

ANTI-GLARE FILM, METHOD FOR PRODUCING ANTI-GLARE FILM, OPTICAL
MEMBER, AND IMAGE DISPLAY DEVICE

5

TECHNICAL FIELD

[0001] The present invention relates to an anti-glare film, a method for producing the anti-glare film, an optical member, and an image display device.

BACKGROUND ART

10 [0002] Anti-glare treatment is applied to various image display devices such as cathode ray tubes (CRTs), liquid crystal displays (LCDs), plasma display panels (PDPs), and electroluminescence displays (ELDs) in order to prevent a reduction in contrast due to reflection of external light such as fluorescent light and sunlight and reflected glare of images on the surface of the image display devices. In particular, as the screen size of image display devices
15 increases, the number of image display devices equipped with anti-glare films is increasing.

[0003] There are many literatures described for anti-glare films, such as Patent Literatures 1 and 2.

Citation List

Patent Literature

20 [0004]

Patent Literature 1: JP 2009-109683 A

Patent Literature 2: JP 2003-202416 A

SUMMARY OF INVENTION

Technical Problem

25 [0005] In the anti-glare film, a color difference (hereinafter referred to as "white haze") having a wavy shape of black and white may be generated when a light source is reflected. In a display (image display device) or the like using an anti-glare film, if the white haze is remarkably generated, the quality of the appearance may be deteriorated.

[0006] With the foregoing in mind, it is an object of the present invention to provide an anti-glare film suppressed from generation of white haze, a method for producing the anti-glare film,
30 an optical member, and an image display device.

Solution to Problem

[0007] In order to achieve the above object, the present invention provides a first anti-glare film including: a translucent base (A); and an anti-glare layer (B), wherein the anti-glare layer (B) is
35 laminated on the translucent base (A), asperities are formed on an outermost surface of the anti-

glare film on a side of the anti-glare layer (B), and the asperities satisfy the following mathematical equations (1) and (2):

$$\theta_a \leq 0.24 \quad (1)$$

$$R_z \leq 0.20 \quad (2)$$

- 5 where in the mathematical equation (1), θ_a is an average tilt angle [$^\circ$] of the asperities, and in the mathematical equation (2), R_z is a ten-point average height [μm] of the asperities.

[0008] The present invention also provides a second anti-glare film including: a translucent base (A); an anti-glare layer (B); and other layer, wherein the anti-glare layer (B) and the other layer are laminated in this order on the translucent base (A), asperities are formed on an
10 outermost surface of the other layer, and the asperities satisfy the following mathematical equations (1) and (2). In the following, the first and second anti-glare films of the present invention may be collectively referred to as the "anti-glare film of the present invention".

$$\theta_a \leq 0.24 \quad (1)$$

$$R_z \leq 0.20 \quad (2)$$

- 15 where in the mathematical equation (1), θ_a is an average tilt angle [$^\circ$] of the asperities, and in the mathematical equation (2), R_z is a ten-point average height [μm] of the asperities.

[0009] The present invention also provides a method for producing the anti-glare film according to the present invention, including the steps of: forming the anti-glare layer (B) on the translucent base (A); and forming asperities on the outermost surface of the anti-glare film on the
20 side of the anti-glare layer (B) so as to satisfy the mathematical equations (1) and (2), wherein the anti-glare layer (B)-forming includes the steps of: coating a coating liquid on the translucent base (A); and forming a coating film by drying the coated coating liquid, and the coating liquid contains a resin and a solvent.

[0010] The present invention also provides an optical member including the anti-glare film
25 according to the present invention.

[0011] The present invention also provides an image display device including the anti-glare film according to the present invention or the optical member according to the present invention.

Advantageous Effects of Invention

[0012] The present invention can provide an anti-glare film suppressed from generation of
30 white haze, a method for producing the anti-glare film, an optical member, and an image display device.

BRIEF DESCRIPTION OF DRAWINGS

[0013] [FIG. 1] FIG. 1 is a cross-sectional view showing an example of a configuration of an anti-glare film of the present invention.

35 [FIG. 2] FIG. 2 is a cross-sectional view showing another example of the configuration

of the anti-glare film of the present invention.

[FIG. 3] FIG. 3 is a cross-sectional view showing yet another example of the configuration of the anti-glare film of the present invention.

[FIG. 4] FIG. 4 is a cross-sectional view showing yet another example of the configuration of the anti-glare film of the present invention.

DESCRIPTION OF EMBODIMENTS

[0014] Next, the present invention is described in details with reference to examples. The present invention, however, is not limited thereto.

[0015] The anti-glare film of the present invention may further satisfy the following mathematical equation (3):

$$Ra \leq 0.050 \quad (3)$$

where in the mathematical equation (3), Ra is an arithmetic average surface roughness [μm] of the asperities.

[0016] In the anti-glare film of the present invention, for example, other layer may be laminated on the surface of the anti-glare layer (B) on the side opposite to the translucent base (A). The other layer may be, for example, a low reflection layer.

[0017] In the anti-glare film of the present invention, for example, the anti-glare layer (B) may contain a binder resin and a flocculation filler. The flocculation filler may be organoclay.

[0018] In the anti-glare film of the present invention, for example, the anti-glare layer (B) may contain no particles.

[0019] In the anti-glare film production method of the present invention, for example, the anti-glare layer (B)-forming may further include the step of curing the coating film.

[0020] In the anti-glare film production method of the present invention, for example, the solvent may contain toluene and methyl ethyl ketone.

[0021] In the anti-glare film production method of the present invention, for example, the anti-glare film may be an anti-glare film including the other layer and the asperities-forming may include the step of forming the other layer on the anti-glare layer (B).

[0022] The optical member of the present invention may be a polarizing plate, for example.

[0023] [1. Anti-glare film]

As described above, the first anti-glare film of the present invention includes: a translucent base (A); and an anti-glare layer (B), wherein the anti-glare layer (B) is laminated on the translucent base (A), asperities are formed on an outermost surface of the anti-glare film on a side of the anti-glare layer (B), and the asperities satisfy the following mathematical equations (1) and (2):

$$\theta_a \leq 0.24 \quad (1)$$

$$R_z \leq 0.20 \quad (2)$$

where in the mathematical equation (1), θ_a is an average tilt angle [$^\circ$] of the asperities, and in the mathematical equation (2), R_z is a ten-point average height [μm] of the asperities.

[0024] As described above, the second anti-glare film of the present invention includes: a

5 translucent base (A); an anti-glare layer (B); and other layer, wherein the anti-glare layer (B) and the other layer are laminated in this order on the translucent base (A), asperities are formed on an outermost surface of the other layer, and the asperities satisfy the following mathematical equations (1) and (2):

$$\theta_a \leq 0.24 \quad (1)$$

10 $R_z \leq 0.20 \quad (2)$

where in the mathematical equation (1), θ_a is an average tilt angle [$^\circ$] of the asperities, and in the mathematical equation (2), R_z is a ten-point average height [μm] of the asperities.

[0025] FIG. 1 is a cross-sectional view showing an example of the configuration of an anti-glare film of the present invention. As shown in FIG. 1, in this anti-glare film 10, an anti-glare

15 layer (B) 12 is laminated on one surface of a translucent base (A) 11. In the anti-glare layer (B) 12, particles 12b and a thixotropy-imparting agent 12c are contained in a resin layer 12a. A low reflection layer (C) 13 is further laminated as the other layer on the surface of the anti-glare layer (B) 12 on the side opposite to the translucent base (A) 11. Irregularities are formed on the outermost surface of the anti-glare film 10 on the side of the anti-glare layer (B) 12 (the surface
20 of the low reflection layer (C) 13 on the side opposite to the translucent base (A) 11). The average tilt angle θ_a of the asperities is 0.24° or less as described above, and the ten-point average height (also referred to as ten-point average roughness or ten-point average surface roughness) R_z of the asperities is $0.20 \mu\text{m}$ or less as described above. However, the anti-glare film of the present invention is not limited thereto, and the anti-glare film may or may not
25 contain the particles 12b, the thixotropy imparting agent 12c, and the other layer (low reflection layer (C)) 13.

