

TITLE OF THE INVENTION

LIGHT ADJUSTER AND LAMINATED GLASS

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BACKGROUND OF THE INVENTION

Field of the Invention

The present invention relates to a light adjuster having a liquid crystal material therein, and a laminated
10 glass containing the light adjuster, and in particular relates to a light adjuster that enables visual field control, and a laminated glass containing the light adjuster.

15 Description of the Related Art

Hitherto, electrochromic devices (hereinafter referred to as "EC devices") have been known as devices such as light adjusters having a light adjusting capability of enabling the transmissivity to be freely
20 adjusted (hereinafter referred to as "light adjusting devices"). Such an EC device is, for example, made from a material that undergoes a spectral change upon an electrochemical redox reaction, such as tungsten oxide or prussian blue, and controls the amount of light
25 transmitted by absorbing light. However, because such an EC device is current driven, if the EC device is made to have a large area, then a large voltage drop arises, the response speed drops markedly, and degradation of constituent materials due to electrochemical changes and
30 so on occurs during prolonged passing of a current; such an EC device thus cannot be used as a light adjuster that is required to be durable.

In recent years, voltage driven light adjusting devices have thus been used as light adjusters instead of
35 such current driven EC devices. For example, nematic

curvilinear aligned phase (NCAP) liquid crystal light adjusters are known as such voltage driven light adjusting devices. Such a nematic liquid crystal light adjuster is made from a liquid crystal material, and has
5 excellent durability, and can easily be made to have a large area (see Published Japanese Translation of PCT Application (Kohyo) No. S58-501631).

In general, such a light adjuster is comprised of a liquid crystal layer having a light adjusting function in
10 which a plurality of voids are filled with liquid crystals, and a pair of PET films that sandwich the liquid crystal layer therebetween; transparent electrically conductive films are provided on facing surfaces of the PET films so as to be bonded to the
15 liquid crystal layer, and a voltage is applied to the liquid crystal layer via this pair of transparent electrically conductive films. The liquid crystal layer is formed of a transparent polymer film having a plurality of voids therein, and each void is filled with
20 liquid crystals so as to form a liquid crystal capsule.

According to such a light adjuster, when a voltage is not being applied, the liquid crystal molecules line up along the curved wall surfaces of the liquid crystal capsules, and are thus not arranged along the direction
25 of travel of transmitted light transmitted through the liquid crystal capsules; the optical path of the transmitted light thus meanders around, and incident light is scattered at boundary layers between the liquid crystal capsules and the polymer film, and hence the
30 liquid crystal layer becomes cloudy. On the other hand, when a voltage is applied, the liquid crystal molecules line up along the direction of the electric field produced, and at this time, due to the liquid crystal layer being made from a material such that the ordinary
35 refractive index n_o of the liquid crystal molecules

matches the refractive index n_p of the polymer film, it becomes such that boundary layers between the liquid crystal capsules and the polymer film do not exist optically, and hence transmitted light incident on the liquid crystal layer can be transmitted unhindered, whereby the liquid crystal layer becomes transparent.

Due to the above principle, the light adjuster has a visual field controlling capability of shutting off the visual field through scattering of incident light when a voltage is not being applied, and securing the visual field through allowing incident light to be transmitted unhindered when a voltage is being applied.

Due to this visual field controlling capability, such a light adjuster is suitable for use as a partition or the like either alone or in the form of a laminated glass sandwiched between a plurality of glass plates.

Here, a small degree of scattering remaining in the transparent state is referred to as "haze". There are demands for such a light adjuster not only to have high shielding ability when not applying a voltage, and to be able to carry out driving with a low voltage when applying a voltage, but also to reduce the haze when applying a voltage. Furthermore, in the case that such a light adjuster is used in window glass of buildings or automobiles, because such window glass has a large area, in addition to reducing the haze when applying a voltage, there are also demands for the dependence of the haze on the viewing angle to be low.

It is known that the dependence of the haze on the viewing angle when applying a voltage using a sinusoidal power source can be reduced by using liquid crystals having a low birefringence (hereinafter referred to as " Δn ") (see Japanese Laid-open Patent Publication (Kokai) No. H03-116019).

By using liquid crystals having low Δn , the

dependence of the haze on the viewing angle when applying a voltage is thus improved, but the shielding ability when not applying a voltage tends to drop. In this case, it is necessary to make the film thickness (the thickness of the liquid crystal layer) higher so as to compensate for the drop in the shielding ability when not applying a voltage. However, there is a problem that if the film thickness is made higher, then the driving voltage and the haze when applying a voltage are increased.

