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DESCRIPTION

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

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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 increases, the number of image display devices equipped with anti-glare films is increasing.

15 [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] From the viewpoint of visibility, the anti-glare film needs to be suppressed from reflected glare due to reflection of external light.

[0006] For example, in recent years, the demand for public information displays (PIDs) has increased. PIDs are often used outdoors. When a display (image display device) is used outdoors, reflected glare due to reflection of external light is more likely to occur than when it is used indoors. If reflected glare occurs, it may be difficult to visually recognize the image.

30 [0007] With the foregoing in mind, it is an object of the present invention to provide an anti-glare film suppressed from reflected glare, a method for producing the anti-glare film, an optical member, and an image display device.

Solution to Problem

35 [0008] In order to achieve the above object, the present invention provides an anti-glare film

including: 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):

5 $Ry \geq 1$ (1)

$\theta_a \geq 0.7$ (2)

where in the mathematical equation (1), Ry is a maximum height [μm] of a convex portion of the asperities, and

in the mathematical equation (2), θ_a is an average tilt angle [$^\circ$] of the asperities.

10 [0009] The present invention also provides a method for producing the anti-glare film according to the present invention, including the step of: forming the anti-glare layer (B) on the translucent base (A) 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
15 contains a resin and a solvent.

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

20 Advantageous Effects of Invention

[0012] The present invention can provide an anti-glare film suppressed from reflected glare, 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 an anti-glare film of the
25 present invention.

[FIG. 2] FIG. 2 is a cross-sectional view showing another example of the anti-glare film of the present invention.

[FIG. 3] FIG. 3 is a cross-sectional view showing an example of an anti-glare film.

DESCRIPTION OF EMBODIMENTS

30 [0014] Next, the present invention is described in details with reference to examples. The present invention, however, is not limited thereto.

[0015] In the anti-glare film of the present invention, for example, the anti-glare layer (B) may contain fine particles.

[0016] In the anti-glare film of the present invention, for example, asperities may be formed on
35 a surface of the anti-glare layer (B) on a side opposite to the translucent base (A) and a weight-

average particle size of the fine particles may be larger than a thickness obtained by subtracting the maximum height of the convex portion of the asperities from a maximum thickness of the anti-glare layer (B).

[0017] In the anti-glare film of the present invention, for example, the weight-average particle size of the fine particles may be in a range from 2 to 10 μm .

[0018] 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).

[0019] The anti-glare film may be, for example, an 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 outermost surface of the other layer, and the asperities satisfy the following mathematical equations (1) and (2):

$$R_y \geq 1 \quad (1)$$

$$\theta_a \geq 0.7 \quad (2)$$

where in the mathematical equation (1), R_y is a maximum height [μm] of a convex portion of the asperities, and

in the mathematical equation (2), θ_a is an average tilt angle [$^\circ$] of the asperities.

[0020] 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.

[0021] In the anti-glare film production method of the present invention, for example, the coating liquid may contain fine particles.

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

[0023] The image display device of the present invention may be a public information display.

[0024] [1. Anti-glare film]

As described above, an 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):

$$R_y \geq 1 \quad (1)$$

$$\theta_a \geq 0.7 \quad (2)$$

where in the mathematical equation (1), R_y is a maximum height [μm] of a convex portion of the asperities, and

in the mathematical equation (2), θ_a is an average tilt angle [$^\circ$] 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 layer (B) 12 is laminated on one surface of a translucent base (A) 11. In the anti-glare layer (B) 12, fine particles 12b and a thixotropy-imparting agent 12c are contained in a resin layer 12a.

5 Asperities are formed on the outermost surface of the anti-glare film 10 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 maximum height R_y of the convex portion of the asperities is $1\ \mu\text{m}$ or more. The average tilt angle θ_a (not shown) of the asperities is 0.7° or more. The particle size D of the fine particle 12b is larger than the film thickness t obtained by subtracting R_y from the maximum thickness d of the anti-glare layer (B). However, FIG. 1 is illustrative, and the present invention is not limited thereto. For example, the anti-glare film of the present invention may or may not contain fine particles and a thixotropy-imparting agent. While the particle size D of the fine particle 12b is larger than the film thickness t of the anti-glare layer (B) in FIG. 1, the present invention is not limited thereto.

15 [0026] FIG. 3 is a cross-sectional view showing an example of the configuration of an anti-glare film which is not an anti-glare film of the present invention. This anti-glare film is the same as the anti-glare film of FIG. 1 except that the maximum height R_y of the asperities is less than $1\ \mu\text{m}$ and the average tilt angle θ_a (not shown) of the asperities is less than 0.7° .

