Fabrication and Analysis of Periodic Polymer Structures Induced by Photopolymerization Using Scanning Light

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Control of phase-separated structures has been studied for many years as a method for designing highly functional materials due to the close relationship between material properties and phase-separated structures.[1–3] Nevertheless, controlling the mesoscopic orientation of phase-separated structures is still a challenge. Recently, we discovered the spontaneous formation of periodically aligned phase-separated structures during photopolymerization with a scanned slit light;[4] however, the formation mechanism remains unclear. In this study, optical analyses of the periodic structures fabricated under various photopolymerization conditions were conducted to explore the formation mechanism towards the arbitrary control of the periodic structures.

A mixture consisting of an anisotropic monomer A6CB, a crosslinker HDDMA, and a photoinitiator Irgacure651 was prepared (**Figure 1**). The mixture was injected into a handmade glass cell with a thickness of 3 μm at its isotropic temperature (150 °C), and photopolymerized by scanning a slit UV light to fabricate a polymer film. Subsequently, the film was cooled down to room temperature at a cooling rate of 1 °C/min.

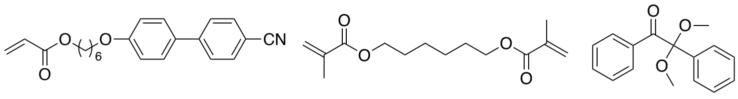

Figure 1. Chemical structures used for photopolymerization.

The observation of the film with a polarized optical microscope revealed that a micrometer-sized periodic structure formed in the polymer film. When a He-Ne laser beam (λ = 633 nm) was incident on the obtained film, the diffracted light appeared along the light scanning direction. The diffraction efficiency depended on the photopolymerization conditions, such as temperature, light intensity, and light scanning rate. This result indicates that the photopolymerization condition affects the morphology of the periodic structure. Furthermore, we performed an *in-situ* observation of the photopolymerization process using a polarized optical microscope equipped with a digital UV light processor, and analyzed the relationship between the photopolymerization process and the formation of periodic structures.

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