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SUMMARY OF THE INVENTION

It is an object of the present invention to provide a light adjuster and a laminated glass, according to which the dependence of the haze on the viewing angle when applying a voltage can be reduced, and high shielding ability when not applying a voltage, driving with a low voltage when applying a voltage, and reduced haze when applying a voltage can be realized.

To attain the above object, in a first aspect of the present invention, there is provided a light adjuster comprising a liquid crystal layer having a plurality of voids therein, each of the voids being filled with a liquid crystal material, a pair of substrates that sandwich the liquid crystal layer therebetween, at least one of the substrates being transparent, and transparent electrically conductive films provided on respective facing surfaces of the substrates, wherein the liquid crystal material has a birefringence Δn in a range of $0.12 \geq \Delta n \geq 0.08$, a product of a diameter $D1$ of a sphere having a same volume as a volume of each of the voids, the diameter $D1$ being calculated from the volume of the void, and the birefringence Δn is in a range of $0.55\mu\text{m} \geq \Delta n \times D1 \geq 0.45\mu\text{m}$, and in a distribution of sample values of the diameter $D1$, if a total number of the sample values

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corresponds to 100%, a ratio $D3/D2$ of a diameter $D3$ of a sample value corresponding to 90% which a cumulative value of numbers of sample values counted from a minimum value of the sample values reaches, to a diameter $D2$ of a sample value corresponding to 10% which the cumulative value reaches satisfies $2.5 \times D1 \geq D3/D2$.

To attain the above object, in a second aspect of the present invention, there is provided a laminated glass comprising a light adjuster comprising a liquid crystal layer having a plurality of voids therein, each of the voids being filled with a liquid crystal material, a pair of substrates that sandwich the liquid crystal layer therebetween, at least one of the substrates being transparent, and transparent electrically conductive films provided on respective facing surfaces of the substrates, wherein the liquid crystal material has a birefringence Δn in a range of $0.12 \geq \Delta n \geq 0.08$, a product of a diameter $D1$ of a sphere having a same volume as a volume of each of the voids, the diameter $D1$ being calculated from the volume of the void, and the birefringence Δn is in a range of $0.55\mu\text{m} \geq \Delta n \times D1 \geq 0.45\mu\text{m}$, and in a distribution of sample values of the diameter $D1$, if a total number of the sample values corresponds to 100%, a ratio $D3/D2$ of a diameter $D3$ of a sample value corresponding to 90% which a cumulative value of numbers of sample values counted from a minimum value of the sample values reaches, to a diameter $D2$ of a sample value corresponding to 10% which the cumulative value reaches satisfies $2.5 \times D1 \geq D3/D2$.

According to the present invention, the liquid crystal material has a birefringence Δn in a range of $0.12 \geq \Delta n \geq 0.08$, the product of the diameter $D1$ of a sphere having the same volume as the volume of each of the voids and the birefringence Δn is in a range of $0.55\mu\text{m} \geq \Delta n \times D1 \geq 0.45\mu\text{m}$, and, in a distribution of sample

values of the diameter D1, if the total number of the sample values corresponds to 100%, the ratio D3/D2 of the diameter D3 of a sample value corresponding to 90% which the cumulative value of numbers of sample values counted from the minimum value of the sample values reaches, to the diameter D2 of a sample value corresponding to 10% which the cumulative value reaches satisfies $2.5 \times D1 \geq D3/D2$.

As a result, the dependence of the haze on the viewing angle when applying a voltage can be reduced, and high shielding ability when not applying a voltage, driving with a low voltage when applying a voltage, and reduced haze when applying a voltage can be realized.

The above and other objects, features, and advantages of the invention will become more apparent from the following detailed description taken in conjunction with the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a sectional view of a light adjuster according to an embodiment of the present invention;

FIG. 2 is a flowchart of a process for manufacturing the light adjuster of FIG. 1; and

FIG. 3 is a graph showing a distribution of values of diameters of spheres having the same volumes as the volumes of respective corresponding voids in a liquid crystal layer.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

The present invention will now be described with reference to the drawings showing a preferred embodiment thereof.

First, a description will be given of the approach

to setting Δn of liquid crystals in the present invention, a diameter D1 of a sphere having the same volume as the volume of each of voids in a liquid crystal layer, the diameter D1 being calculated or converted from the volume of the void (hereinafter referred to as the "capsule diameter"), and a capsule diameter ratio, described below.