[0027] 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, this anti-glare film 10 has other layer 13 laminated on the surface of the anti-glare layer (B) 12 on the side opposite to the translucent base (A) 11. The other layer 13 is not particularly limited, and may be, for example, a low refractive index layer, an antireflection layer, a high refractive index layer, a hard coat layer, a pressure-sensitive adhesive layer, or the like. Except for this, the configuration of the anti-glare film 10 of FIG. 2 is the same as that of the anti-glare film 10 of FIG. 1. In FIG. 2, asperities are formed on the outermost surface of the anti-glare film 10 on the side of the anti-glare layer (B) 12 (the surface of the other layer 13 on the side opposite to the translucent base (A) 11). The maximum height R_y of the convex portion of the asperities is $1\ \mu\text{m}$ or more. The average tilt angle θ_a (not shown) of the asperities is 0.7° or more. The maximum height of the portions (the anti-glare layer (B) 12 and the other layer 13) of the anti-glare film 10 other than the translucent base (A) 11 is represented by d in FIG. 2. Asperities are formed on the surface of the anti-glare layer (B) 12 on the side opposite to the translucent base (A) 11 (on the side of the other layer 13). The film thickness obtained by subtracting the maximum height R_y' of the asperities of the anti-glare layer (B) 12 from the maximum thickness d' of the anti-glare layer (B) 12 is represented by t in FIG. 2. As shown in FIG. 2, t is equal to " $d' - R_y'$ " and equal to " $d - R_y$ ". The particle size D

of the fine particle 12b is larger than the film thickness t as in the case of FIG. 1, but as described above, the present invention is not limited to this. In addition, as in the case of FIG. 1, the anti-glare layer (B) 12 may or may not contain fine particles and/or a thixotropy-imparting agent.

While the other layer 13 is a single layer in FIG. 2, the other layer 13 may include a plurality of layers. When the anti-glare film has no other layer 13, R_y' is equal to R_y and d' is equal to d , as shown in FIG. 1.

[0028] 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 will be mainly described below, the present invention is not limited thereto.

[0029] 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 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 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 anti-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.

[0030] 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 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.

[0031] In the anti-glare film of the present invention, for example, a resin contained in the translucent base (A) may contain an acrylic resin.

[0032] In the anti-glare film of the present invention, for example, the translucent base (A) may

be an acrylic film.

[0033] As described above, asperities are formed on the outermost surface on the anti-glare film of the present invention on the side of the anti-glare layer (B), and the maximum height R_y of the asperities is 1 μm or more. The maximum height R_y may be, for example, 1.5 μm or more, and may be, for example, 9 μm or less, 8 μm or less, 7 μm or less, or 6 μm or less. The maximum height R_y may be, for example, in the range from 1 to 9 μm , from 1 to 8 μm , from 1 to 7 μm , or from 1.5 to 6 μm . The R_y is preferably large from the viewpoint of suppressing reflected glare, but is preferably not too large from the viewpoint of haze value to be described below. In the present invention, the maximum height R_y is a numerical value based on JIS B 0601 (1994 edition). The method for measuring R_y is not particularly limited, and can be measured by, for example, a measurement method described in Examples described below.

[0034] 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., FIG. 1). The "outermost surface on the side of the anti-glare layer (B)" is the outermost surface of the other layer on the side opposite to the translucent base (A) when the anti-glare film includes the other layer (e.g., FIG. 2).

[0035] 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 0.7 or more. The average tilt angle θ_a may be 0.7 $^\circ$ or more, 0.8 $^\circ$ or more, 0.9 $^\circ$ or more, or 1.0 $^\circ$ or more, or may be 8 $^\circ$ or less, 7 $^\circ$ or less, 6 $^\circ$ or less, or 5 $^\circ$ or less, for example. The average tilt angle θ_a may be in the range from 0.7 to 8 $^\circ$, 0.7 to 7 $^\circ$, 0.7 to 6 $^\circ$, 0.7 to 5 $^\circ$, 0.8 to 8 $^\circ$, 0.8 to 7 $^\circ$, 0.8 to 6 $^\circ$, 0.8 to 5 $^\circ$, 0.9 to 8 $^\circ$, 0.9 to 7 $^\circ$, 0.9 to 6 $^\circ$, 0.9 to 5 $^\circ$, 1.0 to 8 $^\circ$, 1.0 to 7 $^\circ$, 1.0 to 6 $^\circ$, or 1.0 to 5 $^\circ$, for example. The θ_a is preferably large from the viewpoint of suppressing reflected glare, but is preferably not too large from the viewpoint of haze value to be described below. The average tilt angle θ_a is a value defined by the following mathematical equation (3). The average tilt angle θ_a can be measured, for example, by the method described in Examples to be described below.

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

[0036] 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 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.