[0026] FIG. 2 is a cross-sectional view showing another example of the configuration of the anti-glare film of the present invention. As shown in FIG. 2, the configuration of this anti-glare film 10 is the same as that of the anti-glare film 10 of FIG. 1 except that it includes no other

30 layer (low reflection layer (C)) 13. Irregularities are formed on the outermost surface of the anti-glare film 10 of FIG. 2 on the side of the anti-glare layer (B) 12 (the surface of the anti-glare layer (B) 12 on the side opposite to the translucent base (A) 11). The average tilt angle θ_a of the asperities is 0.24° or less, and the ten-point average height R_z of the asperities is $0.20 \mu\text{m}$ or less.

[0027] FIG. 3 is a cross-sectional view showing yet another example of the configuration of the
35 anti-glare film of the present invention. As shown in FIG. 3, the configuration of this anti-glare

film 10 is the same as that of the anti-glare film 10 of FIG. 1 except that the anti-glare layer (B) 12 contain no particles 12b. FIG. 4 is a cross-sectional view showing yet another example of the configuration of the anti-glare film of the present invention. As shown in FIG. 4, the configuration of this anti-glare film 10 is the same as that of the anti-glare film 10 of FIG. 2 except that the anti-glare layer (B) 12 contain no particles 12b.

[0028] In the anti-glare film of the present invention, the "outermost surface on the side of the anti-glare layer (B)" is the outermost surface of the anti-glare film on the side of the anti-glare layer (B). Specifically, the "outermost surface on the side of the anti-glare layer (B)" is a surface of the anti-glare layer (B) on the side opposite to the translucent base (A) when the anti-glare film includes no other layer (e.g., FIGs. 2 and 4). The "outermost surface on the side of the anti-glare layer (B)" is the outermost surface of the other layer (low reflection layer (C) 13 in FIGs. 1 and 3) on the side opposite to the translucent base (A) when the anti-glare film includes the other layer (e.g., FIGs. 1 and 3).

[0029] The anti-glare film of the present invention is excellent in anti-glare properties even if the outermost surface has asperities with gradual convex portions having small θ_a and R_z , and can suppress the generation of white haze as described above. In particular, in a general anti-glare film, there is a possibility that the generation of white haze become more remarkable when a low reflection layer is provided on the anti-glare layer. However, according to the anti-glare film of the present invention, for example, even when the low reflection layer (C) is provided on the anti-glare layer (B), the generation of white haze can be suppressed.

[0030] While the other layer is the low reflection layer (C) 13 in FIGs. 1 and 3, the other layer is not limited to the low reflection layer in the anti-glare film of the present invention. Examples of the other layer include a low refractive index layer, a low reflection layer, a conductive layer, an antifouling layer, a high hardness layer, a high refractive index layer, and a UV absorbing 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 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] As described above, the average tilt angle θ_a ($^\circ$) of the asperities of the outermost surface of the anti-glare film of the present invention on the side of the anti-glare layer (B) is 0.24 or less. The average tilt angle θ_a may be, for example, 0.23 $^\circ$ or less, 0.20 $^\circ$ or less, or 0.19 $^\circ$ or less. The lower limit of the average tilt angle θ_a is not particularly limited, and is, for example, a value 0 $^\circ$ or more or greater than 0 $^\circ$, and may be 0.10 $^\circ$ or more, 0.11 $^\circ$ or more, 0.13 $^\circ$ or more, or 0.15 or more. The average tilt angle θ_a may be, for example, greater than 0 $^\circ$ and 0.23 $^\circ$ or less,

0.10° to 0.23°, 0.11° to 0.23°, 0.13° to 0.23°, 0.15° to 0.23°, greater than 0° and 0.20° or less, 0.10° to 0.20°, 0.11° to 0.20°, 0.13° to 0.20°, 0.15° to 0.20°, greater than 0° and 0.19° or less, 0.10° to 0.19°, 0.11° to 0.19°, 0.13° to 0.19°, or 0.15° to 0.19°. The average tilt angle θ_a is a value defined by the following mathematical equation (3). The average tilt angle θ_a can be

5 measured, for example, by the method described in Examples to be described below.

$$\text{average tilt angle } \theta_a = \tan^{-1} \Delta a \quad (3)$$

[0032] In the mathematical equation (3), as shown in the following mathematical equation (4), Δa denotes a value obtained by dividing the sum ($h_1 + h_2 + h_3 \dots + h_n$) of the differences (heights h) between adjacent peaks and the lowest point of the valley formed therebetween by
10 the standard length L of the roughness curve defined in JIS B 0601 (1994 edition). The roughness curve is a curve obtained by removing the surface waviness components with longer wavelengths than the predetermined one from the profile curve using a retardation compensation high-pass filter. The profile curve denotes a profile that appears at the cut surface when an object surface was cut in a plane perpendicular to the object surface.

$$15 \quad \Delta a = (h_1 + h_2 + h_3 \dots + h_n) / L \quad (4)$$

[0033] As described above, the ten-point average height R_z of the asperities is 0.20 μm or less in the asperities of the outermost surface of the anti-glare film of the present invention on the side of the anti-glare layer (B). The ten-point average height R_z may be, for example, 0.19 μm or less, or 0.18 μm or less. The lower limit of the ten-point average height R_z is not particularly
20 limited, and is, for example, a numerical value of 0 μm or more or greater than 0 μm , and may be 0.10 μm or more, 0.12 μm or more, 0.13 μm or more, or 0.17 μm or more. The ten-point average height R_z may be, for example, greater than 0 μm and 0.20 μm or less, 0.10 μm to 0.20 μm , 0.12 μm to 0.20 μm , 0.13 μm to 0.20 μm , 0.17 μm to 0.20 μm , greater than 0 μm and 0.19 μm or less, 0.10 μm to 0.19 μm , 0.12 μm to 0.19 μm , 0.13 μm to 0.19 μm , 0.17 μm to 0.19 μm , greater than
25 0 μm and 0.18 μm or less, 0.10 μm to 0.18 μm , 0.12 μm to 0.18 μm , 0.13 μm to 0.18 μm , or 0.17 μm to 0.18 μm . The ten-point average height R_z can be measured, for example, by the method described in Examples to be described below.

[0034] The arithmetic average surface roughness (also referred to as arithmetic average height) R_a in the asperities of the outermost surface of the anti-glare film on the side of the anti-glare
30 layer (B) is not particularly limited, and may be, for example, 0.050 μm or less as described above. The arithmetic average surface roughness R_a may be, for example, 0.048 μm or less, 0.045 μm or less, or 0.043 μm or less. The lower limit of the arithmetic average surface roughness R_a is not particularly limited, and may be, for example, a numerical value of 0 μm or more or greater than 0 μm , and may be 0.010 μm or more, 0.020 μm or more, 0.030 μm or more,
35 or 0.035 μm or more. The arithmetic average surface roughness R_a is, for example, greater than

0 μm and 0.050 μm or less, 0.010 μm to 0.050 μm , 0.020 μm to 0.050 μm , 0.030 μm to 0.050 μm , 0.035 μm to 0.050 μm , greater than 0 μm and 0.048 μm or less, 0.010 μm to 0.048 μm , 0.020 μm to 0.048 μm , 0.030 μm to 0.048 μm , 0.035 μm to 0.048 μm , greater than 0 μm and 0.045 μm or less, 0.010 μm to 0.045 μm , 0.020 μm to 0.045 μm , 0.030 μm to 0.045 μm , 0.035 μm to 0.045 μm , greater than 0 μm and 0.043 μm or less, 0.010 μm to 0.043 μm , 0.020 μm to 0.043 μm , 0.030 μm to 0.043 μm , or 0.035 μm to 0.043 μm . In order to prevent reflection of external light or reflected glare of images on the surface of the anti-glare hard coat film, it is preferable that there be some degree of surface roughness, that is, Ra be large to some extent.