Values of the diameters (converted diameter D1) of spheres each having the same volume as the volume of a corresponding one of the voids in the liquid crystal layer are distributed as shown in FIG. 3. FIG. 3 is plotted such that in the distribution of sample values of the diameter D1, if the total number of the sample values corresponds to 100%, the diameter of a sample value corresponding to 10% which a cumulative value of numbers of sample values counted from the minimum sample value reaches is indicated by D2, and the diameter of a sample value corresponding to 90% which the cumulative value reaches is indicated by D3. The ratio of the diameter D2 to the diameter D3 is referred to as the "capsule diameter ratio".

In general, the properties required in practice of a light adjuster used in window glass or the like are a visibility (V), which indicates the shielding ability, as described below, of not more than 0.1, and a haze when applying a voltage of not more than 10%. Here, the visibility (V) is an index that quantitatively represents the shielding ability when not applying a voltage, and can be determined by arranging a light source, a screen, the light adjuster having the liquid crystals therein, and a spectral luminance meter in this order on the same optical axis, measuring white stripe luminance (I_w) and black stripe luminance (I_b) at a wavelength of 700nm of a zebra pattern on the screen illuminated by the light source using the spectral luminance meter via the light adjuster, and then using undermentioned equation (1).

$$\text{Visibility (V)} = (I_w - I_b) / (I_w + I_b) \dots (1)$$

Moreover, the haze can be measured using a haze meter (e.g. a "Suga Haze Meter" made by Suga Test Instruments Co., Ltd.). The haze can be determined using
 5 undermentioned equation (2) from the relationship between total transmissivity (T_t), which is the ratio of the amount of transmitted light over all viewing angles to the amount of incident light, and parallel transmissivity (T_p), which is the ratio of the amount of transmitted
 10 light parallel to the incident light to the amount of incident light.

$$\text{Haze} = (T_t - T_p) / T_t \dots (2)$$

Here, as described earlier, by using liquid crystals having low Δn , the haze when applying a voltage is
 15 reduced; if Δn is greater than 0.12, then sufficiently low haze is not obtained. On the other hand, if Δn is low, then the shielding ability when not applying a voltage drops. For example, if Δn is lower than 0.08, then even if this is combined with a suitable capsule
 20 diameter and capsule diameter ratio, the visibility (V) will rise, and sufficiently high shielding ability will not be obtained. Δn of the liquid crystals must thus be in a range of 0.08 to 0.12.

Moreover, there exist ranges of the capsule diameter
 25 (D_1) and the capsule diameter ratio (D_3/D_2) corresponding to this range of Δn of the liquid crystals for which the shielding ability when not applying a voltage becomes highest.

First, regarding the capsule diameter, the product
 30 $\Delta n \times D_1$ of Δn and the capsule diameter (D_1) must be in the range represented by undermentioned equation (3).

$$0.55 \geq \Delta n \times D_1 \geq 0.45 \dots (3)$$

Here, taking Δn to be fixed, if $0.45 > \Delta n \times D_1$, then the capsule diameter in this range is lower than the
 35 capsule diameter satisfying the equation (3), and in this

case the amount of scattering will increase accompanying the reduction in the capsule diameter, whereby the mean transmissivity in the visible region will drop, but on the other hand the visibility (V) will increase due to
 5 diffraction of light on the long wavelength region, and hence ultimately the shielding ability when not applying a voltage will drop.

Moreover, if $\Delta n \times D_1 > 0.55$, then the capsule diameter in this range is greater than the capsule diameter
 10 satisfying the equation (3), and in this case the amount of scattering will decrease accompanying the increase in the capsule diameter, whereby the visibility (V) will increase, and hence again the shielding ability when not applying a voltage will drop.

15 In either case, by making the film thickness higher, the visibility (V) when not applying a voltage can be reduced, and hence the shielding ability can be improved, but the haze when applying a voltage will be increased, and hence the performance required of the light adjuster
 20 will not be obtained.

Here, the performance required of the light adjuster is achieved in the case that the capsule diameter (D_1) and the capsule diameter ratio (D_3/D_2) satisfy undermentioned equation (4).