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

[0037] The anti-glare film of the present invention may have, for example, a haze value of 4% or more, 6% or more, 10% or more, or 15% or more, and may have, for example, a haze value of 50% or less, 40% or less, 35% or less, or less than 30%. The haze value may be, for example, in the range from 4 to 50%, from 6 to 40%, from 10 to 40%, further from 15 to 40%, or from 15 to 35%. The haze value is a haze value (cloudiness) of the entire anti-glare film according to JIS K 7136 (2000 edition). In general, in the anti-glare film, if the haze value is large, reflected glare is likely to be suppressed. However, if the haze value is too large, the display characteristics tend to deteriorate, for example, the image becomes blurred, the contrast in a dark place decreases, and the like. However, according to the present invention, R_y and θ_a satisfy the mathematical equations (1) and (2) so that the reflected glare can be suppressed, even if the haze value is, for example, 50% or less, 40% or less, 35% or less, or less than 30%. In order to reduce the haze value as much as possible, in addition to the adjustment of R_y and θ_a , the fine particles and the resin may be selected so that the difference in the refractive index between the resin and the fine particles to be described below becomes as small as possible (e.g., in the range from 0.001 to 0.02).

[0038] 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 fine particles and a thixotropy-imparting agent (thixotropic agent).

[0039] 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).

[0040] 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.

[0041] 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.

[0042] 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-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

direction in which the fillers are gathered coincides with the long side direction of the black matrix pattern.

[0043] 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.

[0044] 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.

[0045] The anti-glare film of the present invention may contain the fine particles in the range from 0.2 to 12 parts by weight or 0.5 to 12 parts by weight relative to 100 parts by weight of the resin of the anti-glare layer (B), for example.

[0046] 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 fine particles relative to 100 parts by weight of the resin in the anti-glare layer forming material.

[0047] 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.

[0048] 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.

[0049] 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.

[0050] The main function of the fine 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 fine particles and the resin. Examples of the fine particles include inorganic fine particles and organic fine particles. The inorganic fine 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 fine 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 fine particles and organic fine particles may be used alone, or two or more kinds of the same may be used in combination.

[0051] The particle size (D) (weight-average particle size) of the fine 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 fine 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 fine 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 fine particles be not too large. The weight-average particle size of the fine particles may be, for example, 2 μm or more or 3 μm or more, and may be, for example, 10 μm or less, 9 μm or less, or 8 μm or less. The weight-average particle size of the fine particles may be, for example, in the range from 2 to 10 μm , 2 to 9 μm , or 3 to 8 μm . The weight-average particle size of the fine 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 fine particles when the fine particles pass through the pores. Thus, the number and volume of fine particles are measured and then the weight-average particle size is calculated.

[0052] The shape of the fine 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 fine particles are spherical particles.

[0053] The content ratio of the fine particles in the anti-glare layer (B) is not particularly limited, and may be appropriately set in consideration of, for example, the surface profile of the anti-glare layer (B). The relationship between the content ratio (number of parts by weight relative to the resin) and the weight-average particle size of the fine particles and the surface profile of the anti-glare layer (B) will be described below.

[0054] In the anti-glare layer (B), the filler may be fine 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 fine particles. By containing the thixotropy-imparting agent, the flocculated state of the fine particles can be easily controlled. Examples of the thixotropy-imparting agent include organoclay, oxidized polyolefin, and denatured urea.

[0055] 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).

[0056] 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).

[0057] 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).

[0058] One kind of the thixotropy-imparting agents may be used alone, or two or more kinds of them may be used in combination.

[0059] 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.

[0060] 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-average particle size (D) of the fine 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 fine 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 .

[0061] The ratio D/d' between the thickness (d') of the anti-glare layer (B) and the weight-average particle size (D) of the fine particles may be, for example, 1 or less, less than 1, 0.98 or less, 0.96 or less, 0.93 or less, 0.90 or less, and 0.5 or more, 0.6 or more, 0.7 or more, or 0.8 or more. 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. For example, when D/d' is large, R_y and θ_a tend to be large.

[0062] 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 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.

[0063] The surface profile of the anti-glare layer (B) can be designed, for example, by adjusting the film thickness t , which is obtained by subtracting the maximum height R_y' of the asperities of the anti-glare layer (B) from the maximum thickness d' of the anti-glare layer (B), and the weight-average particle size D of the fine particles. Specifically, for example, when the weight-average particle size D of the fine particles is relatively large relative to the film thickness t of the anti-glare layer (B), the R_y and θ_a tend to be large. The film thickness t can be adjusted by, for example, the coating thickness of the resin. The surface profile of the anti-glare layer (B) can

also be designed by adjusting the number of parts by weight of the fine particles relative to 100 parts by weight of the resin in the anti-glare layer forming material. For example, when the number of parts by weight of the fine particles is relatively large relative to the resin, θ_a tends to be large.

[0064] Further, the anti-glare film of the present invention may include, for example, an 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_y and θ_a , and decreasing the thickness of the intermediate layer tends to decrease the R_y and θ_a .

[0065] 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 method for producing an anti-glare hard coat film of the present inventor. 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.

[0066] 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 thickness ratio R of the intermediate layer may be, for example, in the range from 0.15 to 0.75, 0.20 to 0.70, 0.25 to 0.65, 0.30 to 0.60, 0.40 to 0.50, 0.45 to 0.50, 0.15 to 0.45, 0.15 to 0.40, 0.15 to 0.30, or 0.20 to 0.30. 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.

