

REARVIEW MIRROR

This invention relates to rearview mirrors for
5 vehicles, and more particularly to a rearview mirror to
absorb the incident light by using a liquid crystal of
negative dielectric anisotropy mixed with a blue dye by
2%.

10 When vehicles are driven at night, the drivers are
dazzled by the light beams reflected into the sight from
the headlights of following vehicles by the rearview
mirrors. In order to prevent such dazzling of reflected
light, rearview mirrors must be improved.

15 In the beginning, as the means for attenuating the
reflections of light had been mainly used polarizers,
color filters, and prisms together with a method of
scattering light by means of an uneven reflecting surface.

20 However, since such a rearview mirror essentially
attenuates the incident light to a certain level or
otherwise, reflects the incident light toward a certain
direction, the image of an object projected on the mirror
is always not clear, false images are generated, etc.,
thereby making its practical use impossible.

25 Recently, a rearview mirror using a liquid crystal
device having light absorption property is attracting
attention. In this construction, a liquid crystal device
is incorporated into the rearview mirror so that the

orientations of the liquid crystal molecules are changed to absorb light when the amount of the light incident on the mirror exceeds a certain limit.

5 The liquid crystal used in the mirror said above is such a kind that a dichromatic dye mixes with a nematic liquid crystal of positive or negative dielectric anisotropy.

10 The nematic liquid crystal of positive dielectric anisotropy and the nematic liquid crystal of negative dielectric anisotropy are oriented parallel with the electrodes and absorb light respectively with the voltage not applied and with the voltage applied. Hence, the nematic liquid crystal of positive dielectric anisotropy should by always supplied with the voltage to keep its
15 orientation perpendicular to the electrode, thereby resulting in high consumption of power and its life becoming short. On the other hand, the nematic liquid crystal of negative dielectric anisotropy seems to be the most suitable in view of power consumption and life, but it
20 has the problem that the initial operating voltage is relatively high and the projected image becomes unclear owing to low on-off contrast ratio.

Furthermore, the life of a liquid crystal is impaired by ultraviolet rays, which causes the dichromatic dye of
25 the liquid crystal to undergo chemical reaction and to be disqualified.

Further, because the vertical orientation films are not electrically insulated, electric currents flow between

the electrodes due to the conductive impurities intervening into liquid crystal during the manufacture, thereby resulting in shortcomings.

5 Besides, since glasses are much used in the mechanism employing the liquid crystal device, considerable fragments are scattered when the mirror is fragmentized, thereby causing safety problems.

10 The rearview mirror to be described has a high on-off contrast ratio and requiring little consumption of power.

In addition the mirror has good electrical insulation between the two transparent electrodes. A layer for blocking ultraviolet rays is formed to prolong the life, and fragments are not scattered
15 when the mirror is fragmentized.

According to the present invention there is provided a rearview mirror operable to absorb light when the orientation of a liquid crystal of the mirror is caused to change, an improvement comprising
20 adding a sufficient amount of cholesteric material to a mixture of a blue dye and an nematic liquid crystal of negative dielectric anisotropy in which the blue dye constitutes 2% by volume of the mixture, so that the ratio of the thickness of the liquid crystal
25 layer to the focal conic pitch d/p lies within the range of 0.4 to 0.6.

Rearview mirrors embodying the invention will now be described, by way of example, with reference to the accompanying diagrammatic drawings
30 in which:

Fig. 1 is a cross-sectional view illustrating the structure of a rearview mirror according to an embodiment of this invention.

35 Fig. 2 is a cross-sectional view showing the change of the orientation according to the applied voltage.

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Fig. 3 is a graph showing the relation between the voltage and the light absorption according to the ratio of thickness of the liquid crystal layer to focal conic pitch.

5 Fig. 4 is a cross-sectional view illustrating the structure of a rearview mirror according to another embodiment of this invention.

A rearview mirror of this invention is obtained through the following process.

10 Firstly, the ITOs (indium-thin-oxide) 3,4 is respectively deposited on the upper and lower glass plates 1,2. After the upper and lower vertical orientation layers 5,6 is formed on the ITOs 3,4 by using Spin-Coating method, the spacers are interposed
15 between the glass plates 1,2 so that the spacers are arranged to maintain a certain gap therebetween and the periphery of the spacers is shielded with sealing materials 7. Thereafter, the surface of the upper glass plate 1 is coated with a magnesium fluoride
20 film 8, and the lower glass plate 2 is coated with a thin film of aluminium 9 by the thickness

of 1500 - 3000 Å to form the reflecting surface.

Subsequently, a liquid crystal is injected through an inlet. As the liquid crystal, in this invention, is used a nematic liquid crystal of negative dielectric anisotropy mixed with the blue dye by 2%. Specifically such liquid crystals are 4-4'-methoxyphthyl-azoxybenzene, 4-methoxyphenyl-4'-pentylebenzoate and 4-pentyleoxyphenyl-4'-n-pentylecyclo hexyl carboxylate, each of which may be individually or in a suitable mixture with others. For the blue dyes are exemplified various kinds, but the selection thereof should be made with considering the compatibility with the liquid crystal, all the barometers and the absorption wavelength.

