

LIGHT-REGULATION MEMBRANE

This application claims the priority benefit of U.S. patent applications number 11/812,969 and 12/134,192 filed on June 22, 2007 and June 6, 2008 respectively.

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BACKGROUND OF THE INVENTION

1. Field of the Invention:

The present invention relates to light regulation technology and more specifically, to a light-regulation
10 membrane that utilizes two polymer compound layers to support a PDLC (polymer dispersed liquid crystal) film for regulating light and an adhesion layer for repetitively adhering on light transmissible plate e.g. transparent glass panel or the like.

2. Description of the Related Art:

15 Conventionally, to keep a window or partition glass from sight or to isolate the radiation heat of the sun, a blind, Low-emissive glass or heat insulation film may be installed. When a heat insulation film is covered on a window glass, the color of the heat insulation film produces a certain extent of
20 light-blocking effect. However, a regular heat insulation film simply reduces the extent of the glare of the radiation of the sun. It cannot effectively block ultraviolet light. Further, the heat insulation effect of conventional heat insulation films is still not perfect. Conventional heat insulation films tend to be oxidized,

and can easily be caused to wrinkle or to fade after a long use. Further, when covering a glass curtain wall, vehicle window glass, indoor partition wall or the like with a dark color heat insulation film, the dark color heat insulation film can block
5 light and isolate heat. However, during a dark or raining condition, a color heat insulation film prohibits light from passing through the glass panel. When a heat insulation film is used indoors or in a car, it interferes with people's sight. Further, when a heat insulation film is covered on a glass panel, a person
10 can no longer regulate the transmittance of the glass panel. Further, when a blind is used, the installation procedure is complicated. Further, because a window blind must be mounted on the inner side of a window, it occupies much indoor space. Further, the cleaning work of a window blind is also
15 complicated.

Recently, polyvision privacy glass has been intensively used for regulating light. A polyvision privacy glass can transform from a cloudy white translucent barrier to an optically clear state with the flick of a switch. It is produced by
20 laminating polymer-dispersed liquid crystal film with architectural grade PVB between two layers of glass. When the power is off, the liquid crystal molecules are randomly oriented

so that incident light is scattered and the polyvision privacy glass is opaque. With electricity applied, the liquid crystal molecules line up, the incident light passes through, and polyvision privacy glass looks clear.

5 Although a polyvision privacy glass can change its transmissible status subject to the application of electric current, its installation is complicated, and the original indoor design may have to be destructed. Further, a polyvision privacy glass tends to be covered with dust and must be regularly cleaned. For
10 protection against ultraviolet light and isolation of heat, an extra surface treatment is necessary. Therefore, a polyvision privacy glass has the drawbacks of complicated structure, expensive cost, complicated maintenance and cleaning works.

 Further, a glass panel made by laminating PET
15 (polyethylene terephthalate) on two opposite sides of a PDLC (polymer dispersed liquid crystal) film has the advantages of lightweight, impact resistance, high transmittance and high machinability. It is practical for many applications. However, PET will decompose and become aged soon when exposed to the
20 radiation of the sun. Further, the surface of this kind of glass panel tends to be scratched, or damaged by a solvent.

 Therefore, it is desirable to provide a light-regulation

membrane that eliminates the aforesaid problems.

SUMMARY OF THE INVENTION

The present invention has been accomplished under the circumstances in view. According to one aspect of the present invention, the light-regulation membrane comprises a surface structure, an adhesion layer for adhering on light transmissible plate, two polymer compound layers sandwiched between the hard coating layer of the surface structure and the adhesion layer, and a PDLC (polymer dispersed liquid crystal) film sandwiched between the two polymer compound layers. The PDLC (polymer dispersed liquid crystal) film comprises two conducting layers, and a liquid crystal layer sandwiched between the two conducting layers. The adhesion layer is adhered on light transmissible plate e.g. a transparent glass or the like. The transmittance status of the light-regulation membrane is controlled while the PDLC (polymer dispersed liquid crystal) film is connected the electric power source, and then light passing through the transmissible plate is controlled and regulated. On the contrary, when electricity is disconnected from the PDLC (polymer dispersed liquid crystal) film, light is quickly blocked by the light-regulation membrane.

According to another aspect of the present invention, the

adhesion layer is prepared from a silicone/acrylic based pressure sensitive adhesive composition, and can be directly adhered on light transmissible plate such as transparent glass, PMMA (polymethyl methacrylate) and PC (polycarbonate) panels.

5 During installation of the light-regulation membrane, it is not necessary to destruct the original construction or indoor design. Because of the reusable characteristic of the adhesion layer, the installation, repair and replacement of the light regulation membrane are easy.