[0067] The surface profile of the anti-glare layer (B) can also be designed 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 fine 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 fine particles can be precisely controlled by the thixotropy-imparting agent.

[0068] 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.

[0069] The other layer is not particularly limited, and examples thereof include a low refractive index layer, an antireflection layer, a high refractive index layer, a hard coat layer, and a pressure-sensitive adhesive layer, as described above. The other layer may be a single layer or the other layer may include a plurality of layers, and in the case of a plurality of layers, one kind of the layers or two or more kinds of the same may be used. For example, the other layer may be a thin optical film whose thickness and refractive index are controlled strictly or the one including two or more of the thin optical films laminated together.

[0070] [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.

[0071] The anti-glare film production method can be performed, for example, as follows.

[0072] 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.

[0073] 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.

[0074] The coating liquid preferably exhibits thixotropic properties, and the T_i value defined by the following mathematical equation is preferably in the range from 1.3 to 3.5, more preferably in the range from 1.4 to 3.2, and still more preferably in the range from 1.5 to 3.

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

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

[0075] When the T_i 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 T_i value is 3.5 or less, a problem that the particles are in the dispersed state in which the particles are not flocculated or the like is unlikely to occur.

[0076] Further, while the coating liquid may or may not contain a thixotropy-imparting agent, it is preferable to contain a thixotropy-imparting agent because it tends to exhibit thixotropy.

Further, as described above, when the coating liquid contains the thixotropy-imparting agent, an effect (thixotropy effect) of preventing sedimentation of the particles can be obtained. Further, it is also possible to freely control the surface profile of the anti-glare film in a wider range by shear flocculation of the thixotropy-imparting agent itself.

[0077] 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 to obtain the anti-glare film of the present invention, an optimum solvent type and solvent ratio may be appropriately selected in accordance with the composition of the resin, the kinds of the particles and the thixotropy-imparting agents, and the contents thereof. The solvent is not particularly limited, and examples thereof include alcohols such as methanol, ethanol, isopropyl alcohol (IPA), butanol, t-butyl alcohol (TBA), and 2-methoxyethanol; ketones such as acetone, methylethylketone, methylisobutylketone, and cyclopentanone; esters such as methyl acetate, ethyl acetate, and butyl acetate; ethers such as diisopropyl ether and propyleneglycol

monomethylether; glycols such as ethyleneglycol and propyleneglycol; cellosolves such as ethyl cellosolve and butyl cellosolve; aliphatic hydrocarbons such as hexane, heptane, and octane; and aromatic hydrocarbons such as benzene, toluene, and xylene. Further, for example, the solvent may contain a hydrocarbon solvent and a ketone solvent. The hydrocarbon solvent may be, for example, an aromatic hydrocarbon. The aromatic hydrocarbon may be, for example, at least one selected from the group consisting of toluene, o-xylene, m-xylene, p-xylene, ethylbenzene, and

benzene. The ketone solvent may be, for example, at least one selected from the group consisting of cyclopentanone, acetone, methyl ethyl ketone, methyl isobutyl ketone, diethyl ketone, cyclohexanone, isophorone, and acetophenone. It is preferable that the solvent include, for example, the hydrocarbon solvent (e.g., toluene) in order to dissolve a thixotropy-imparting agent (e.g., a thickener). 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. Further, the solvent may include toluene, and may further include at least one selected from the group consisting of ethyl acetate, butyl acetate, IPA, methyl isobutyl ketone, methyl ethyl ketone, methanol, ethanol, and TBA.

[0078] 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.

[0079] 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.

[0080] 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.

[0081] 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 an antireflection 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.

[0082] 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.

[0083] 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.

[0084] Any of conventionally known photoinitiators described in JP 2008-88309 A can be used in the anti-glare layer forming material, for example.

[0085] 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.

[0086] 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.

[0087] 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.

[0088] 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.

5 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.

[0089] As described above, a laminate of the translucent base (A) and the anti-glare layer (B)
10 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, a high refractive index layer, a hard
15 coat layer, a pressure-sensitive adhesive layer, or the like, for example.

[0090] [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
20 other components. Each of the components of the polarizing plate may be bonded by, for example, an adhesive or a pressure-sensitive adhesive.

[0091] 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.

25 [0092] 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.

[0093] 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
30 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
35 adhesive, or the like are in a wide range corresponding to the surface profile of the anti-glare

film.

[0094] 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.

[0095] 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.

[0096] 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).

[0097] According to the anti-glare film of the present invention, for example, strong external light can be scattered and reflection can be suppressed, so that reflected glare can be suppressed even outdoors. Therefore, the image display device of the present invention can be suitably used for, for example, a public information display for outdoor use. However, the image display device of the present invention is not limited to this application, and can be used for any other application. 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]

[0098] 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.

[0099] 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.

