Functionalization by Self-Assembly in Soft Matter

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Abstract: Self-assembly and self-organization often occur in soft matters. We have studied the functionalization by the self-assembly in soft matters. Our works are divided into two categories: self-assembly of LC molecules and self-assembly in LC phases. Here, I will give a talk about the two topics.

Cholesteric LC (CLC) phases have one-dimensional helical structures, which strongly affect the propagation of visible lights when the helical pitch is comparable to their wavelength ranges. Meanwhile, a CLC shell with tangentially aligning interfaces can be three-dimensional chiral photonic crystals as viewed from the center of the shell; the CLC shell works as a resonator of omnidirectional laser action [1]. A topologically essential defect in the shell leads to self-assembly of particles dispersed in the shell, and it can induce “mutualistic self-assembly” in the CLC shell with magnetic nanoparticles [2]. In addition to the new functions of CLC shells, we have recently developed the fabrication methods of LC shells [3].

To manipulate LC shells, we need containers with ordered pores. There are some top-down methods for the fabrication of ordered porous materials by using some instruments like drills and lasers. We challenged to develop an easy bottom-up method to obtain the ordered porous materials using self-assembly in emulsions [4]. We call the bottom-up method to fabricate the structures using self-assembly in soft matters “soft-templating methods”. As another example of the soft-templating methods, we have recently proposed a new method to synthesize nanosheets (NSs) by using an hyperswollen lyotropic lamellar (HL) phase composed of bilayers of a non-ionic amphiphile. Hydrophobic polystyrene NSs and NSs of metal-organic frameworks (MOFs) successfully synthesized in the thin hydrophobic regions in the sandwich-like reaction fields (SRFs) inside the bilayers of HL phases of aqueous amphiphilic solutions [5][6].

References
Bio

Yoshiaki Uchida was born in 1981 in Japan. He worked on the design and synthesis of paramagnetic LC compounds containing a chiral-nitroxide unit as new soft matters with Professor Rui Tamura at Kyoto University and received his PhD in 2009. After postdoctoral researches on physics of LC colloid emulsions at Harvard University with Professor David A. Weitz and on laser action in CLC shells at Kyoto University with Professor Jun Yamamoto, he joined Osaka University as an assistant professor in 2011 and he has been an associate professor there since 2014. He was also a PRESTO researcher at Japan Science and Technology Agency from 2013 to 2017. He worked on the magnetic and optical properties of the chiral organic radical LC materials as a PRESTO researcher. He specializes in synthetic organic chemistry, physical chemistry, microfluidics, and soft matter physics. He is interested in the synthesis of new LC compounds containing nitroxide radical moieties, the fabrication of monodispersed LC emulsions, the statics and dynamics of defect structures in LC phases, electron paramagnetic resonance (EPR) spectroscopy of LC phases of paramagnetic compounds, magnetic drug delivery (DDS) systems using LC emulsions, laser action in LC emulsions, soft-templating synthesis of materials in soft-matters, and so on.