When the Ra is within the above range, scattering of reflected light when viewed from an oblique direction is suppressed, white blur can be ameliorated, and a contrast in bright place can be improved in the case of using the anti-glare layer in an image display device or the like. In the present invention, the "arithmetic average surface roughness Ra" is the arithmetic average surface roughness Ra defined in JIS B 0601 (1994 edition).

[0035] In the asperities of the outermost surface on the side of the anti-glare layer (B), the average convex-to-convex distance Sm (mm) of the surface is not particularly limited, and may be, for example, in the range from 0.025 to 0.275. As a result, for example, an anti-glare hard coat film having excellent anti-glare properties and capable of preventing white blur can be obtained. In the present invention, the average convex-to-convex distance Sm (mm) of the anti-glare layer (B) surface is the average convex-to-convex distance Sm (mm) of the surface

measured according to JIS B0601 (1994 edition). The Sm may be, for example, 0.050 mm or more, 0.075 mm or more, 0.100 mm or more, 0.125 mm or more, and 0.250 mm or less, 0.225 mm or less, 0.200 mm or less, or 0.175 mm or less. The Sm may be, for example, 0.050 mm to 0.250 mm, 0.050 mm to 0.225 mm, 0.050 mm to 0.200 mm, 0.050 mm to 0.175 mm, 0.075 mm to 0.250 mm, 0.075 mm to 0.225 mm, 0.075 mm to 0

.200 mm, 0.075 mm to 0.175 mm, 0.100 mm to 0.250 mm, 0.100 mm to 0.225 mm, 0.100 mm to 0.200 mm, 0.100 mm to 0.175 mm, 0.125 mm to 0.250 mm, 0.125 mm to and 0.225 mm, 0.125 mm to 0.200, or 0.125 mm to 0.175 mm.

[0036] In the anti-glare film of the present invention, the haze value is not particularly limited, and may be in the range from 0 to 10%, for example. The haze value is a haze value (cloudiness) of the entire anti-glare film according to JIS K 7136 (2000 edition). The haze value is more preferably in the range from 0% to 5%, yet more preferably in the range from 0% to 3%. In order to set the haze value within the above range, it is preferable to select the particles and the resin such that the difference in refractive index between the particles and the resin is in the range from 0.001 to 0.02. By setting the haze value within the above range, a sharp image can be obtained, and a contrast in dark place can be improved.

[0037] The translucent base (A), the anti-glare layer (B), and the other layer will be described below with further examples. While a case in which the anti-glare layer (B) is an anti-glare hard coat layer and a case in which the other layer is a low reflection layer (C) will be mainly described below, the present invention is not limited thereto.

5 [0038] The translucent 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 bases described in JP 2008-90263 A. As the transparent
10 plastic film base, a base having optically low birefringence is preferably used. The anti-glare 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 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 invention, the transparent plastic film base may be a polarizer
15 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 transparent plastic film base is a polarizer, the anti-glare layer (B) and the
20 low reflection layer (C) function as a protective layer. Further, with such a configuration, for example, the anti-glare film also functions as a cover plate in the case where the anti-glare film is attached to the surface of the liquid crystal cell.

[0039] In the present invention, the thickness of the translucent base (A) is not particularly limited, and is, for example, in the range from 10 to 500 μm , from 20 to 300 μm , or from 30 to
25 200 μm from the viewpoint of strength, workability such as handleability, and film thinness, for example. The refractive index of the translucent 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.

[0040] In the anti-glare film of the present invention, for example, the resin contained in the translucent base (A) may contain an acrylic resin.

30 [0041] In the anti-glare film of the present invention, for example, the translucent base (A) may be an acrylic film.

[0042] In the anti-glare film of the present invention, for example, the anti-glare layer (B) may contain a resin and a filler. The filler may contain at least one of particles and a thixotropy-imparting agent (thixotropic agent).

35 [0043] For example, when the anti-glare layer (B) contains a thixotropy imparting agent

without containing particles, it is possible to obtain an anti-glare film of the present invention whose outermost surface has asperities with gradual convex portions having small θ_a and R_z . Further, when the anti-glare layer (B) contains a thixotropy imparting agent and particles having a small particle size, it is also possible to obtain an anti-glare film of the present invention whose
5 outermost surface has asperities with gradual convex portions having small θ_a and R_z .

[0044] In the anti-glare film of the present invention, for example, the resin contained in the anti-glare layer (B) may contain an acrylate resin (also referred to as an acrylic resin).

[0045] In the anti-glare film of the present invention, for example, the resin contained in the anti-glare layer (B) may contain a urethane acrylate resin.

10 [0046] In the anti-glare film of the present invention, for example, the resin contained in the anti-glare layer (B) may be a copolymer of a curable urethane acrylate resin and a polyfunctional acrylate.

[0047] In the anti-glare film of the present invention, for example, the anti-glare layer (B) is formed by using an anti-glare layer forming material containing a resin and a filler, and the anti-
15 glare layer (B) may have a flocculated portion forming a convex portion on the surface of the anti-glare 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 anti-glare layer (B). In the image display device of the present invention, for example, the anti-glare film of the present invention may be disposed such that the one
20 direction in which the fillers are gathered coincides with the long side direction of the black matrix pattern.

[0048] In the anti-glare 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.

25 [0049] The anti-glare 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 anti-glare layer (B), for example.

[0050] The anti-glare 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
30 of the anti-glare layer (B), for example.

[0051] In the method for producing an anti-glare film of the present invention, further, the surface profile of the anti-glare 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 anti-glare layer forming material.

35 [0052] By having a flocculated portion in which particles are flocculated, for example, the anti-

glare 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 anti-glare layer (B) becomes large. The anti-glare film having such a surface profile can effectively prevent reflected glare of a fluorescent lamp or the like. However, the anti-glare film of the present invention is not limited thereto.

[0053] The anti-glare layer (B) is formed, for example, by coating a coating liquid containing the resin, the filler, and a solvent on at least one surface of the translucent 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 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.

[0054] 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 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 the resins may be used alone or two or more kinds of the same may be used in combination.

[0055] 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 anti-glare 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.

[0056] The main function of the particles for forming the anti-glare layer (B) is to impart anti-glare properties by forming asperities on the surface of the anti-glare layer (B) and control the haze value of the anti-glare layer (B). The haze value of the anti-glare layer (B) can be designed by controlling the difference in refractive index between the particles and the resin. 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 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 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.

[0057] The particle size (D) (weight-average particle size) of the particles is not particularly 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 an anti-glare film which is more excellent in anti-glare 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 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, 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 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 particles are measured and then the weight-average particle size is calculated.

[0058] 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.

[0059] The proportion of the particles in the anti-glare layer (B) may be, for example, 0.1 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 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 an anti-glare film having more excellent anti-glare properties and suppressed from reflected glare can be obtained, for example.