[0100] <Production Example 1> Preparation of Base Film A

5 First, in the same manner as in Production Example 1 of JP 2010-284840 A, an imidized polymethylmethacrylate resin was produced using a tandem type reaction extruder in which two extrusion reactors are aligned in series. As the tandem type reaction extruder, the same direction meshing type twin screw extruder in which the first extruder and the second extruder each has a diameter of 75 mm and L/D (ratio of length L and diameter D of the extruder) of 74 was used. A
10 constant weight feeder (produced by Kubota Corporation) was used to supply the raw material resin to the raw material supply port of the first extruder. The degree of decompression of each vent in the first extruder and the second extruder was set to -0.095 MPa. A pipe having a diameter of 38 mm and a length of 2 m was used for the connection between the first extruder and the second extruder. A constant flow pressure valve was used for the in-part pressure control
15 mechanism connecting the resin discharge port of the first extruder and the raw material supply port of the second extruder. Further, each of the first extruder outlet, the central portion of the connecting part between the first extruder and the second extruder, and the second extruder outlet is provided with a resin pressure gauge. The resin pressure gauge can be used to adjust the pressure in a component connecting the resin discharge port of the first extruder and the raw
20 material supply port of the second extruder, or to determine extrusion variations.

[0101] The imidized polymethyl methacrylate resin was produced as follows. First, a polymethyl methacrylate resin (M_w : 105,000) as a raw material resin and a monomethylamine as an imidizing agent were charged into the first extruder to produce an imide resin intermediate 1. At this time, the temperature of the maximum temperature portion of the extruder was 280°C , the
25 screw rotation speed was 55 rpm, the raw material resin supply amount was 150 kg/hour, and the amount of monomethylamine added was 2.0 parts relative to 100 parts of the raw material resin. The pressure at the monomethylamine inlet of the first extruder was adjusted to 8 MPa by a constant flow pressure valve provided just before the raw material supply port of the second extruder. Next, the imide resin intermediate 1 was transferred into the second extruder, and the
30 remaining imidized reaction reagent and by-products were devolatilized with a rear vent and a vacuum vent. Thereafter, a mixed solution of dimethyl carbonate and triethylamine was added as an esterifying agent to produce an imide resin intermediate 2. At this time, the temperature of each barrel of the second extruder was 260°C , the screw rotation speed was 55 rpm, the amount of dimethyl carbonate added was 3.2 parts relative to 100 parts of the raw material resin, and the
35 amount of triethylamine was 0.8 parts relative to 100 parts of the raw material resin. Further, the

esterifying agent was removed with a vent, then the imide resin intermediate 2 was extruded from the strand die and cooled in an aqueous tank, and then the resultant was pelletized with a pelletizer to obtain an imidized polymethyl methacrylate resin as a target product. The imidization ratio of this imidized polymethyl methacrylate resin was 3.7%, and the acid value was 0.29 mmol/g.

[0102] Next, 100 parts by weight of the imidized polymethylmethacrylate resin and 0.62 parts by weight of a triazine-based UV absorber (trade name: T-712 produced by ADEKA CORPORATION) were mixed in a twin screw kneader at 220°C to prepare a resin pellet. The resin pellet was dried at 100.5 kPa and 100°C for 12 hours, and extruded from the T die at a die temperature of 270°C in a single screw extruder to form a film (thickness: 160 μm). Further, the film was stretched in the conveying direction under an atmosphere of 150°C to have a thickness of 80 μm. Next, the film was stretched in a direction orthogonal to the conveying direction of the film under an atmosphere of 150°C, thereby obtaining a base film A ((meth) acrylic resin film) having a thickness of 40 μm. The transmittance of light having a wavelength of 380 nm of the obtained base film A was 8.5%, the in-plane retardation Re was 0.4 nm, and the thickness direction retardation Rth was 0.78 nm. The moisture permeability of the obtained base film A was 61g/m²•24hr. The light transmittance was measured in the wavelength range of 200 nm to 800 nm using a spectrophotometer (device name; U-4100) produced by Hitachi High-Tech Corporation. to read the transmittance at the wavelength of 380 nm. The retardation was measured using the device (trade name: "KOBRA21-ADH") produced by Oji Scientific Instruments at the wavelength of 590 nm at 23°C. The moisture permeability was measured by the method according to JIS K 0208 at the relative humidity of 92% at 40°C.

[0103] [Coating Liquid 1]

60 parts of pentaerythritol triacrylate (PETA) (produced by OSAKA ORGANIC CHEMICAL INDUSTRY LTD, trade name: Viscoat #300, concentration: 80%), 40 parts of 15 functional urethane acrylic oligomer (produced by SHIN-NAKAMURA CHEMICAL CO, LTD., trade name: NK OLIGO UA-53H, weight-average molecular weight: 2300, concentration: 100%), 20 parts of 4-hydroxybutyl acrylate (produced by OSAKA ORGANIC CHEMICAL INDUSTRY LTD, trade name: 4-HBA, concentration: 100%), 1 part of leveling agent (produced by DIC Corporation, trade name: GRANDIC PC-4100), 5 parts of photopolymerization initiator (produced by BASF Japan Ltd., trade name: IRGACURE 907), 8 parts of fine particles of crosslinked acrylic styrene copolymer resin (produced by SEKISUI PLASTICS Co., Ltd., trade name: SSX1055QXE, weight-average particle size: 5.5 μm), and 2.5 parts of a thickener (a thixotropy-imparting agent, produced by Kunimine Industries, Co. Ltd., trade name: smectin SAN adjusted to a concentration of 6% with toluene) were mixed and diluted so that the total

amount of toluene and methyl ethyl ketone was 7:3, thereby preparing a coating liquid 1 (composition for forming an anti-glare layer).

