論文 / 著書情報
Article / Book Information

題目(和文)	動的光重合法の開発と二次元分子配向パターン形成
Title(English)	Development of a scanning wave photopolymerization method and inscription of two-dimensional molecular alignment patterns
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種別(和文)	要約
Type(English)	Outline

The purpose of this study is to develop a new dye-free optical method for macroscopically, two-dimensionally (2D) aligning LCs in polymeric systems. The author proposed a concept of scanning wave photopolymerization (SWaP) using spatiotemporal scanning of light that triggers a mass flow as the polymerization reaction propagates, generating arbitrary LC alignment coincident with the incident light patterns.

In **Chapter 2**, a serendipitous discovery for achieving the concept of SWaP was proposed. A simple photopolymerization through a photomask with non-polarized light and no alignment layer resulted in generating uniform one-dimensional (1D) due to 1D molecular diffusion along the normal vector to the edge line of the irradiated region. The existence of diffusion was evident by analyzing surface structure of the resultant polymer film. Furthermore, the photopolymerization through a patterned photomask realized the generation of 2D radial molecular alignment with a resolution of 2 μm.

In **Chapter 3**, the author explored to generate alignment patterns over large areas. As a first transition step and for ease of characterization, 1D scanning of slit light during photopolymerization was investigated. Optical measurements such as polarized optical microscopy, polarized ultraviolet-visible (UV-vis) spectroscopy, and polarized infrared spectroscopy revealed that the resultant film had macroscopic, in-plane 1D alignment of both LC units and polymer main chains along the light scanning direction. Furthermore, the author achieved a macroscopic 1D alignment in a wide variety of chemical systems with various combinations of monomers, crosslinkers and photoinitiators.

In **Chapter 4**, the author proposed the mechanism that SWaP generated a diffusion-triggered mass flow enabling to align molecules. For proving this, a test system was designed. In the system, diffusion was caused simply by contacting two different mixtures injected into a glass cell from separate sides where one included a

monomer and a photoinitiator, and the other additionally included a well-defined polymer. After a certain duration, the cell was normally irradiated with UV light causing uniform polymerization and fixing any generated alignment. The polymerized film exhibited 1D molecular alignment around the contacted region. The alignment length had good agreement with that of theoretically estimated from Fick's law of diffusion. This means that the driving force aligning molecules is a diffusion-triggered mass flow.

In **Chapter 5**, the author developed optical setups using a digital light processor for achieving SWaP with a mask-free spatiotemporally scanned light, and inscribed representative 2D alignment patterns over large areas in a single step: radial alignment, azimuthal alignment, in-plane helical alignment, and spay-bent alignment along the light scanning direction. Furthermore, optical functionality of the films was evaluated by using appropriate light sources. The author confirmed that films had the ability to manifest unique optical functionalities that have never been reported previously.

In this study, the author proposed a simple photopolymerization method, termed SWaP, enabling one to inscribe arbitrary 2D alignment patterns over large areas without for any extra steps, with the potential resolution down to light diffraction limit merely by spatiotemporally scanning the actinic light. It is noteworthy that SWaP can be applicable in a wide variety of chemical systems because the alignment was triggered by a simple mass flow arising from molecular diffusion, evident from experimental and theoretical results. Furthermore, the author achieved to design and develop new photonic applications with unique optical properties that could not be achieved by using conventional photoalignment methods. The author believes that SWaP provides a new, general, and powerful pathway as a chemical system platform for the simple creation of a variety of high-performance LC devices such as photonic materials.