[0060] In the anti-glare 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 flocculated state of the particles can be easily controlled. Examples of the thixotropy-imparting agent include organoclay, oxidized polyolefin, and denatured urea.

[0061] 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).

[0062] The oxidized polyolefin 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).

[0063] 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).

[0064] One kind of the thixotropy-imparting agents may be used alone, or two or more kinds of

them may be used in combination.

[0065] The proportion of the thixotropy-imparting agents in the anti-glare 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.

5 [0066] The maximum thickness (d') of the anti-glare 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 anti-glare layer (B) within the above range, for example, generation of curling in the anti-glare 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-
10 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 anti-glare layer (B) and the weight-average particle size (D) of the particles are in the combination described above, an anti-glare film excellent in anti-glare properties can be obtained. The maximum thickness (d') of the anti-glare layer (B) is more preferably in the range from 3 to 8 μm .

15 [0067] The ratio D/d between the thickness (d') of the anti-glare 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, 0.6 or less, 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
20 0.6, 0.3 to 0.6, or 0.4 to 0.6. With such a relationship, it is possible to obtain an anti-glare film which is more excellent in anti-glare properties and suppressed from reflected glare.

[0068] In the anti-glare film according to the present invention, for example, the anti-glare layer (B) may have a flocculated portion forming a convex portion on the surface of the anti-glare layer (B) by flocculating the fillers, and in the flocculated portion forming the convex
25 portion, the fillers may be present in the state of being gathered in one direction in an in-plane direction of the anti-glare layer (B). As a result, for example, the reflected glare of the fluorescent lamp can be prevented. However, the anti-glare film of the present invention is not limited thereto.

[0069] Further, the anti-glare film of the present invention may include, for example, an
30 intermediate layer containing a resin derived from the translucent base (A) and a resin derived from the anti-glare layer (B) between the translucent base (A) and the anti-glare layer (B). By controlling the thickness of the intermediate layer, it is possible to control the surface profile of the anti-glare layer (B). For example, increasing the thickness of the intermediate layer tends to increase the R_z and θ_a , and decreasing the thickness of the intermediate layer tends to decrease
35 the R_z and θ_a .

[0070] 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 anti-glare film production method of the present invention. Specifically, for example, in the drying, a coating liquid for forming the anti-glare layer (B) penetrates into the translucent base (A), and the intermediate layer containing a resin derived from the translucent base (A) and a resin derived from the anti-glare layer (B) is formed. The resin contained in the intermediate layer is not particularly limited, and for example, a resin contained in the translucent base (A) and a resin contained in the anti-glare 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 translucent base (A) and a resin contained in the anti-glare layer (B) may be chemically changed by heating, light irradiation, or the like.

[0071] 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, 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, 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 anti-glare hard coat 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 [μm] of the anti-glare layer (B), and D_C is the thickness [μm] of the intermediate layer.

[0072] In the anti-glare film according to the present invention, as described above, the anti-glare layer (B) may have a flocculated portion forming a convex portion on the surface of the anti-glare 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 anti-glare layer (B), for example. Thus, the convex portions become gradual convex portions having anisotropy. By having a convex portion having such a shape, the anti-glare film can prevent from reflected glare or the like of the fluorescent lamp. However, the anti-glare film of the present invention is not limited thereto.

[0073] The surface profile of the anti-glare layer (B) can also be designed freely by controlling the flocculated state of the fillers contained in the anti-glare 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 anti-glare 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 anti-glare 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 anti-glare layer forming material.

[0074] While the convex portions in the anti-glare 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 anti-glare layer (B), the present invention is not limited thereto. In addition, in the anti-glare 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 anti-glare layer (B), for example.

[0075] The other layer is not particularly limited, and examples thereof include a low refractive index layer, a low reflection layer, a conductive layer, an antifouling layer, a high hardness layer, a high refractive index layer, and a UV absorbing 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 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. Hereinafter, a case in which the other layer is the low reflection layer (C) will be described.

[0076] For example, when an anti-glare film is attached to an image display device, reflection of light at the interface between the air and the anti-glare layer (B) is one of the factors that deteriorate visibility of the image. The low reflection layer (C) can reduce the surface reflection. The anti-glare layer (B) and the low reflection layer (C) may be formed only on one surface or on both surfaces of the translucent base (A). The anti-glare layer (B) and the low reflection layer (C) may each have a multilayer structure in which two or more layers are laminated.

[0077] In the present invention, the low reflection layer (C) 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. The low reflection layer (C) uses the interference effect of light to cancel opposite phases of incident light and reflected light and thereby exhibits an antireflection function. The wavelength range of visible light that allows the antireflection function to be exhibited is, for example, from 380 to 780 nm, the wavelength range in which particularly high visibility is obtained is in the range of 450 to 650 nm, and the low reflection layer (C) may be designed so that the reflectance at 550 nm, which is the center wavelength, is

minimized.

[0078] Further, for example, it is preferred that a contamination preventive film formed of a silane compound having a fluorine group, an organic compound having a fluorine group, or the like be laminated on the low reflection layer (C) in order to prevent adhesion of contaminant and improve removability of adherent contaminant.

[0079] [2. Method for producing anti-glare film]

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

[0080] The anti-glare film production method can be performed, for example, as follows.

[0081] First, the anti-glare layer (B) is formed on the translucent base (A) so as to satisfy the mathematical equations (1) and (2) (anti-glare layer (B)-forming). Thereby, a laminate of the translucent base (A) and the anti-glare layer (B) is produced. The anti-glare layer (B)-forming includes the steps of: coating a coating liquid on the translucent base (A); and forming a coating film by drying the coated coating liquid as described above. Further, for example, as described above, the anti-glare 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.

[0082] The coating liquid includes a resin and a solvent as described above. The coating liquid may be, for example, an anti-glare layer forming material (coating liquid) containing the resin, particles, thixotropy-imparting agent, and solvent.

[0083] The coating liquid preferably exhibits thixotropic properties, and the Ti 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.

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

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.

[0084] When the Ti value is 1.3 or more, problems of a defect in outward appearance and deterioration in characteristics of anti-glare properties and white blur are unlikely to occur. When the Ti 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.

[0085] 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

5 is also possible to freely control the surface profile of the anti-glare film in a wider range by shear flocculation of the thixotropy-imparting agent itself. For example, as described above, when the coating liquid contains a thixotropy imparting agent without containing particles, it is possible to obtain an anti-glare film of the present invention whose outermost surface has asperities with gradual convex portions having small θ_a and R_z . Further, when the coating liquid
10 contains a thixotropy imparting agent and particles having a small particle size, it is also possible to obtain an anti-glare film of the present invention whose outermost surface has asperities with gradual convex portions having small θ_a and R_z .

[0086] 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 them may be used in combination. In order

15 to obtain the anti-glare film of the present invention in accordance with the composition of the resin, the kinds 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,
20 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
25 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,
30 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 methyl ethyl ketone.

35 [0087] In the case where an acrylic film is employed as the translucent 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 methyl ethyl ketone.

[0088] In the case where triacetylcellulose (TAC) is employed as the translucent base (A) to form an intermediate layer (permeable layer), a good solvent for TAC can be suitably used, for example. Examples of the solvent include ethyl acetate, methyl ethyl ketone, and cyclopentanone.

[0089] In the case of containing a thixotropy-imparting agent, the anti-glare 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.

[0090] Various leveling agents can be added to the anti-glare layer forming material. For the purpose of preventing unevenness in coating (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 anti-glare layer (B) is required to have antifouling properties, the case where a low reflection layer (low refractive index layer) and/or a layer containing interlayer fillers is formed on the anti-glare layer (B) as mentioned 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.