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$$2.5 \times D_1 \geq D_3/D_2 \dots (4)$$

In the case that the capsule diameter ratio (D_3/D_2) is greater than $2.5 \times D_1$, i.e. the capsule diameter ratio (D_3/D_2) is broader than the capsule diameter ratio satisfying equation (4), in general the proportion of
 30 large capsule diameters (D_1) will increase, and hence there will be hardly any scattering in the visible region, and thus the visibility (V) will increase, and hence the shielding ability when not applying a voltage will drop. In this case, the visibility (V) can be reduced, and
 35 hence the shielding ability can be improved, by reducing

the capsule diameter (D_1) or increasing the film thickness, but again, the haze when applying a voltage will increase, and hence the performance required of the light adjuster will not be obtained.

5 Based on the above considerations, according to the present invention, despite using a liquid crystal material having low Δn , by using a suitable combination of Δn of the liquid crystal material, the capsule diameter (D_1), and the capsule diameter ratio (D_3/D_2), a
10 liquid crystal light adjuster can be realized for which driving with a low voltage is possible and the haze is low when applying a voltage, with no impairment of the shielding ability when not applying a voltage.

FIG. 1 is a sectional view of a light adjuster
15 according to an embodiment of the present invention.

In FIG. 1, the light adjuster 100 is comprised of a liquid crystal layer 104 comprised of a transparent polymer film 101 made of a latex having a plurality of voids therein and liquid crystal capsules 103 formed
20 through the voids being filled with nematic liquid crystalline rod-like molecules 102, a pair of PET films 105a and 105b that sandwich the liquid crystal layer 104 therebetween, and transparent electrically conductive films 106a and 106b that are provided on respective
25 facing surfaces of the pair of PET films 105a and 105b; the pair of transparent electrically conductive films 106a and 106b apply a voltage to the liquid crystal layer 104.

According to this light adjuster 100, when a voltage
30 is not being applied to the liquid crystal layer 104, the nematic liquid crystalline rod-like molecules 102 line up along the curved wall surfaces of the liquid crystal capsules 103, and are thus not arranged along the direction of travel of transmitted light transmitted
35 through the liquid crystal capsules 103; the optical path

of the transmitted light thus meanders around, and incident light is scattered at boundary layers between the liquid crystal capsules 103 and the polymer film 101, and hence the liquid crystal layer 104 becomes cloudy.

5 On the other hand, when a voltage is applied to the liquid crystal layer 104, the nematic liquid crystalline rod-like molecules 102 line up along the direction of the electric field produced, and at this time, due to the liquid crystal layer 104 being made from a material such
10 that the ordinary refractive index n_o of the nematic liquid crystalline rod-like molecules 102 matches the refractive index n_p of the polymer film 101, it becomes such that boundary layers between the liquid crystal capsules 103 and the polymer film 101 do not exist
15 optically, and hence transmitted light incident on the liquid crystal layer 104 can be transmitted unhindered, whereby the liquid crystal layer 104 becomes transparent.

Due to the above principle, the light adjuster 100 has a visual field controlling capability of shutting off
20 the visual field through scattering of incident light when a voltage is not being applied, and securing the visual field through allowing incident light to be transmitted unhindered when a voltage is being applied.

Next, a description will be given of a method of
25 manufacturing the light adjuster 100.

FIG. 2 is a flowchart of a process for manufacturing the light adjuster 100 of FIG. 1.

In FIG. 2, first, a transparent electrically conductive film 106a or 106b made of ITO is formed on one
30 surface of each of 175 μ m-thick PET films 105a and 105b (step S20).

Next, a liquid crystal material and an aqueous phase are mixed together to prepare an emulsion, and the prepared emulsion is added to a latex, or else a liquid
35 crystal material and a latex are mixed together directly

to prepare an emulsion. At this time, to form stable liquid crystal particles, it is preferable to add a surfactant to the emulsion. The mixing together of the liquid crystal material and the aqueous phase or the latex is carried out using a mixer such as a blender or a colloid mill (step S21). The capsule diameter (D1) of the liquid crystal capsules 103 can be controlled to a desired value through the rotational speed of the mixer, and here D1 is controlled to be approximately 5 μ m.

10 A crosslinking agent for crosslinking the latex in the emulsion is then added to form a medium (step S22). The amount added of the crosslinking agent is set, in correspondence with the amount of solids in the latex, to be an amount capable of crosslinking all of the latex in terms of solids.

15 The medium thus formed is then applied onto the transparent electrically conductive film 106a using a suitable means such as a knife blade, and the medium applied is dried, whereby crosslinking of the latex by the crosslinking agent is made to progress, and hence a liquid crystal layer 104 is formed (step S23).

20 Next, the PET film 105b is stuck onto the liquid crystal layer 104 thus formed such that the transparent electrically conductive film 106b contacts the liquid crystal layer 104 (step S24), thus completing the manufacturing process.