The blue dye ZLI 3292 produced by E. Merck of West Germany which absorbs the visible lights is used in this invention.

When said liquid crystal is injected into the space between the upper and lower glass plates 1,2 through the inlet, the cholesteric material is added. The cholesteric material controls the focal conic pitch of the liquid crystal and the more the cholesteric material is added, the shorter the pitch becomes. The ratio of the thickness d of the liquid crystal layer to the focal conic pitch p of the liquid crystal in the rearview mirror influences significantly the on-off contrast ratio. In order to obtain the most excellent on-off contrast ratio, the amount of the additive cholesteric material is regulated so that the relation d/p

becomes within 0.4 to 0.6 in this invention.

5 In the rearview mirror of this invention described herein, because the orientation of the liquid crystal is perpendicular to the ITOs 3,4 when the voltage is not applied, the liquid crystal does not absorb the light. In this condition, therefore, the mirror reflects the incident light by the thin film of aluminium 9 deposited on the lower glass plate 2.

10 However, if the amount of the incident light is more than a certain level, the voltage is applied to the ITOs 3,4 deposited on the upper and lower glass plates 1,2 and the liquid crystal is turned by 90° and becomes parallel with the ITOs 3,4, as shown in FIG. 2.

15 As a result, the molecular axis of the liquid crystal becomes perpendicular to the direction of incident light and so, the liquid crystal absorbs the light and the surface of the mirror appears blue owing to the blue dye mixed in the liquid crystal. In this process, the external light can be readily detected by a conventional

20 photo sensor.

On the other hand, because the ultraviolet component of the incident light is blocked by the magnesium fluoride layer 8, the dye does not change.

25 The relation between the light absorption and the voltage according to the ratio d/p in the rearview mirror of this invention is indicated in the graph of FIG. 3.

As known in the graph, if the value d/p is smaller than 0.4 , a rearview mirror cannot be put to

practical use because of the generation of the inflexion point of light absorption, but if the value d/p is within 0.4 to 0.6, the light absorption characteristics appear to be good.

5 FIG. 4 depicts another embodiment of the rearview mirror according to this invention.

 Insulating film 10 intervenes between the upper transparent electrode 3 and the vertical orientation layer 5 in this embodiment. The insulating film 10 is silicon
10 nitride layer deposited with the thickness of 300 Å to 1000 Å. Instead of the magnesium fluoride layer 8, the transparent adhesive layer 11 is applied to the upper surface of the upper glass plate 1 with the thickness of about 1 mm and on the layer 11 is placed a glass plate
15 12, which is pressed at the temperature of 40° to 60° C. Polyvinylbutyral containing the appropriate amount of benzophenon is used as the transparent adhesive layer 11. Because the upper and lower transparent electrodes 3,4 is certainly insulated by the insulating film 10, they can
20 not produce an electrical conduction even with the conductive impurities introduced. Besides, since the glass plate 12 adheres to the transparent adhesive layer 11, the fragments are not scattered out when the mirror is fragmentized accidentally, thereby harm to the human
25 body being not caused.

 Furthermore, because the benzophenon contained in the transparent adhesive layer 11 is capable of blocking ultraviolet rays, it protects the dichromatic dyes from deteriorating owing to ultraviolet rays.

CLAIMS

1. A rearview mirror operable to absorb light when the orientation of a liquid crystal of the mirror is caused to change, an improvement comprising
5 adding a sufficient amount of cholesteric material to a mixture of a blue dye and an nematic liquid crystal of negative dielectric anisotropy in which the blue dye constitutes 2% by volume of the mixture, so that the ratio of the thickness of the liquid
10 crystal layer to the focal conic pitch d/p lies within the range of 0.4 to 0.6.
2. A rearview mirror according to Claim 1, wherein a silicone nitride layer is deposited on the upper transparent electrode 3 by the thickness of 300
15 to 1000 Å so as to form an insulating film 10, and a transparent adhesive layer 11 comprising polyvinylbutyral mixed with a suitable amount of benzophenon is formed on the upper surface of the upper glass plate 1 with a glass plate 12 being
20 pressed down to said adhesive layer 11.
3. A rearview mirror comprising a reflective surface, a liquid crystal extending over the reflective surface, and means responsive to the light intensity of the light impinging upon the reflective
25 surface reaching a predetermined intensity to switch the crystal from a transparent state to a light absorbing state, the liquid crystal having a negative dielectric anisotropy and containing a blue dye mixed with a cholesteric material in such proportions that
30 the focal conic pitch lies in the range of from 0.4 to 0.6.
4. A rearview mirror substantially as hereinbefore described with reference to the accompanying diagrammatic drawings.
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