[0091] The amount of the leveling agent to be added is, for example, 5 parts by weight or less, preferably in the range from 0.01 to 5 parts by weight, relative to 100 parts by weight of the resin.

[0092] 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 anti-glare 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 them may be used in combination.

[0093] Any of conventionally known photoinitiators described in JP 2008-88309 A can be used in the anti-glare layer forming material, for example.

[0094] As a method for forming a coating film by coating the coating liquid on the translucent 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.

[0095] Next, as described above, the coating film is dried and cured to form an anti-glare layer (B). The drying may be, for example, natural drying, air drying by blowing air, heat drying, or a combination thereof.

[0096] The drying temperature of the coating liquid for forming the anti-glare 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 150 seconds or shorter, 130 seconds or shorter, 110 seconds or shorter, or 90 seconds or shorter.

[0097] The way of curing the coating film is not particularly limited and is preferably 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 anti-glare layer (B) has a more sufficient hardness. Moreover, with the amount of irradiation of 500 mJ/cm² or less, the resultant anti-glare layer (B) can be prevented from being colored.

[0098] As described above, a laminate of the translucent base (A) and the anti-glare layer (B) can be produced. This laminate may be used as it is as an anti-glare film of the present invention, or may be used as an anti-glare film of the present invention, for example, by forming the other layer on the anti-glare layer (B). The method for forming the other layer is not particularly

limited, and may be performed in the same manner as or according to a general method for forming a low refractive index layer, an antireflection layer, or the like, for example. Hereinafter, a step of forming the low reflection layer (C) (low reflection layer-forming) in the case where the other layer is the low reflection layer (C) will be described.

5 [0099] First, a coating liquid for forming a low reflection layer for forming the low reflection layer (C) is prepared. The coating liquid for forming a low reflection layer may contain, for example, a resin, a fluorine element-containing additive, hollow particles, solid particles, a diluent solvent, and the like, and may be produced by mixing them, for example.

[0100] Examples of the resin include a heat-curable resin and an ionizing radiation-curable resin which 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.

[0101] 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 15 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.

20 [0102] 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 25 trifunctional group or more is preferable because the hardness of the low reflection layer (C) 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. The resin may have a weight-average molecular weight before curing of, for example, 100 or more, 300 or more, 500 30 or more, 1000 or more, or 2000 or more, and may be 100,000 or less, 70,000 or less, 50,000 or less, 30,000 or less, or 10,000 or less. If the weight-average molecular weight before curing is high, the hardness decreases, but cracking tends to be less likely to occur when bent. On the other hand, if the weight-average molecular weight before curing is low, the molecule crosslinking density tends to be improved and the hardness tends to be high.

35 [0103] For curing the curable resin, for example, a curing agent may be added. The curing

agent is not particularly limited, and for example, a known polymerization initiator (e.g., a thermal polymerization initiator, a photopolymerization initiator, or the like) can be used as appropriate. The amount of the curing agent to be added is not particularly limited, and may be, for example, 0.5 parts by weight or more, 1.0 parts by weight or more, 1.5 parts by weight or more, 2.0 parts by weight or more, or 2.5 parts by weight or more, and may be 15 parts by weight or less, 13 parts by weight or less, 10 parts by weight or less, 7 parts by weight or less, or 5 parts by weight or less, relative to 100 parts by weight of the resin in the coating liquid for forming a low reflection layer.

[0104] The fluorine element-containing additive is not particularly limited, and may be, for example, an organic compound or an inorganic compound containing fluorine in a molecule. The organic compound is not particularly limited, and examples thereof include a fluorine-containing antifouling coating agent, a fluorine-containing acrylic compound, a fluorine- and silicon-containing acrylic compound. Specific examples of the organic compound include compounds "KY-1203" and "KY-100" (trade names, produced by Shin-Etsu Chemical Co., Ltd.), and a compound "MEGAFACE" (trade name, produced by DIC Corporation). The inorganic compound is also not particularly limited. The amount of the fluorine element-containing additive to be added is not particularly limited, and for example, the weight of the fluorine element in the solid content may be, for example, 0.05% by weight or more, 0.1% by weight or more, 0.15% by weight or more, 0.20% by weight or more, or 0.25% by weight or more, and may be 20% by weight or less, 15% by weight or less, 10% by weight or less, 5% by weight or less, or 3% by weight or less, relative to the weight of the total solid content in the coating liquid for forming a low reflection layer. Further, for example, the weight of the fluorine element-containing additive may be, for example, 0.05% by weight or more, 0.1% by weight or more, 0.15% by weight or more, 0.20% by weight or more, or 0.25% by weight or more, and may be 20% by weight or less, 15% by weight or less, 10% by weight or less, 5% by weight or less, or 3% by weight or less, relative to 100 parts by weight of the resin in the coating liquid for forming a low reflection layer. From the viewpoint of scratch resistance of the low reflection layer (C), it is preferable that the amount of the fluorine element-containing additive to be added be not too large or too small.

[0105] The hollow particles are not particularly limited, and examples thereof include silica particles, acrylic particles, and acrylic-styrene copolymer particles. The silica particles may be, for example particles "THRULYA 5320" and "THRULYA 4320" (trade names, produced by JGC C&C.). The weight-average particle size of the hollow particles is not particularly limited, and may be, for example, 30 nm or more, 40 nm or more, 50 nm or more, 60 nm or more, or 70 nm or more, and may be 150 nm or less, 140 nm or less, 130 nm or less, 120 nm or less, or 110 nm

or less. The shape of the hollow 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 hollow particles are spherical particles. By adding the hollow particles, for example, a low refractive index, good anti-reflection characteristics, and the like of the low reflection layer (C) can be achieved. The amount of the hollow particles to be added is not particularly limited, and may be, for example, 30 parts by weight or more, 50 parts by weight or more, 70 parts by weight or more, 90 parts by weight or more, or 100 parts by weight or more, and may be 300 parts by weight or less, 270 parts by weight or less, 250 parts by weight or less, 200 parts by weight or less, or 180 parts by weight or less, relative to 100 parts by weight of the resin in the coating liquid for forming a low reflection layer. From the viewpoint of lowering the refractive index of the low reflection layer (C), it is preferable that the amount of the hollow particles to be added be not too small, and from the viewpoint of ensuring the mechanical characteristics of the low reflection layer (C), it is preferable that the amount of the hollow particles to be added be not too large.

[0106] The solid particles are not particularly limited, and examples thereof include silica particles, zirconium oxide particles, and titanium-containing particles (e.g., Titanium Oxide particles). The silica particles may be, for example, particles "MEK-2140Z-AC", "MIBK-ST", and "IPA-ST" (trade names, produced by NISSAN CHEMICAL INDUSTRIES, LTD). The weight-average particle size of the solid particles may be, for example, 5 nm or more, 10 nm or more, 15 nm or more, 20 nm or more, 25 nm or more, and may be 300 nm or less, 250 nm or less, 200 nm or less, 150 nm or less, or 100 nm or less. The shape of the solid 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 solid particles are spherical particles. By adding the solid particles, for example, the fluorine element-containing additive tends to be unevenly distributed on the surface of the coated coating liquid for forming a low reflection layer, and the scratch resistance of the low reflection layer (C) is increased. Thus, a low refractive index, good anti-reflection characteristics, and the like of the low reflection layer (C) can be achieved. The amount of the solid particles to be added is not particularly limited, and may be, for example, 5 parts by weight or more, 10 parts by weight or more, 15 parts by weight or more, 20 parts by weight or more, or 25 parts by weight or more, and may be 150 parts by weight or less, 120 parts by weight or less, 100 parts by weight or less, or 80 parts by weight or less, relative to 100 parts by weight of the resin in the coating liquid for forming a low reflection layer. From the viewpoint of ensuring the mechanical

characteristics and adjusting the refractive index, it is preferable that the amount of the solid particles to be added be not too small, and from the viewpoint of preventing white turbidity of the coating film due to scattering, it is preferable that the amount of the solid particles to be added be not too large.