10 According to still another aspect of the present invention, the surface structure comprises an anti-stain layer prepared from thermosetting organosiloxane resin which comprises of colloidal silica and hydrolysis-condensation trialkoxysilane, a hard coating layer, and an anti-reflective layer
15 sandwiched between the anti-stain layer and the hard coating layer. The anti-stain layer facilitates the cleaning work. The hard coating layer protects the transparent glass against cracking, having wear-resisting and solvent-resisting characteristic

20 According to still another aspect of the present invention, the polymer compound layers are prepared from a plastic chemical material, for example, PET (polyethylene

terephthalate), PMMA (polymethyl methacrylate) that support the PDLC (polymer dispersed liquid crystal) film without affecting its functioning. By means of the effect of the polymer compound layers, the light-regulation membrane is applicable to
5 glass curtain wall, vehicle sliding sunroof, indoor partition wall, etc. When the light-regulation membrane is in the nontransmissible status, the glass to which the light-regulation membrane is adhered can be used as a rear projection screen. In general, the light-regulation membrane provides an excellent
10 support effect and an added function, having excellent applicability.

According to still another aspect of the present invention, the light-regulation membrane further comprises an anti-radiation layer, having anti-ultraviolet and anti-infrared
15 characteristics. Further, the anti-radiation layer can be made in any of a variety of colors. When the light-regulation membrane is adhered to a glass panel of a building, the anti-radiation layer also blocks infrared light rays from the radiation of the sun, producing a heat isolation effect to keep the indoor space warm
20 in winter or cool in summer and saving much power consumption. Therefore, the invention is an environmentally friendly design.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 illustrates the outer appearance of a light-regulation membrane according to the present invention.

FIG. 2 is a three-dimension cross-sectional drawing of the light-regulation membrane according to the present invention.

FIG. 3 is a sided-view cross-sectional drawing of the light-regulation membrane according to the present invention.

FIG. 4 is an illustration drawing showing one of applications of the present invention.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring to FIGS. 1~3, a light-regulation membrane in accordance with the present invention is shown comprising a PDLC (polymer dispersed liquid crystal) film 1, two polymer compound layers 2, a plurality of PSA (pressure sensitive adhesive) layers 3, a surface structure 4, an anti-radiation layer 5, an adhesion layer 6, and two protective films 7.

The PDLC film 1 comprises a liquid crystal layer 11 and two conducting layers 12. The liquid crystal layer 11 is sandwiched between the two conducting layers 12. The liquid crystal layer 11 can be prepared from a compound of hydroxyl polyfunctional (meth) acrylates and nematic liquid crystal cured

with a polyisocyanate compound crosslinking agent. The conducting layers 12 are made by means of depositing ITO (indium tin oxide) on a base layer of PET (polyethylene terephthalate by means of sputtering deposition.

5 The polymer compound layers 2 are respectively formed on the two conducting layers 12. Further, the polymer compound layers 2 are prepared from a plastic chemical material, for example, PET (polyethylene terephthalate), PMMA (polymethyl methacrylate), PC (polycarbonate), PP (polypropylene), PE
10 (polyethylene) or PVDC (polyvinylidene chloride).

The PSA (pressure sensitive adhesive) layers 3 as adhesion are disposed in-between the polymer compound layer 2 and the conductive layer 12.

The surface structure 4 is formed on the surface of one
15 polymer compound layer 2 opposite to the PSA (pressure sensitive adhesive) layers 3 and the PDLC film 1, comprising an anti-stain layer 41, an anti-reflective layer 42 and a hard coating layer 43. The hard coating layer 43 is bonded to the polymer compound layer 2. The anti-reflective layer 42 is sandwiched
20 between the anti-stain layer 41 and the hard coating layer 43. The anti-stain layer 41 is for protection against dirt and stains, prepared from thermosetting organosiloxane resin which

comprises of colloidal silica and hydrolysis-condensation trialkoxysilane. The anti-reflective layer 42 is sandwiched between the anti-stain layer 41 and the hard coating layer 43. The hard coating layer 43 is sandwiched between the anti-reflective layer 42 and the polymer compound layer 2. The hard coating layer 43 may be made of cross-linking copolymer acrylates and an ultraviolet absorbent, having a specific repeating structure unit and containing a certain amount of carbamate bond. The hard coating layer 43 can be a UV curable organic coating prepared from a mixture of multi-functional acrylates, silicone acrylate as a slip agent, a crosslinkage adhesion promoter, and photo-initiators, or a mixture of multi-functional acrylates, silicone acrylate as a slip agent, a (meth) acrylate terminated toughener, nano sized silica as inorganic filler, a silane coupling agent, and photo-initiators.

