{sk} \leq 0.200$.

[0135] All of the light diffusion films of Examples 1 to 10 had a luminous transmittance loss factor of 3.0% or less and verified to have a high light transmittance. The light diffusion films of Examples 1 to 10 had an appropriate magnitude (level) of the total haze value and verified to have light diffusion property suitable for practical use.

[0136] In contrast, the light diffusion film of Comparative Examples 1 to 6 had a luminous transmittance loss factor of more than 3.0% and verified to have a low light transmittance.

Industrial Applicability

[0137] As described above, the present invention can provide a light diffusion film that can achieve both high light diffusion property and high light transmittance, a method for producing the light diffusion film, an optical member, a display panel for image display device, and an image display device. However, the present invention is not limited to this application, and can be used for a wide range of applications, and can be applied to any image display device, for example.

[0138] This application claims priority from Japanese Patent Application No. 2019-071238 filed on April 3, 2019. The entire subject matter of the Japanese Patent Applications is incorporated herein by reference.

Reference Signs List

[0139]

- 10: light diffusion film
- 11: transparent base (A)
- 12: light diffusion layer (B)
- 12a: resin layer
- 12b: particle
- 12c: thixotropy-imparting agent

CLAIMS

1. A light diffusion film, comprising:
a transparent base (A); and
5 a light diffusion layer (B), wherein
the light diffusion layer (B) is laminated on at least one side of the transparent base (A),
asperities are formed on an outermost surface of the light diffusion film on a side of the
light diffusion layer (B), and
the asperities satisfy the following mathematical equations (1) and (2):

10
$$0.110 \leq S_m \quad (1)$$

$$R_{sk} \leq 0.200 \quad (2)$$

where in the mathematical equation (1), S_m is an average convex-to-convex distance
15 (mm) of the asperities measured according to JIS B0601 (1994 edition), and
in the mathematical equation (2), R_{sk} is a skewness of the asperities measured
according to JIS B0601 (1994 edition).

2. The light diffusion film according to claim 1, wherein
20 a luminous transmittance loss factor at a wavelength of 380 nm to 780 nm is 3.0% or
less.

3. The light diffusion film according to claim 1 or 2, further comprising:
other layer laminated on the surface of the light diffusion layer (B) on a side facing
25 away from the transparent base (A).

4. A light diffusion film, comprising:
a transparent base (A);
a light diffusion layer (B); and
30 other layer, wherein
the light diffusion layer (B) and the other layer are laminated on at least one side of the
transparent base (A),
asperities are formed on an outermost surface of the other layer, and
the asperities satisfy the following mathematical equations (1) and (2):

$$0.110 \leq S_m \quad (1)$$

$$R_{sk} \leq 0.200 \quad (2)$$

5 where in the mathematical equation (1), S_m is an average convex-to-convex distance (mm) of the asperities measured according to JIS B0601 (1994 edition), and
 in the mathematical equation (2), R_{sk} is a skewness of the asperities measured according to JIS B0601 (1994 edition).

10 5. The light diffusion film according to any one of claims 1 to 4, wherein the transparent base (A) contains an acrylic resin.

6. The light diffusion film according to any one of claims 1 to 5, wherein the transparent base (A) is an acrylic film.

15

7. The light diffusion film according to any one of claims 1 to 6, wherein the light diffusion layer (B) contains a binder resin and a filler.

20

8. The light diffusion film according to claim 7, wherein the filler is a particle.

9. The light diffusion film according to claim 8, wherein a refractive index difference between the particle and the binder resin is 0.200 or less.

25

10. The light diffusion film according to any one of claims 1 to 9, further comprising: an intermediate layer containing a resin derived from the transparent base (A) and a resin derived from the light diffusion layer (B) between the transparent base (A) and the light diffusion layer (B).

30

11. The light diffusion film according to any one of claims 1 to 10, for use on a side opposite to a visual side of a display panel for image display device.

12. A method for producing the light diffusion film according to any one of claims 1 to 11, comprising the steps of:

forming a light diffusion layer (B) on a transparent base (A), and
forming asperities on an outermost surface of the light diffusion film on a side of the
light diffusion layer (B) so as to satisfy the mathematical equations (1) and (2), wherein
the light diffusion layer (B) forming comprises the steps of:

5 coating a coating liquid on the transparent base (A); and
 forming a coating film by drying the coated coating liquid, and
 the coating liquid contains a resin and a solvent.

13. The method according to claim 12, wherein
10 the light diffusion layer (B) forming further comprises the step of curing the coating
film.

14. The method according to claim 12 or 13, wherein
 the solvent contains toluene and cyclopentanone.

15 15. The method according to any one of claims 12 to 14, wherein
 the light diffusion film is the light diffusion film according to claim 3 or 4, and
 the asperities forming comprises the step of forming the other layer on the light
diffusion layer (B).

20 16. An optical member, comprising:
 the light diffusion film according to any one of claims 1 to 11.

17. A display panel for image display device, comprising:
25 the light diffusion film according to claim 11.

18. An image display device, comprising:
 the light diffusion film according to any one of claims 1 to 11;
 the optical member according to claim 16; or
30 the display panel for image display device according to claim 17.

19. The image display device according to claim 18, comprising:
 the display panel for image display device according to claim 17; and
 a backlight for the image display device.