Hybrid aligned liquid crystal gel for daylight controllable window

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A reverse mode liquid crystal cell changes from a transparent state to a light scattering state by voltage application. The reverse mode liquid crystal gel which has a homogeneous orientation containing a small amount of a reactive mesogen (RM) has been proposed by Hikmet. Moreover, liquid crystal gels with twisted and supertwisted nematic orientations have also been studied since these cells do not need a polarizer to obtain the strong light scattering state. In this study, we propose the liquid crystal gel with hybrid orientation for an application to a daylight controllable window. The window is clear at any incident angle when no voltage is applied. On the other hand, the cell scatters the incident sunlight around noon by the voltage application, as shown in Fig. 1.

The cell was prepared using the RM of UCL-017 (DIC) in which a small amount of a photo initiator was mixed. The RM was dissolved in the liquid crystal of MLC2136 (Merck) at concentration of 5wt%. The mixture was sandwiched between ITO glass substrates respectively coated with polyimide for homogeneous and homeotropic alignment. The cell was irradiated with UV light of 20 mW/cm² for 600 s at room temperature. The RM was polymerized keeping with the hybrid orientation. The cell thickness was 10 µm. An electro-optical property of the cell was measured using a laser diode (LD, λ=635nm) and a silicon photodiode. The incident light of LD is depolarized. A collection angle of scattered transmission light was about 2°. The transmittance of 100% was defined as the light intensity detected without the cell.

Figure 2 shows transmission curves as a function of incident light angle. The transmittance in the off-state is about 70% at the incident angle of ±40°. When the voltage is applied, asymmetric curves are obtained. The effective refractive index of the RM in the bulk is close to the ordinary index for incident light of −θ direction and the cell is clear. On the other hand, it shows extraordinary index for incident light of +θ direction and the cell become hazy because of a refractive index mismatching between reoriented liquid crystal molecules.

Figure 3 shows photographs of the hybrid aligned liquid crystal gel with the voltage of 10 V. Transmittance of the incident light from left and right horizontal directions is same and is about 55-30% at ±60°. The cell is hazy for the incident light at high pole angle. When we observe the low position through the cell, a view is not damaged. Such electro-optical properties are useful for the application to a smart glass to save a power supply of an air conditioner in a warm period.


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