[0104] [Coating Liquid 2]

A coating liquid 2 (composition for forming an anti-glare layer) was prepared in the same manner as the coating liquid 1, except that fine particles of the crosslinked acrylic styrene copolymer resin of the coating liquid 1 were changed to 6 parts of fine particles of the crosslinked acrylic styrene copolymer resin having a weight-average particle size of 3.0 μm .

[0105] [Coating Liquid 3]

A coating liquid 3 (composition for forming an anti-glare layer) was prepared in the same manner as in the coating liquid 1, except that fine particles of the crosslinked acrylic styrene copolymer resin of the coating liquid 1 were changed to 20 parts of fine particles of the crosslinked acrylic styrene copolymer resin having a weight-average particle size of 8.0 μm .

[0106] <Measurement Method>

[Measurement of Surface Shape]

A glass sheet (with a thickness of 1.3 mm) produced by Matsunami Glass Ind., Ltd. was attached to a surface of an anti-glare film on which no anti-glare layer had been formed, with a pressure-sensitive adhesive. Subsequently, the surface profile

of the anti-glare layer (B) was measured under the condition where a cutoff value was 0.8 mm using a high-precision microfigure measuring instrument (SURFCORDER ET4000 (trade name), produced by Kosaka Laboratory Ltd.), and the maximum height and the average tilt angle were calculated. Furthermore, the average values obtained by measuring the maximum height and the average tilt angle at any 10 points were defined as the maximum height R_y and the average tilt angle θ_a , respectively. The high-precision microfigure measuring instrument automatically calculated the maximum height R_y and the average tilt angle θ_a . The method for measuring and calculating the maximum height R_y and the average tilt angle θ_a was based on JIS B 0601 (1994 edition).

[0107] [Reflected glare]

(1) A black acrylic plate (with a thickness of 2.0 mm, produced by Mitsubishi Rayon Co., Ltd.) was attached to a surface of the anti-glare film on which no anti-glare layer had been formed, with a pressure-sensitive adhesive. Thus, 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 anti-glare properties of the sample produced above were evaluated by visual check according to the following criteria:

Evaluation criteria:

Excellent: anti-glare properties are superior, and no reflected glare of an image of the outline of the fluorescent lamp remains

Good: anti-glare properties are inferior to that of Excellent, but reflected glare can be prevented without problems

5 Poor: the outline of the fluorescent lamp is not blurred, and is clearly reflected.

[0108] [Film Thickness t]

10 The maximum thickness of the anti-glare layer (B) was measured at the same 10 points as the measuring point of the maximum height R_y using a high-precision microfigure measuring instrument (SURFCORDER ET4000 (trade name)). The average value of the measured values of the maximum thickness at the 10 points was defined as the maximum thickness d of the anti-glare layer (B). A numerical value obtained by subtracting the maximum height R_y from the maximum thickness d was defined as a film thickness t of the anti-glare layer (B). The high-precision microfigure measuring instrument automatically calculates the maximum thickness d and the film thickness t . In the present Example and the Comparative Example, since the

15 maximum thickness d is substantially equal to the weight-average particle size of the fine particles, a numerical value obtained by subtracting the maximum height R_y from the weight-average particle size can be approximately defined as the film thickness t .

[0109] Haze Value

20 The haze value was measured by setting the anti-glare film alone according to the haze defined in JIS K 7136 (2000 edition) using a haze meter (trade name: "HM-150", produced by MURAKAMI COLOR RESEARCH LABORATORY).

[0110] [Example 1]

25 A coating liquid 1 was applied (coated) to one surface of the base (translucent base (A)) of Production Example 1 to form an applying layer (coating layer). Thereafter, the coating layer was dried by heating at 90°C for 1 minute to form a coating film. Thereafter, the coating film was cured by being irradiated with ultraviolet having an accumulated light amount of 300 mJ/cm² using a high-pressure mercury lamp to form the anti-glare layer (B), thereby obtaining a target anti-glare film. The maximum height R_y of the anti-glare layer (B) was 4.6 μm. In the present embodiment, the anti-glare layer (B) is an anti-glare hard coat layer. The same applies to

30 the following Examples and Comparative Examples.

[0111] [Example 2]

 An anti-glare film was obtained in the same manner as in Example 1 except that the maximum height R_y of the anti-glare layer (B) was set to 2.6 μm by changing the thickness of the coating film.

35 [0112] [Example 3]

An anti-glare film was obtained in the same manner as in Example 1 except that the maximum height R_y of the anti-glare layer (B) was set to 1.8 μm by changing the thickness of the coating film.