The anti-radiation layer 5 is formed on one side of the other polymer compound layer 2 opposite to the surface structure 4, having anti-ultraviolet and anti-infrared characteristics. Further, the anti-radiation layer 5 can be made in any of a variety of colors.

The adhesion layer 6 is formed on one side of the anti-radiation layer 5 opposite to the polymer compound layer 2

for repetitively adhering to a transparent glass 9. The adhesion layer 6 can be made of a mixture of organic silicone and acrylic pressure sensitive adhesive.

The two protective films 7 are respectively covered on the adhesion layer 6 and the anti-stain layer 41 of the surface structure 4. The protective films 7 are strippable films made of PET (polyethylene terephthalate). Before application of the light-regulation membrane, the two protective films 7 are respectively covered on the two opposite sides of the light-regulation membrane for surface protection.

Referring to FIG. 4 and FIGS. 1~3 again, during application, the protective film 7 is removed from the adhesion layer 6, and then the adhesion layer 6 is adhered to the surface of the transparent glass 9, and then the other protective film 7 is removed from the anti-stain layer 41 of the surface structure 4., and then the positive and negative terminals of the power source 8 are respectively connected to the two conducting layers 12. with silver conductive paste. When the power source 8 is switched off, the liquid crystal layer 11 of the PDLC film 1 is off, the molecules are not arranged in an order and the refractive index of the liquid crystal layer 11 is lower than the external polymers so that incident light is dispersed in the polymers of

the light-regulation membrane, causing the light-regulation membrane to show the color of oyster white that does not admit light. At this time, the light-regulation membrane causes the glass 9 to show a frosted glass effect. When the power source 8
5 is switched on, electricity goes through the two conducting layers 12 to conduct the liquid crystal layer 11, causing the molecules to be in the liquid arranged and/or oriented in a crystal-like way. At this time, the refractive index of the liquid crystal layer 11 is equal to the external polymers, for allowing
10 incident light to pass. At this time, the glass 9 is seen in its original transparent status.

Further, the light-regulation membrane of the present invention can be adhered to any of a variety of other light transmissible plate, for example, PMMA (polymethyl
15 methacrylate) plate or PC (polycarbonate) plate. Further, the anti-radiation layer 5 can be made in any desired light transmissible color so that the light-regulation membrane shows a color effect when it is nontransmissible.

In conclusion, the invention provides a light-regulation
20 membrane that the following characteristics and advantages:

1. The two conducting layers 12 of the PDLC film 1 are electrically connected to the power source 8 so that a person can

switch on/off the power source 8 to change the transmittance of the light-regulation membrane so as to block light or to let light pass through the glass 9 on which the light-regulation membrane is adhered. By means of the adhesion layer 6, the
5 light-regulation membrane can be directly adhered to any window glass of a building without destructing the construction. Further, the adhesion layer 6 allows the light-regulation membrane for reusable application, simplifying maintenance work and saving much installation cost.

10 2. The anti-stain layer 41 of the surface structure 4 is prepared from thermosetting organosiloxane resin which comprises of colloidal silica and hydrolysis-condensation trialkoxysilane. The anti-stain layer 41 of the surface structure 4 facilitates cleaning work. After the light-regulation membrane is
15 adhered to the glass 9, the cleaning work becomes easy. Therefore, the light-regulation membrane of the present invention is convenient and practical to use.

 3. The hard coating layer 43 of the surface structure 4 is made of cross-linking copolymer acrylates and ultraviolet
20 absorbent, containing a certain amount of carbamate bond. It protects the glass 9 against cracking, having wear resisting and solvent resisting characteristics.

4. The PDLC (polymer dispersed liquid crystal) film 1 is sandwiched between the polymer compound layers 2 are prepared from a plastic chemical material, for example, PET (polyethylene terephthalate), PMMA (polymethyl methacrylate),
5 PC (polycarbonate), PP (polypropylene), PE (polyethylene) or PVDC (polyvinylidene chloride). Therefore, the polymer compound layers 2 give excellent support to the PDLC (polymer dispersed liquid crystal) film 1 without affecting the light regulation functioning of the PDLC (polymer dispersed liquid
10 crystal) film 1. Therefore, the light-regulation membrane is applicable to glass curtain wall, vehicle sliding sunroof, indoor partition wall, etc. When the light-regulation membrane is in the nontransmissible status, the glass 9 to which the light-regulation membrane is adhered can be used as a rear projection screen.