5 [0107] The diluent 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 them may be used in combination. Examples of the diluent solvent include alcohols such as methanol, ethanol, isopropyl alcohol, butanol, TBA (tertiary butyl alcohol), and 2-methoxyethanol; ketones such as acetone, methylethylketone, MIBK (methylisobutylketone), and cyclopentanone; esters such as
10 methyl acetate, ethyl acetate, butyl acetate, and PMA (propylene glycol monomethyl ether); 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. For example, the polarity of the diluent solvent may be adjusted by
15 mixing a plurality of solvents in any given ratio.

[0108] The diluent solvent may be, for example, a mixed solvent containing MIBK (methylisobutylketone) and PMA (propylene glycol monomethyl ether acetate). The mixing ratio in this case is not particularly limited, and, when the weight of MIBK is set to 100% by weight, the weight of PMA may be, for example, 20% by weight or more, 50% by weight or more, 100%
20 by weight or more, 150% by weight or more, or 200% by weight or more, and may be 400% by weight or less, 350% by weight or less, 300% by weight or less, or 250% by weight or less.

[0109] The diluent solvent may be, for example, a mixed solvent containing TBA (tertiary butyl alcohol) in addition to MIBK and PMA. The mixing ratio in this case is not particularly limited, and, when the weight of MIBK is set to 100% by weight, the weight of PMA may be, for
25 example, 10% by weight or more, 30% by weight or more, 50% by weight or more, 80% by weight or more, or 100% by weight or more, and 200% by weight or less, 180% by weight or less, 150% by weight or less, 130% by weight or less, or 110% by weight or less. Further, when the weight of MIBK is set to 100% by weight, the weight of TBA may be, for example, 10% by weight or more, 30% by weight or more, 50% by weight or more, 80% by weight or more, or
30 100% by weight or more, and may be 200% by weight or less, 180% by weight or less, 150% by weight or less, 130% by weight or less, or 110% by weight or less.

[0110] The amount of the diluent solvent to be added is not particularly limited, and the weight of the solid content relative to the weight of the entire coating liquid for forming a low reflection layer may be, for example, 0.1% by weight or more, 0.3% by weight or more, 0.5% by weight or
35 more, 1.0% by weight or more, or 1.5% by weight or more, and may be 20% by weight or less,

15% by weight or less, 10% by weight or less, 5% by weight or less, or 3% by weight or less, for example. From the viewpoint of ensuring coatability (nulle, leveling), it is preferable that the content ratio of the solid content be not too high, and from the viewpoint of preventing appearance defects caused by drying such as air drying asperities and whitening, it is preferable that the content ratio of the solid content be not too low.

[0111] Next, the coating liquid for forming a low reflection layer is coated on the anti-glare layer (B) (the coating). The coating method is not particularly limited, and a well-known 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. The coating amount of the coating liquid for forming a low reflection layer is not particularly limited, and the thickness of the low reflection layer (C) to be formed may be, for example, 0.1 μm or more, 0.3 μm or more, 0.5 μm or more, 1.0 μm or more, or 2.0 μm or more, and may be 50 μm or less, 40 μm or less, 30 μm or less, 20 μm or less, or 10 μm or less.

[0112] Next, the coated coating liquid for forming a low reflection layer is dried to form a coating film (the coating film-forming). The drying temperature is not particularly limited, and may be, for example, in the 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.

[0113] Further, the coating film may be cured (curing). 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. The amount of irradiation with the energy radiation source in the ultraviolet curing is preferably from 50 to 500 mJ/cm^2 in terms of accumulative exposure at the ultraviolet wavelength of 365 nm. With the amount of irradiation of at least 50 mJ/cm^2 , the coating film is cured more sufficiently, and the resultant low reflection layer (C) has a more sufficient hardness. Moreover, with the amount of irradiation of 500 mJ/cm^2 or less, the resultant low reflection layer (C) can be prevented from being colored.

[0114] As described above, the anti-reflection film of the present invention in which the anti-glare layer (B) and the low reflection layer (C) are laminated in this order on at least one surface of the translucent base (A) can be produced. Note that, as described above, the antireflection film

of the present invention may include layers other than the translucent base (A), the anti-glare layer (B), and the low reflection layer (C).

[0115] In addition, in the step of producing the antireflection film of the present invention, it is preferable that at least one of the translucent base (A) and the anti-glare layer (B) be subjected to surface treatment. If the surface of the translucent base (A) is subjected to surface treatment, the adhesiveness to the anti-glare layer (B) or the polarizer or the polarizing plate is further improved. In addition, if the surface of the anti-glare layer (B) is subjected to surface treatment, the adhesiveness to the low reflection layer (C) is further improved.

[0116] [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, for example, an anti-glare 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.

[0117] 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 and an organic EL display device.

[0118] The image display device of the present invention may be, for example, an image display device having the anti-glare film of the present invention on the viewing side surface, and the image display device may have a black matrix pattern.

[0119] Generally, the translucent base (A) side of the anti-glare 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 translucent base (A) may be subjected to any of the above-mentioned surface treatments. As described above, according to the anti-glare film production method of the present invention, the surface profile of the anti-glare film can be freely controlled in a wide range. Therefore, the optical characteristics that can be obtained by laminating the anti-glare 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 anti-glare film.

[0120] 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 surfaces of the polarizer. When a transparent protective film is provided on both surfaces 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.

[0121] The configuration of the polarizing plate on which the anti-glare film has been 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 anti-glare film in this order or a configuration obtained by laminating the polarizer and the transparent protective film on the anti-glare film in this order.

[0122] 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 anti-glare film is disposed in a specific direction. 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).

[0123] 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

[0124] Next, the Examples of the present invention are described together with the Comparative Examples. The present invention, however, is not limited by the Examples and the Comparative Examples.

[0125] In the following Examples and Comparative Examples, the number of parts of the substance is expressed in parts by mass (parts by weight), unless otherwise specified.

[0126] [Coating liquid 1: anti-glare layer forming material]

As a resin contained in the anti-glare layer, 40 parts by weight of a urethane acrylate prepolymer (trade name: "UA-53H-80BK", produced by SHIN-NAKAMURA CHEMICAL CO, LTD., solid content: 80%) and 60 parts by weight of a polyfunctional acrylate containing pentaerythritol triacrylate as a main component (trade name: "Viscoat #300", produced by OSAKA ORGANIC CHEMICAL INDUSTRY LTD, solid content: 100%) were prepared. Per 100 parts by weight of the resin solid content of the resin, 1.2 parts by weight of synthetic smectite (trade name: "LUCENTITE SAN" produced by CO-OP CHEMICAL Co. Ltd.) which is

organoclay as a thixotropy imparting agent, 5 parts by weight of a photopolymerization initiator (trade name: "IRGACURE 907" produced by BASF Co., Ltd.), and 0.15 parts by weight of a leveling agent (trade name: "LE-303" produced by Kyoeisha Chemical Co., Ltd., solid content: 40%) were mixed. Note that the organoclay was used by diluting with toluene so that the solid content became 6% by weight. This mixture was diluted with a toluene/methyl ethyl ketone (MEK) mixed solvent (weight ratio: 70/30) so that the solid concentration became 40% by weight to prepare an anti-glare layer forming material (coating liquid 1) using an ultrasonic disperser.