25 For the light adjuster 100, utilizing the property of a liquid crystal material that the haze when applying a voltage is reduced if Δn is low, Δn of the nematic liquid crystalline rod-like molecules 102 is set to be low. Specifically, if Δn is greater than 0.12, then sufficiently low haze will not be obtained, whereas if Δn is too low, then the shielding ability when not applying a voltage will drop; Δn of the nematic liquid crystalline rod-like molecules 102 is thus set to $0.08 \leq \Delta n \leq 0.12$.

Furthermore, regarding the capsule diameter (D_1) of the liquid crystal capsules 103, if the capsule diameter (D_1) is too low, then the amount of scattering will increase accompanying the reduction in the capsule diameter, whereby the mean transmissivity in the visible region will drop, but the visibility (V) will increase due to diffraction of light on the long wavelength region by the liquid crystal capsules 103, and hence ultimately the shielding ability when not applying a voltage will drop. On the other hand, if the capsule diameter (D_1) is too high, then the amount of scattering will decrease accompanying the increase in the capsule diameter, whereby the visibility (V) will increase, and hence again the shielding ability when not applying a voltage will drop. With the light adjuster 100, the product $\Delta n \times D_1$ of Δn and the capsule diameter (D_1) is thus set to be in a range of $0.55 \geq \Delta n \times D_1 \geq 0.45$.

Here, taking Δn to be fixed, if $0.45 > \Delta n \times D_1$, then this indicates that the capsule diameter is too low, whereas if $\Delta n \times D_1 > 0.55$, then this indicates that the capsule diameter is too high.

In general, making the film thickness of the liquid crystal layer 104 higher is effective in reducing the visibility (V) and thus improving the shielding ability, but if the film thickness of the liquid crystal layer 104 is merely made higher, then the haze when applying a voltage will increase, and hence the performance required of the light adjuster 100 will not be attained.

Moreover, with the liquid crystal material, if the proportion of liquid crystal capsules 103 having a large capsule diameter is high, then there will be hardly any scattering of transmitted light in the visible region, and thus the visibility (V) will increase, and hence the shielding ability when not applying a voltage will drop. In this case, if the capsule diameter (D_1) is merely

reduced, then the visibility (V) will drop, and hence the shielding ability will be improved, but the haze when applying a voltage will increase, and hence the performance required of the light adjuster will not be
5 obtained.

For the light adjuster 100, the capsule diameter (D1) and the capsule diameter ratio ($D3/D2$) are thus set so as to satisfy the relationship $2.5 \times D1 \geq D3/D2$.

From the above, for the light adjuster 100 according
10 to the present embodiment, Δn of the nematic liquid crystalline rod-like molecules 102 is set to $0.08 \leq \Delta n \leq 0.12$, the product $\Delta n \times D1$ of Δn and the capsule diameter (D1) is set to be in a range of $0.55 \geq \Delta n \times D1 \geq 0.45$, and the capsule diameter (D1) and the capsule diameter ratio
15 ($D3/D2$) are set so as to satisfy the relationship $2.5 \times D1 \geq D3/D2$. As a result, the dependence of the haze on the viewing angle when applying a voltage can be reduced, and high shielding ability when not applying a voltage, driving with a low voltage when applying a voltage, and
20 reduced haze when applying a voltage can be realized.

The liquid crystals in the light adjuster 100 according to the present embodiment are not limited to being nematic liquid crystalline rod-like molecules 102, but rather cholesteric liquid crystals or smectic liquid
25 crystals may be used.

As the material of the polymer film 101 in the light adjuster 100 according to the present embodiment, either an inorganic or organic material can be used so long as this material has a refractive index n matching the
30 ordinary refractive index n_o of the liquid crystal material that is nematic or the like, and is able to hold the liquid crystal material in the form of a plurality of capsules; however, it is particularly preferable to use a latex that is optically homogeneous and has good adhesion
35 to the transparent electrically conductive films 106a,

106b formed on the PET films 105a, 105b, whereby a light adjuster 100 having excellent physical durability can be provided.

Moreover, instead of the PET films 105a, 105b having
5 the transparent electrically conductive films 106a, 106b formed thereon in the light adjuster 100 according to the present embodiment, glass sheets, plastic films or the like each having an indium tin oxide (ITO) film or a tin oxide (SnO_2) film formed on a surface thereof may be used.