15 5. The anti-radiation layer 5 has anti-ultraviolet and anti-infrared characteristics. When applied to a glass curtain wall of a building, the light-regulation membrane blocks ultraviolet from the radiation of the sun, avoiding sun radiation damage to human body skin and indoor furniture. The
20 anti-radiation layer 5 also blocks infrared light rays from the radiation of the sun, producing a heat isolation effect to keep the indoor space warm in winter or cool in summer and saving much

power consumption. Therefore, the invention is an environmentally friendly design. Further, by means of the anti-reflective layer 42 of the surface structure 4, the light-regulation membrane has a low reflective and a high transmittance. When applied to a glass curtain wall of a building, the light-regulation membrane provides a good lighting effect, saving lighting power consumption.

Although particular embodiments of the invention have been described in detail for purposes of illustration, various modifications and enhancements may be made without departing from the spirit and scope of the invention.

What the invention claimed is:

1. A light-regulation membrane comprising:
a surface structure, said surface structure comprising an anti-stain layer and a hard coating layer;
5 an adhesion layer for adhering on light transmissible plate;
two polymer compound layers sandwiched between the hard coating layer of said surface structure and said adhesion layer; and
10 a PDLC (polymer dispersed liquid crystal) film sandwiched between said two polymer compound layers, said PDLC (polymer dispersed liquid crystal) film comprising two conducting layers and a liquid crystal layer sandwiched between said two conducting layers.
- 15 2. The light-regulation membrane as claimed in claim 1, wherein said anti-stain layer is prepared from cross-linked organosiloxane.
3. The light-regulation membrane as claimed in claim 1, wherein said anti-stain layer is prepared from thermosetting
20 organosiloxane resin which comprises of colloidal silica and hydrolysis-condensation trialkoxysilane.
4. The light-regulation membrane as claimed in claim 1,

wherein said hard coating layer is made of a compound material prepared from cross-linking copolymer acrylates and an ultraviolet absorbent.

5 5. The light-regulation membrane as claimed in claim 4, wherein the compound material of said hard coating layer has a specific repeating structure unit and contains a predetermined amount of carbamate bond.

6. The light-regulation membrane as claimed in claim 1, wherein said hard coating layer is a UV curable organic coating
10 prepared from a mixture of multi-functional acrylates, silicone acrylate as a slip agent, a crosslinkage adhesion promoter, and photo-initiators.

7. The light-regulation membrane as claimed in claim 1, wherein said hard coating layer is a UV curable organic coating
15 prepared from a mixture of multi-functional acrylates, silicone acrylate as a slip agent, a crosslinkage adhesion promoter, a (meth) acrylate terminated toughener, nano sized silica as inorganic filler, a silane coupling agent, and photo-initiators.

8. The light-regulation membrane as claimed in claim 1,
20 wherein said hard coating layer is a UV curable organic coating prepared from a mixture of multi-functional acrylates, silicone acrylate as a slip agent, a (meth) acrylate terminated toughener,

nano sized silica as inorganic filler, a silane coupling agent, and photo-initiators.

9. The light-regulation membrane as claimed in claim 1, wherein said polymer compound layers are prepared from a plastic chemical material.

10. The light-regulation membrane as claimed in claim 9, wherein said plastic chemical material is selected from the group of PET (polyethylene terephthalate), PMMA (polymethyl methacrylate), PC (polycarbonate), PP (polypropylene), PE (polyethylene) or PVDC (polyvinylidene chloride).

11. The light-regulation membrane as claimed in claim 9, further comprising two pressure sensitive adhesive layers respectively bonding said polymer compound layers to the two conducting layers of said PDLC (polymer dispersed liquid crystal) film.

12. The light-regulation membrane as claimed in claim 1, wherein said liquid crystal layer is prepared from a compound of hydroxyl polyfunctional (meth) acrylates and nematic liquid crystal cured with a polyisocyanate compound crosslinking agent.

13. The light-regulation membrane as claimed in claim 1, wherein each said conducting layer comprises a base layer of

PET (polyethylene terephthalate and a layer of ITO (indium tin oxide) deposited on said base layer of PET (polyethylene terephthalate by means of sputtering deposition.

14. The light-regulation membrane as claimed in claim 1,
5 wherein said surface structure further comprises an anti-reflective layer sandwiched between said anti-stain layer and said hard coating layer.

15. The light-regulation membrane as claimed in claim 1,
further comprising an anti-radiation layer sandwiched between
10 said adhesion layer and said PDLC (polymer dispersed liquid crystal) film and adapted for blocking ultraviolet light and infrared light.

16. The light-regulation membrane as claimed in claim 1,
wherein said adhesion layer is made of a mixture of organic
15 silicone and acrylic pressure sensitive adhesive.

17. The light-regulation membrane as claimed in claim 1,
further comprising two strippable protective films made of PET
(polyethylene terephthalate) and respectively covered on said
adhesion layer and the anti-stain layer of said surface structure.

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