Laboratoire PPSM – UMR CNRS 8531

Photochimie et Photophysique Supramoléculaires et Macromoléculaires

Séminaire PPSM

Mardi 22 octobre 2019 - 14h00

Salle de conférences du bâtiment "Pavillon des Jardins"

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«Control of Helical Axis Orientation of Chiral Liquid Crystals and Their Application to Optical Materials»

In the chiral-liquid-crystal (LC*) phase, calamitic liquid crystal molecules are aligned helically; hence, the refractive indices of the LC* materials are altered periodically along the helical axis. The LC* materials have unique optical properties, such as selective reflection, that arise from the periodic structure of the refractive index. Therefore, the LC* materials are expected to be applied to highly functionalized optical materials. In order to apply to the optical materials, control of the orientation of LC molecules and helical axis is the most important. In this study, we have developed methods to control freely the helical axis orientation of the LC* materials.

We also investigated some applications of LC* materials to optical materials. One example of the application, which I will present, is mechano-optical material. The wavelength of the selective reflection depends on the helical pitch as it is a Bragg reflection; therefore, we can control the reflective wavelength, i.e. color, by controlling the helical pitch. By introducing the LC* molecules to the structures of polymer networks of elastomers chemically, the motion of the liquid crystal molecules can be coupled with the motion of the polymer main chain; thus, when mechanical stimuli is applied to the LC* elastomers, the orientation of the liquid crystal molecules is changed simultaneously along with the structure of the polymer main chains. As a result, in LC* elastomers, we expect the helical pitches to vary owing to the application of external mechanical stimuli, which in turn induces changes in the color of the selective reflections. Thus, in this study, we also observed the mechano-optical behaviors of LC* elastomers, and discussed the relationship between the chemical structures of elastomers and mechano-responsive optical properties. The films of the LC* elastomers were prepared by the photopolymerization of the mixture of liquid crystal monomer, chiral dopant, and cross-linker. When tensile strain was applied to the films, reversible hypsochromic shift in the reflection wavelength was induced. It may be considered that this change in the reflection wavelength is attributable to the contraction of the helical pitch due to thinning of the film thickness owing to tensile deformation. The mechanism of the change in the reflection wavelength was discussed based on the non-linear mechanical response of the elastomers to the tensile stress. The results of the mechano-optical behavior observed for the LC* elastomers suggest that LC* materials have potential for application in mechanical sensors for soft robots.

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