

学 位 論 文 の 要 旨

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学位論文題目	フレキシブルなアキラル三量体液晶が形成する中間相における自発的対称性の破れ <b>Spontaneous symmetry breaking in the mesophase of an achiral flexible liquid crystal trimer</b>		
<p>Spontaneous symmetry breaking has been of great importance in the study of science. In particular, the spontaneous mirror symmetry breaking is attracting a lot of attention in liquid crystal science. Chiral conglomerates consisting of domains with opposite handedness of achiral liquid crystal molecules are significant interest, and they can be classified into liquid-crystalline sponge phases (dark conglomerate (DC) phase) and helical nanofilament (HNF) phases. Almost molecules exhibiting chiral conglomerates are rigid bent-core molecules. Layer chirality or conformation chirality is thought to be the origin producing the chiral conglomerates possessing layer structure. Inherent bent shape of a liquid crystal molecule producing those chiral conglomerate phenomena of achiral liquid crystals. Much research has focused on the chiral conglomerate phases not only for the spontaneous mirror symmetry breaking but also for their nanostructures. The network in DC phases can act as a porous nanoconfinement medium to produce nanocomposites for applications, such as semiconductors and photovoltaics.</p> <p>Yoshizawa et al. reported that LC oligomers in which several mesogenic units are connected via flexible spacers exhibited frustrated phases with hierarchical structures. LC oligomers are thought to have an order within a molecules. Various molecular packing structures in the liquid-crystalline phases of LC oligomers induced frustrated liquid crystal phases, however, spontaneous mirror symmetry breaking was not observed. A liquid crystal trimer is a supermolecule in which three mesogenic units are organized. Intermolecular interactions can be designed between adjacent trimers depending on the spacer parity. Furthermore, designed core-core intermolecular interactions between zigzag trimers with odd-membered spacers is expected to induce a twist conformation in the trimer. A novel spontaneous mirror symmetry breaking can be observed for designed liquid crystal trimers. Not only observation of spontaneous mirror symmetry breaking but also new nanostructures will be presented in this thesis.</p> <p>In chapter 1, an equimolecular mixture of a trimer with an N phase and that with SmA, SmC and SmB was found to exhibit N, SmC and HNF phases. This is the first report of a trimer system forming chiral conglomerates. The interdigitation of the zigzag trimers driven by the dipole–dipole interaction might form a supermolecular bent configuration, which induces a local preference for the saddle splay curvature to drive the HNF phase.</p> <p>In chapter 2, the following liquid crystal trimer <b>V-(7,7)</b> was found to exhibit the DC phase possessing chiral domains with opposite senses (Fig.2). The trimer forms an achiral ground-state conformation in the N phase,</p>			

however, by intermolecular interactions between cores they adopt a twisted chiral conformation to exhibit the spontaneous mirror symmetry breaking in the low-temperature DC phase.

Furthermore, in chapter 3, the produced dark conglomerate phase of trimer **V-(9,9)** was found to exhibit a single gyroid-like surface and a sponge like bulk structure (Fig.2). The microstructures in the DC phase of the flexible trimer are quite different from those in DC phases of bent-core molecules. The soft crystalline chiral conglomerate phase forming porous structures is a promising new candidate for producing nanostructured composites.

In chapter 4, I designed a photosensitive achiral liquid crystal trimer exhibiting N and DC phases. The UV irradiation induced a phase transition from the soft crystalline chiral conglomerate phase to the achiral liquid crystalline phase consisting of short correlation length layer structures via the *trans-cis* photo-isomerization of the azobenzene unit. The photo-driven reversible chirality switching transforms the sponge structure in the DC phase to a more ordered porous structure. Not only an unusual layered phase but also a porous material is demonstrated.

An achiral liquid crystal trimer was found to produce a DC phase possessing chiral domains with opposite senses. Intermolecular interactions between cores induce a twisted conformation in the trimer exhibiting the spontaneous mirror symmetry breaking in the DC phase. The DC phase exhibit chiral gyroid-like surface, which can produce a novel nanostructure system.

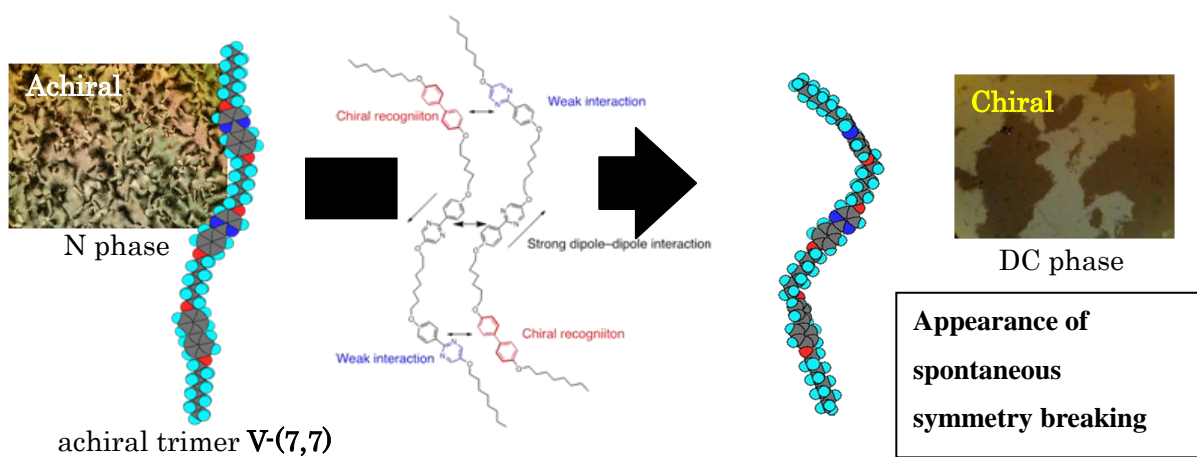


Fig.1 Model for the origin of the chirality of trimers in the DC phase.

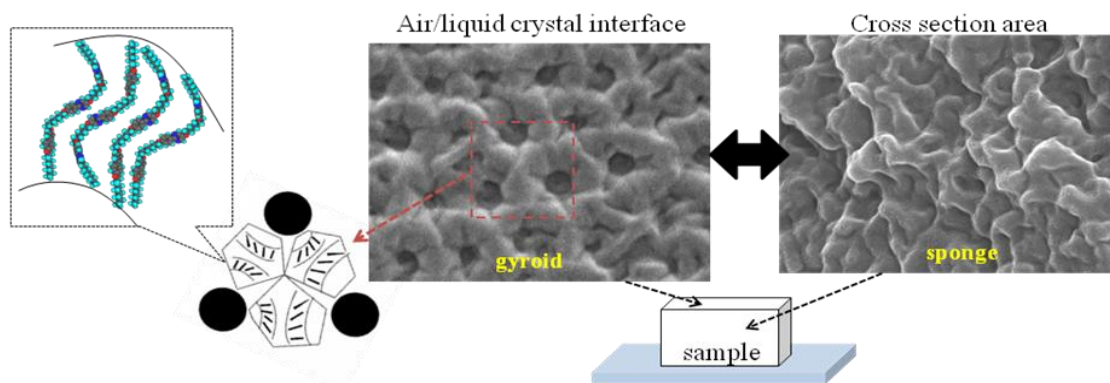


Fig.2 SEM image of the surface and the bulk structure in the DC phase with a possible model for the molecular organization.