[0127] [Coating liquid 2: low reflection layer forming material]

As a resin contained in the low reflection layer, 100 parts by weight of a polyfunctional acrylate containing pentaerythritol triacrylate as a main component (trade name: "Viscoat #300", produced by OSAKA ORGANIC CHEMICAL INDUSTRY LTD, solid content 100%) was prepared. Per 100 parts by weight of the resin solid content of the resin, 30 parts by weight of an organosilica sol (particle size: 10 to 15 nm), 100 parts by weight of hollow silica particles (weight-average particle size: 75 nm), 10 parts by weight of photopolymerization initiators (trade names: "IRGACURE 907" and "IRGACURE 2959" produced by BASF Co., Ltd.) in total, and 10 parts by weight of a radically reactive group-containing fluorine-based antifouling additive were mixed. This mixture was diluted with methyl isobutyl ketone/propylene glycol monomethyl ether acetate mixed solvent (weight ratio: 25/75) so that the solid concentration became 1.5% by weight to prepare a low reflection layer forming material (coating liquid 2) using an ultrasonic disperser.

[0128] [Coating liquid 3: anti-glare layer forming material]

The coating liquid 1 was diluted with a toluene/methyl ethyl ketone (MEK) mixed solvent (weight ratio: 70/30) so that the solid concentration became 42% by weight to prepare an anti-glare layer forming material (coating liquid 3).

[0129] [Coating liquid 4: anti-glare layer forming material]

0.5 parts by weight of inorganic particles (Sekisui Chemical Industry Co., Ltd., product name: "TECHPOLYMER SSX-103DXE" weight-average particle size: 3.0 μ m) per 100 parts by weight of resin solid content was mixed to the coating liquid 1 to obtain a mixture. The mixture was diluted with a toluene/methyl ethyl ketone (MEK) mixed solvent (weight ratio: 70/30) so that the solid concentration of the mixture became 42% by weight to prepare an anti-glare layer forming material (coating liquid 4).

[0130] [Coating liquid 5: anti-glare layer forming material]

The coating liquid 1 was diluted with a toluene/methyl ethyl ketone (MEK) mixed solvent (weight ratio: 70/30) so that the solid concentration became 38% by weight to prepare an

anti-glare layer forming material (coating liquid 3).

[0131] [Coating liquid 6: anti-glare layer forming material]

0.5 parts by weight of inorganic particles (Sekisui Chemical Industry Co., Ltd., product name "TECHPOLYMER SSX-103DXE") per 100 parts by weight of resin solid content was mixed to the coating liquid 1 to obtain a mixture. The mixture was diluted with a toluene/methyl ethyl ketone (MEK) mixed solvent (weight ratio: 70/30) so that the solid concentration of the mixture became 40% by weight to prepare an anti-glare layer forming material (coating liquid 6).

[0132] [Coating liquid 7: anti-glare layer forming material]

0.5 parts by weight of inorganic particles (Sekisui Chemical Industry Co., Ltd., product name "TECHPOLYMER SSX-103DXE") per 100 parts by weight of resin solid content was mixed to the coating liquid 1 to obtain a mixture. The mixture was diluted with a toluene/methyl ethyl ketone (MEK) mixed solvent (weight ratio: 70/30) so that the solid concentration of the mixture became 38% by weight to prepare an anti-glare layer forming material (coating liquid 6).

[0133] Example 1

An anti-glare film was produced in the following manner.

[0134] As the translucent base (A), a transparent plastic film base (acrylic film, produced by Toyo Kohan Co., Ltd., trade name: "HX-40UC", thickness: 40 μm , refractive index: 1.50) was prepared. The anti-glare layer forming material (coating liquid 1) was applied to one surface of the transparent plastic film base using a wire bar to form a coating film (coating). The coating film was then dried by heating at 100°C for 1 minute (drying). Thereafter, the coating film was cured by being irradiated with ultraviolet having an accumulated light amount of 300 mJ/cm^2 using a high-pressure mercury lamp to form the anti-glare layer (B) having a thickness of 6.5 μm . The anti-glare layer (B) in the anti-glare film of the present embodiment is an anti-glare hard coat layer. The same applies to the all of the following Examples and Comparative Examples.

[0135] Further, on the anti-glare layer (B), the low reflection layer forming material (coating liquid 2) was applied using a spin coater to form a coating film (coating). Then, the coating film was dried by heating at 90°C for 1 minute (drying). Thereafter, the coating film was cured by being irradiated with ultraviolet having an accumulated light amount of 300 mJ/cm^2 using a high-pressure mercury lamp to form the low reflection layer (C) having a thickness of 100 nm, thereby obtaining an anti-glare film of the present embodiment.

[0136] [Example 2]

An anti-glare film was produced in the same manner as in Example 1, except that the coating liquid 3 was used instead of the coating liquid 1 as the anti-glare layer forming material.

[0137] [Example 3]

An anti-glare film was produced in the same manner as in Example 1, except that the

coating liquid 4 was used instead of the coating liquid 1 as the anti-glare layer forming material.

[0138] [Example 4]

An anti-glare film was produced in the same manner as in Example 1, except that the coating liquid 5 was used instead of the coating liquid 1 as the anti-glare layer forming material.

5 [0139] [Example 5]

An anti-glare film was produced in the same manner as in Example 1 except that the thickness (film thickness) of the anti-glare layer (B) was set to 8.5 μm .

[0140] [Example 6]

10 An anti-glare film was produced in the same manner as in Example 1 except that the coating liquid 6 was used instead of the coating liquid 1 as the anti-glare layer forming material and the thickness (film thickness) of the anti-glare layer (B) was set to 5.0 μm .

[0141] [Example 7]

An anti-glare film was produced in the same manner as in Example 1 except that the low reflection layer (C) was not formed on the anti-glare layer (B).

15 [0142] [Comparative Example 1]

An anti-glare film was produced in the same manner as in Example 1 except that the coating liquid 6 was used instead of the coating liquid 1 as the anti-glare layer forming material.

[0143] [Comparative Example 2]

20 An anti-glare film was produced in the same manner as in Example 1 except that the coating liquid 6 was used instead of the coating liquid 1 as the anti-glare layer forming material and the thickness (film thickness) of the anti-glare layer (B) was set to 8.5 μm .

[0144] [Comparative Example 3]

An anti-glare film was produced in the same manner as in Example 1, except that the coating liquid 7 was used instead of the coating liquid 1 as the anti-glare layer forming material.

25 [0145] [Comparative Example 4]

An anti-glare film was produced in the same manner as in Comparative Example 1 except that the low reflection layer (C) was not formed on the anti-glare layer (B).

30 [0146] For the anti-glare film of Examples 1 to 7 and Comparative Examples 1 to 4 produced as described above, the average tilt angle θ_a ($^\circ$), ten-point average height R_z (μm), the arithmetic average surface roughness R_a (μm), and the average convex-to-convex distance S_m (mm) of the asperities of the outermost surface (the anti-glare layer (B) surface or the low reflection layer (C) surface) on the side of the anti-glare layer (B) were measured or calculated by the following method.