10 Next, an example according to the present invention will be described in detail.

Example

0.5wt% of an IGEPAL CO-610 surfactant (made by GAF) was added to ZLI-4171 liquid crystals (made by Merck, Δn
15 = 0.097), the liquid crystals to which the surfactant had been added were added to Neorez R-967 (made by Zeneca) containing 40wt% of latex particles such that the liquid crystal proportion was 0.62, and then stirring was carried out for 10 minutes at 7000 rpm using a
20 homogenizer, thus obtaining an emulsion. Next, while gently mixing the emulsion, a CX-100 crosslinking agent (made by Zeneca) was added in a proportion of 3wt% to the emulsion. The emulsion to which the crosslinking agent had been added was then applied onto an ITO film-
25 possessing PET film using a doctor blade, and drying was carried out.

After the applied emulsion had been dried, another ITO film-possessing PET film was stuck onto the emulsion , thus obtaining a light adjuster. The thickness of the
30 light adjuster was 20 μm .

For the above light adjuster, the capsule diameter (D_1) of the liquid crystal capsules was 5 μm , and the capsule diameter ratio (D_3/D_2) was 11.5.

The visibility of the light adjuster obtained as
35 described above was measured using a multifunctional

multichannel spectrophotometer MCPD-1000 (28C) (made by Otsuka Electronics Co., Ltd.), and the haze upon applying a low voltage (sinusoidal, 100V, 50Hz) was measured using a haze meter, whereupon the measurement results were that
5 the visibility (V) was 0.08 and the haze was 8%. It was thus found that reduced haze when applying a voltage could be realized while still securing high shielding ability when not applying a voltage.

It was thus found that for a light adjuster, if Δn
10 satisfies $0.08 \leq \Delta n \leq 0.12$, the product $\Delta n \times D1$ of Δn and the capsule diameter (D1) satisfies $0.55 \geq \Delta n \times D1 \geq 0.45$, and the capsule diameter (D1) and the capsule diameter ratio (D3/D2) satisfy $2.5 \times D1 \geq D3/D2$, then the light
adjuster has sufficient visual field controlling
15 performance, it being possible to realize high shielding ability when not applying a voltage, driving with a low voltage when applying a voltage, and reduced haze when applying a voltage.

What is claimed is:

1. A light adjuster comprising:

5 a liquid crystal layer having a plurality of voids therein, each of said voids being filled with a liquid crystal material;

a pair of substrates that sandwich said liquid crystal layer therebetween, at least one of said substrates being transparent; and

10 transparent electrically conductive films provided on respective facing surfaces of said substrates;

wherein:

said liquid crystal material has a birefringence Δn in a range of $0.12 \geq \Delta n \geq 0.08$;

15 a product of a diameter $D1$ of a sphere having a same volume as a volume of each of said voids, the diameter $D1$ being calculated from the volume of the void, and the birefringence Δn is in a range of $0.55\mu m \geq \Delta n \times D1 \geq 0.45\mu m$; and

20 in a distribution of sample values of the diameter $D1$, if a total number of the sample values corresponds to 100%, a ratio $D3/D2$ of a diameter $D3$ of a sample value corresponding to 90% which a cumulative value of numbers of sample values counted from a minimum value of the sample values reaches, to a diameter $D2$ of a sample
25 corresponding to 10% which the cumulative value reaches satisfies $2.5 \times D1 \geq D3/D2$.

2. A laminated glass comprising:

30 a light adjuster comprising a liquid crystal layer having a plurality of voids therein, each of said voids being filled with a liquid crystal material, a pair of substrates that sandwich said liquid crystal layer therebetween, at least one of said substrates being transparent, and transparent electrically conductive
35 films provided on respective facing surfaces of said

substrates;

wherein:

said liquid crystal material has a birefringence Δn in a range of $0.12 \geq \Delta n \geq 0.08$;

5 a product of a diameter D1 of a sphere having a same volume as a volume of each of said voids, the diameter D1 being calculated from the volume of the void, and the birefringence Δn is in a range of $0.55\mu\text{m} \geq \Delta n \times D1 \geq 0.45\mu\text{m}$; and

10 in a distribution of sample values of the diameter D1, if a total number of the sample values corresponds to 100%, a ratio D3/D2 of a diameter D3 of a sample value corresponding to 90% which a cumulative value of numbers of sample values counted from a minimum value of the
15 sample values reaches, to a diameter D2 of a sample corresponding to 10% which the cumulative value reaches satisfies $2.5 \times D1 \geq D3/D2$.