[0113] [Example 4]

5 An anti-glare film was obtained in the same manner as in Example 1 except that the maximum height R_y of the anti-glare layer (B) was set to 1.1 μm by changing the thickness of the coating film.

[0114] [Example 5]

10 An anti-glare film was obtained in the same manner as in Example 1 except that the coating liquid 1 was changed to the coating liquid 2 and the maximum height R_y of the anti-glare layer (B) was set to 2.4 μm .

[0115] [Example 6]

15 An anti-glare film was obtained in the same manner as in Example 5 except that the maximum height R_y of the anti-glare layer (B) was set to 1.5 μm by changing the thickness of the coating film.

[0116] [Example 7]

An anti-glare film was obtained in the same manner as in Example 5 except that the maximum height R_y of the anti-glare layer (B) was set to 1.1 μm by changing the thickness of the coating film.

20 [0117] [Example 8]

An anti-glare film was obtained in the same manner as in Example 1 except that the coating liquid 1 was changed to the coating liquid 3 and the maximum height R_y of the anti-glare layer (B) was set to 6.9 μm .

[0118] [Example 9]

25 An anti-glare film was obtained in the same manner as in Example 1 except that the coating liquid 1 was changed to the coating liquid 3 and the maximum height R_y of the anti-glare layer (B) was set to 4.5 μm .

[0119] [Example 10]

30 An anti-glare film was obtained in the same manner as in Example 1 except that the coating liquid 1 was changed to the coating liquid 3 and the maximum height R_y of the anti-glare layer (B) was set to 2.6 μm .

[0120] [Example 11]

35 An anti-glare film was obtained in the same manner as in Example 5 except that the maximum height R_y value of the anti-glare layer (B) was set to 1.8 μm by changing the thickness of the coating film.

[0121] [Example 12]

An anti-glare film was obtained in the same manner as in Example 5 except that the maximum height R_y of the anti-glare layer (B) was set to 1.2 μ by changing the thickness of the coating film.

5 [0122] [Comparative Example 1]

A coating liquid obtained by removing 8 parts of fine particles of crosslinked acrylic styrene copolymer resin (produced by SEKISUI PLASTICS Co., Ltd., trade name: SSX1055QXE, average particle size: 5.5 μ m) from the coating liquid 1 was again coated on the anti-glare layer (A) in the anti-glare film of Example 2. Thereafter, the overcoated layer was
10 dried and cured by the same method as in Example 1 to form an anti-glare layer. The maximum height R_y of this anti-glare layer was less than 1.0 μ m.

[0123] [Comparative Example 2]

A coating liquid obtained by removing 8 parts of fine particles of crosslinked acrylic styrene copolymer resin (produced by SEKISUI PLASTICS Co., Ltd., trade name:
15 SSX1055QXE, average particle size: 5.5 μ m) from the coating liquid 1 was again coated on the anti-glare layer (A) in the anti-glare film of Example 5. Thereafter, the overcoated layer was dried and cured by the same method as in Example 1 to form an anti-glare layer. The maximum height R_y of this anti-glare layer was less than 1.0 μ m.

[0124] [Comparative Example 3]

20 A coating liquid obtained by removing 8 parts of fine particles of crosslinked acrylic styrene copolymer resin (produced by SEKISUI PLASTICS Co., Ltd., trade name: SSX1055QXE, average particle size: 5.5 μ m) from the coating liquid 1 was again coated on the anti-glare layer (A) in the anti-glare film of Example 10. Thereafter, the overcoated layer was dried and cured by the same method as in Example 1 to form an anti-glare layer. The maximum
25 height R_y of this anti-glare layer was less than 1.0 μ m.

[0125] [Comparative Example 4]

An anti-glare film was obtained in the same manner as in Example 8, except that no smectin SAN was added (addition amount: 0 parts) and the amount of fine particles added was changed to 0.3 parts. The average tilt angle θ_a of the asperities of the anti-glare layer in this anti-
30 glare film was less than 0.7°.

[0126] [Comparative Example 5]

An anti-glare film was obtained in the same manner as in Example 1, except that no smectin SAN was added (addition amount: 0 parts) and the amount of fine particles added was changed to 0.1 parts. The average tilt angle θ_a of the asperities of the anti-glare layer in this anti-
35 glare film was less than 0.7°.

[0127] The film thickness t (the thickness obtained by subtracting the maximum height of the convex portion of the asperities from the maximum thickness of the anti-glare layer (B)), the maximum height R_y of the convex portion of the asperities of the outermost surface, the average tilt angle θ_a of the asperities of the outermost surface, the haze value, and the reflected glare test results in Examples 1 to 12 and Comparative Examples 1 to 5 are summarized in Table 1 below.

