Mechano-optical Behavior of Multilayered Chiral-Nematic Liquid Crystal Elastomers with Auxetic Structures

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Chiral-nematic liquid crystal elastomers (N*LCEs) show selective reflection derived from the helical orientation of the liquid crystal molecules. N*LCEs can respond to applied strain as a change in the selective reflection wavelength, they are expected to be applied to stress/strain sensors. We have previously developed N*LCEs stacked with different materials and reported that the mechanical-optical response behavior of N*LCEs can be controlled by the mechanical properties of the outer layer materials[1]. In this study, we focus on the auxetic structure and consider that the optical response behavior can be controlled more sensitively by changing the structure of the outer layer. Auxetic structures have the property of elongation perpendicular to the axial direction as shown in Figure 1. In this study, we fabricated stacked N*LCEs incorporating various forms of auxetic structures and developed materials that show sensitive optical response to strain.

The liquid crystal monomers, chiral agents, cross-linking agents, plasticizers, and initiators shown in Figure 2 were mixed and permeated into cells made of glass substrates to which polydimethylsiloxane (PDMS) films were attached, and photo-polymerization was applied to obtain stacked N*LCEs. Auxetic structures were fabricated by cutting PET film and double-sided tape using a laser cutting machine, and then affixed to the N*LCE to fabricate a film incorporating the Auxetic structure. The tensile behavior of the film was observed and reflectance spectra were measured.

When the laminated N*LCE with the paper cut structure was elongated and deformed, only the reflectance color of the cut area changed (Figure 3). Compared to the N*LCE without the paper cut structure, the reflectance color changed more sensitively to strain. This result was attributed to the increased strain in the film thickness direction caused by the Auxetic structure.

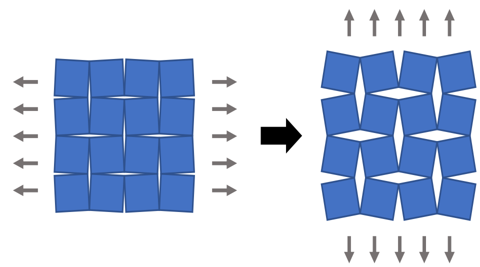

Figure 1. Image of Auxetic structure.

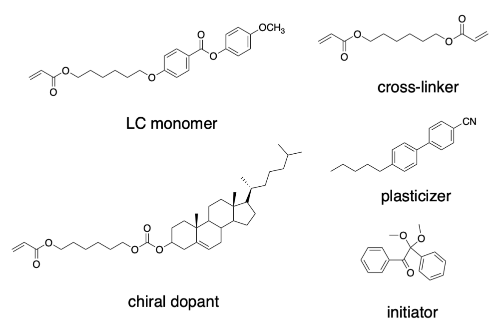

Figure 2. Chemical structures of a monomer mixture used in this study.

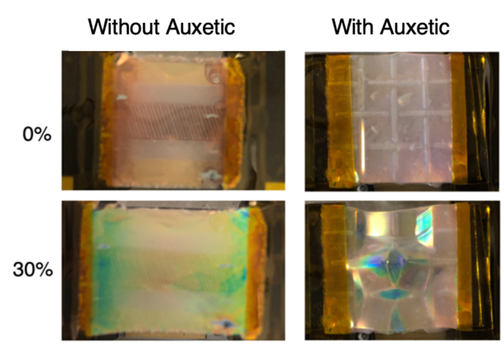

Figure 3. Picture of N*LCE at each applied strain.

1) Hisano, K.; Kimura, S.; Ku, K.; Shigeyama, T.; Akamatsu, N.; Shishido, A.; Tsutsumi, O. *Adv. Funct. Mater.* **2021,** 31, 2104702.