[0147] [Measurement and calculation method of asperities]

35 In accordance with JIS B0601 (1994 edition), the average convex-to-convex distance

Sm (mm), the ten-point average height Rz (μm), and the arithmetic average surface roughness Ra (μm) of the outermost surface of the anti-glare film 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 attached to the surface of the translucent base (A) of the anti-glare film on the side opposed to the anti-glare layer (B) to prepare a sample. Next, using a stylus-type surface roughness measuring instrument having a measuring needle having a radius of curvature $R = 2 \mu\text{m}$ 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 outermost surface (the surface of the anti-glare layer (B) or the surface of the low reflection layer (C)) of the sample on the side of the anti-glare layer (B) was measured in a constant direction. Based on this measurement, the average convex-to-convex distance Sm, the ten-point average height Rz, and the arithmetic average surface roughness Ra of the outermost surface (mm) were calculated. Furthermore, the average tilt angle θ_a ($^\circ$) was calculated from the surface roughness curve obtained based on the measured value (calculated value). The high-precision microfigure measuring instrument automatically calculates each measured value.

[0148] Further, for the anti-glare films of Examples 1 to 7 and Comparative Examples 1 to 4, suppression of generation of white haze was determined (evaluated) by the following method.

[0149] [White haze determination method]

(1) A black acrylic plate (thickness: 2.0 mm, produced by Mitsubishi Rayon Co., Ltd.) was attached to a surface of the anti-glare film on which the anti-glare layer (B) had not been formed, with a pressure-sensitive adhesive. Thereby, a sample having a back surface with no reflection was produced.

(2) In an office environment (about 1000 Lx) where displays are used in general, the sample was illuminated by a fluorescent lamp (three wavelength light source), and white haze of the sample produced was evaluated by visual check according to the following criteria:

Evaluation criteria:

OK: a wavy color difference of black and white is not visually recognized or the color difference is small enough that there is no problem in practical use.

NG: a wavy color difference of black and white is visually recognized.

[0150] The asperities of the outermost surfaces of the anti-glare films of Examples 1 to 7 and Comparative Examples 1 to 4 and the white haze determination results are summarized in Table 1 below.

[0151] Table 1

	Sample No.	Layer configuration	Surface profile value				Anti-glare layer configuration			Determination
			Arithmetic average height	Ten-point average height	Average tilt angle	Average convex-to-convex distance	Number of parts of inorganic particle	Total solid concentration	Anti-glare layer thickness	
			Ra	Rz	θ_a	Sm				White haze
Ex. 1	1	Anti-glare layer + low reflection layer	0.041	0.171	0.197	0.138	0	40%	6.5	OK
Ex. 2	2	Anti-glare layer + low reflection layer	0.033	0.143	0.173	0.136	0	42%	6.5	OK
Ex. 3	3	Anti-glare layer + low reflection layer	0.045	0.184	0.190	0.169	0.5	42%	6.5	OK
Ex. 4	4	Anti-glare layer + low reflection layer	0.043	0.180	0.193	0.164	0	38%	6.5	OK
Ex. 5	5	Anti-glare layer + low reflection layer	0.045	0.179	0.193	0.165	0	40%	8.5	OK
Ex. 6	6	Anti-glare layer + low reflection layer	0.048	0.190	0.192	0.144	0.5	40%	5.0	OK
Ex. 7	7	Anti-glare layer	0.045	0.198	0.237	0.138	0	40%	6.5	OK
Comp.	8	Anti-glare layer +	0.052	0.230	0.260	0.142	0.5	40%	6.5	NG

[0152] As shown in Table 1 above, in the anti-glare films of Examples 1 to 7 satisfying $\theta_a \leq 0.24$ and $R_z \leq 0.20$, white haze was suppressed. On the other hand, in the anti-glare films of Comparative Examples 1 to 4 not satisfying $\theta_a \leq 0.24$ and $R_z \leq 0.20$, suppression of white haze was insufficient. As for the anti-glare properties, all of the anti-glare films of Examples 1 to 7 could prevent the reflected glare of the image of the outline of the fluorescent lamp under the conditions of the white haze determination method, and thus, the anti-glare properties were at a level with no problem in practical use.

Industrial Applicability

[0153] As described above, the present invention can provide an anti-glare film suppressed from generation of white haze, a method for producing the anti-glare film, an optical member, 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.

[0154] This application claims priority from Japanese Patent Application No. 2018-213945 filed on November 14, 2018. The entire subject matter of the Japanese Patent Applications is incorporated herein by reference.

Reference Signs List

[0155]

- 10: anti-glare film
- 11: translucent base (A)
- 12: anti-glare layer (B)
- 12a: resin layer
- 12b: particle
- 12c: thixotropy-imparting agent
- 13: low reflection layer (C) (other layer)

1. An anti-glare film, comprising:

a translucent base (A); and

5 an anti-glare layer (B), wherein

the anti-glare layer (B) is laminated on the translucent base (A),

asperities are formed on an outermost surface of the anti-glare film on a side of the anti-glare layer (B), and

the asperities satisfy the following mathematical equations (1) and (2):

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$$\theta_a \leq 0.24 \quad (1)$$

$$R_z \leq 0.20 \quad (2)$$

where in the mathematical equation (1), θ_a is an average tilt angle [$^\circ$] of the asperities,

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in the mathematical equation (2), R_z is a ten-point average height [μm] of the asperities.

2. The anti-glare film according to claim 1, further satisfying the following mathematical equation (3):

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$$R_a \leq 0.050 \quad (3)$$

where in the mathematical equation (3), R_a is an arithmetic average surface roughness [μm] of the asperities.

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3. The anti-glare film according to claim 1 or 2, further comprising:

other layer laminated on the surface of the anti-glare layer (B) on the side opposite to the translucent base (A).

30 4. An anti-glare film, comprising:

a translucent base (A);

an anti-glare layer (B); and

other layer, wherein

the anti-glare layer (B) and the other layer are laminated in this order on the translucent

35 base (A),

asperities are formed on an outermost surface of the other layer, and the asperities satisfy the following mathematical equations (1) and (2):

$$\theta_a \leq 0.24 \quad (1)$$

$$5 \quad R_z \leq 0.20 \quad (2)$$

where in the mathematical equation (1), θ_a is an average tilt angle [$^\circ$] of the asperities, and

in the mathematical equation (2), R_z is a ten-point average height [μm] of the asperities.

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5. The anti-glare film according to claim 3 or 4, wherein the other layer is a low reflection layer (C).

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6. The anti-glare film according to any one of claims 1 to 5, wherein the anti-glare layer (B) contains a binder resin and a flocculation filler.

7. The anti-glare film according to claim 6, wherein the flocculation filler is organoclay.

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8. The anti-glare film according to any one of claims 1 to 7, wherein the anti-glare layer (B) contains no particles.

9. A method for producing the anti-glare film according to any one of claims 1 to 8, comprising the steps of:

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forming the anti-glare layer (B) on the translucent base (A); and

forming asperities on an outermost surface of the anti-glare film on a side of the anti-glare layer (B) so as to satisfy the mathematical equations (1) and (2), wherein

the anti-glare layer (B)-forming comprises the steps of:

coating a coating liquid on the translucent base (A); and

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forming a coating film by drying the coated coating liquid, and

the coating liquid contains a resin and a solvent.

10. The method according to claim 9, wherein the anti-glare layer (B)-forming further comprises the step of curing the coating film.

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11. The method according to claim 9 or 10, wherein
the solvent contains toluene and methyl ethyl ketone.

12. The method according to any one of claims 9 to 11, wherein

5 the anti-glare film is the anti-glare film according to any one of claims 3 to 5, and
the asperities-forming comprises the step of forming the other layer on the anti-glare
layer (B).

13. An optical member comprising the anti-glare film according to any one of claims 1 to 8.

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14. The optical member according to claim 13, which is a polarizing plate.

15. An image display device comprising the anti-glare film according to any one of claims 1
to 8 or the optical member according to claim 13 or 14.

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