[0128] [Table 1]

	Ex. 5	Ex. 6	Ex. 7	Comp. Ex. 2	Ex. 1	Ex. 2	Ex. 3	Ex. 4	Comp. Ex. 1	Comp. Ex. 5	Ex. 8	Ex. 9	Ex. 10	Ex. 11	Ex. 12	Comp. Ex. 3	Comp. Ex. 4
t (μm)	0.6	1.5	1.9	2.45	0.9	2.9	3.7	4.4	4.86	4.2	1.1	3.5	5.4	6.2	6.8	7.23	5.7
Ry (μm)	2.4	1.5	1.1	0.55	4.6	2.6	1.8	1.1	0.64	1.3	6.9	4.5	2.6	1.8	1.2	0.77	2.3
θa (°)	3.3	2.1	1.2	0.5	5.0	2.9	2.0	1.0	0.6	0.4	7.5	5.5	3.0	1.2	0.8	0.5	0.5
Haze (%)	24	11	8.1	2.0	30	25	16	7.0	3.0	2.5	47	37	24	17	4.2	3.9	2.6
Reflected glare ^{*1}	E	E	G	P	E	E	E	G	P	P	E	E	E	E	S	P	P
(*weight-average particle size of fine particles)	3 μm (XX-58AA)				5.5 μm (SSX1055QEX)							8 μm (XX-42AA)					

*1: E: Excellent, G: Good, S: Satisfactory, P: Poor

[0129] As shown in Table 1 above, the reflected glare was suppressed in Examples 1 to 12 in which R_y and θ_a satisfy the requirements of the present invention. On the other hand, the reflected glare was remarkable in Comparative Examples 1 to 3 in which R_y and θ_a are outside the scope of the present invention. In addition, the reflected glare was remarkable in

5 Comparative Examples 4 and 5 in which R_y satisfies the requirements of the present invention whereas θ_a is outside the scope of the present invention.

Industrial Applicability

[0130] As described above, the present invention can provide an anti-glare film suppressed from reflected glare, an optical member, and an image display device. According to the anti-glare
10 film of the present invention, for example, strong external light can be scattered and reflection can be suppressed, so that reflected glare can be suppressed even outdoors. Therefore, the present invention can be suitably used for an image display device such as a public information display for outdoor use, for example. However, the present invention is not limited to this application, and can be used for a wide range of applications.

15 [0131] This application claims priority from Japanese Patent Application No. 2018-223536 filed on November 29, 2018. The entire subject matter of the Japanese Patent Applications is incorporated herein by reference.

Reference Signs List

[0132]

- 20 10: anti-glare film
- 11: translucent base (A)
- 12: anti-glare layer (B)
- 12a: resin layer
- 12b: particle
- 25 12c: thixotropy-imparting agent
- 13: other layer
- Ry: maximum height of convex portion of outermost surface asperities
- d: maximum thickness other than translucent base (A)
- D: particle size of fine particle
- 30 Ry': maximum height of convex portion of anti-glare layer (B) asperities
- d': maximum thickness of anti-glare layer (B)
- t: film thickness of anti-glare (B) ($d' - Ry'$)

CLAIMS

1. An anti-glare film, comprising:

a translucent base (A); and

an anti-glare layer (B), wherein

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

the anti-glare layer (B) contains fine particles,

the weight-average particle size of the fine particles is in a range from 5.5 to 10 μm ,

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):

$$R_y \geq 1 \quad (1)$$

$$\theta_a \geq 0.7 \quad (2)$$

where in the mathematical equation (1), R_y is a maximum height [μm] of a convex portion of the asperities, and

in the mathematical equation (2), θ_a is an average tilt angle [$^\circ$] of the asperities.

2. The anti-glare film according to claim 1, wherein

asperities are formed on a surface of the anti-glare layer (B) on a side opposite to the translucent base (A), and

a weight-average particle size of the fine particles is larger than a thickness obtained by subtracting the maximum height of the convex portion of the asperities from a maximum thickness of the anti-glare layer (B).

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).

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

base (A),

the anti-glare layer (B) contains fine particles,

the weight-average particle size of the fine particles is in a range from 5.5 to 10 μm ,

asperities are formed on an outermost surface of the other layer, and

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

$$R_y \geq 1 \quad (1)$$

$$\theta_a \geq 0.7 \quad (2)$$

10 where in the mathematical equation (1), R_y is a maximum height [μm] of a convex portion of the asperities, and

in the mathematical equation (2), θ_a is an average tilt angle [$^\circ$] of the asperities.

5. A method for producing the anti-glare film according to any one of claims 1 to 4,
15 comprising the step of:

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

20 forming a coating film by drying the coated coating liquid, and
the coating liquid contains a resin, a solvent, and fine particles.

6. The method according to claim 5, wherein
the anti-glare layer (B)-forming further comprises the step of curing the coating film.

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7. An optical member comprising the anti-glare film according to any one of claims 1 to 4.

8. The optical member according to claim 7, which is a polarizing plate.

30 9. An image display device comprising the anti-glare film according to any one of claims 1 to 4 or the optical member according to claim 7 or 8.

10. The image display device according to claim 9, which is a public information display.

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