MERIT Internship Program (Domestic) Report

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[Period] December 26th, 2018 ~ January 25th, 2019

[Host Institute] RIKEN, Center for Emergent Matter Science, Physicochemical Soft Matter Research Team

[Outline]

From December 26th, 2018 to January 25th, 2019, I conducted a corporate internship at Center for Emergent Matter Science (CEMS) in RIKEN, located in Wako, Saitama. CEMS is known as a world-leading research center in the fields of soft material research such as hydrogels and liquid crystalline (LC) materials, and also condensed matter physics. In this internship, the coassembled core–shell column LCs, we recently developed, was employed to investigate their orientation behavior by external fields and their physical properties.

[Research]

In our laboratory, we found that supramolecular polymerization of a disk-shaped monomer in LC media comprising rod-shaped molecules affords a coassembled columnar LC material with a core-shell geometry[1]. In this internship, in order to deepen the understanding of the columnar LC materials, their structural evaluation and physical property measurements were conducted.

(1) Photoswitchable adhesion property

Recently, light-melt adhesives based on LC materials have attracted attention[2]. Since we have already found that our coassembled columnar LC material undergoes a photoinduced melting via its LC-to-isotropic phase transition, the photoswitching behavior of adhesion properties was investigated. Dr. Araoka and Dr. Aya, who investigated "photoinduced viscoelasticity change of LC materials[3]", kindly helped to construct the measurement system. The coassembled LC material was sandwiched between glass plates and its tensile test was carried out using a rheometer. However, no adhesion change was observed before and after irradiation of UV light, probably because of the

crystallization of the LC material. As a future task, I am going to introduce a temperature controlling unit into the measurement system.

(2) Magnetic orientation behavior in a superconducting magnet

We developed a coassembled columnar LC material with stable organic radicals[4] and examined the possibility of magnetic field orientation due to the paramagnetic component. The coassembled LC material in a LC cell was introduced into a 9-T superconducting magnet and subjected to a magnetic field while cooling from its isotropic melt. The resultant LC material in its polarized optical microscopy (POM) showed a unidirectional orientation of LC columns up to a millimeter scale.

(3) Investigation of the unidirectionally oriented columnar LC materials.

To investigate the columnar directions oriented by external fields, I conducted POM observation and FTIR spectroscopy combined with IR polarizers to measure the anisotropic absorption of IR light. The magnetically oriented columnar LC material showed a dichroic feature in its polarized IR spectral profiles, indicating the perpendicular orientation of LC columns relative to the applied magnetic flux. Similarly, the electrically oriented columnar LC material was investigated to show the parallel orientation relative to the applied E-field.

(4) Evaluation of magnetic properties of our paramagnetic coassembled columnar LC.

In the collaboration with Dynamic Emergent Phenomena Research Unit in CEMS, I evaluated the magnetic properties of our coassembled columnar LC having paramagnetic units by means of a superconducting quantum interference device (SQUID). Although I Initially suffered from its reproducibility, the SQUID measurement using an aluminum foil resulted in the good reproducibility of experimental results of magnetic susceptibility–magnetic field curves. I will try to estimate the magnetic parameters of our LC materials.

The experimental results described above are now under discussion with the collaborator and are prepared for the publication.

[1] K. Yano *et al. Science* **2019**, *363*, 161–165. [2] S. Saito *et al. Nature Commun.* **2016**, *7*, 12094. [3] S. Aya *et al. Proc. SPIE* **2018**, 10735. [4] K. Yano *et al. to be submitted.*

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