Mechanism of Molecular Orientation Pattern Formation in Liquid-Crystalline Polymers Induced by Gradient Photopolymerization

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We have recently found a new phenomenon that the periodic pattern of the molecular orientation of liquid crystal (LC) can be spontaneously formed by gradient photopolymerization of LC monomers. Since LCs show optical anisotropy, the LC polymers with the periodic orientation pattern can be useful for the highly functional optical materials. However, the mechanism of the periodic pattern of the molecular orientation formation has not been still unclear. So far, we found that the orientational pattern formation occurs simultaneously with the formation of the dissipative structures of polymer, and that the interdiffusion of monomers and non-polymerizable molecules is the key to this phenomenon. In this study, we discussed the mechanism of the orientational pattern formation in details.

Two types of monomer mixtures were prepared with LC/non-LC monomers and non-polymerizable molecules. Sample 1 were prepared using LC monomers and non-LC non-polymerizable molecules (Figure 1A). Sample 2 were prepared using non-LC monomers and LC non-polymerizable molecules (Figure 1B). Monomer mixtures were sealed in glass cells (cell gap: 4 μm) and irradiated with UV light (365 nm) for photopolymerization. In this process, a photomask with a gradient pattern was used to provide a spatial gradient with respect to the intensity of the irradiated light. Polarized light microscopy of polymerized Sample 1 reveal formation of the periodic pattern of the molecular orientation (Figure 2A). However, the periodic pattern of the molecular orientation was not formed by photopolymerization of Sample 2 (Figure 2B). We will discuss the mechanism of this difference.

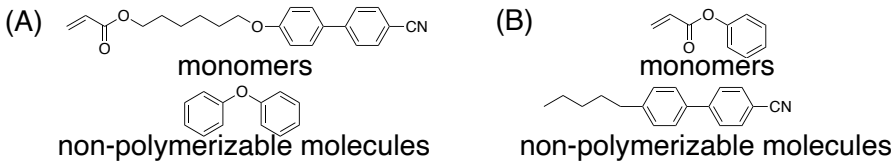

Figure 1 Molecular structures used in monomer mixtures (A) Sample 1 (B) Sample 2

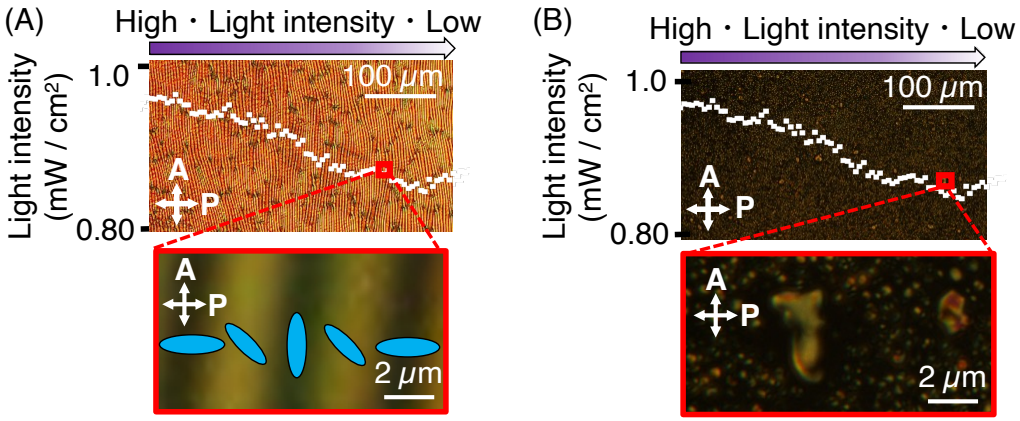

Figure 2 POM observation of polymer films. (A) Sample 1(B) Sample 2 The spatial profile of light intensity is plotted in the figure.