The anomalous cholesteric droplets: the orientational and dynamical behaviour under a temperature gradient

Fumiya Ito*, Jun Yoshioka Yuto Suzuki, and Yuka Tabe

Pure & Applied Physics Department, Graduate School of Advanced Science & Engineering, Waseda University, Tokyo, Japan

Because of the broken mirror symmetry, cholesteric (Ch) LCs are known to exhibit unique properties both in statics and dynamics. One interesting issue is how the director should orient when a Ch sample is confined in such a small box as sphere, cylinder or cube. In the equilibrium, the molecules should align such that the torques due to the helix, Frank elasticity and the surface anchoring are balanced, which sometimes results in the complicated orientational structures[1]. Recently, we found several types of Ch droplets existed in the coexistence region between isotropic-cholesteric phases. The typical Ch droplets observed in a sandwiched cell are shown in Fig. 1. At slightly below the I-Ch transition point, the small Ch domains with a hemispherical shape shown as fig. 1(a) and fig. 1(b) are made on the glass substrate. Lowering the temperature enlarges the droplets more, and when the droplet diameter exceeds the helix pitch, the cross droplets transform into the stripe-type ones and the rugby-type droplets transform into either the stripe-type or the concentric circle (CC) type ones. We examined the threshold size between the type (a) or (b) and type (c) or (d) with changing the chiral dopant concentration and obtained the phase diagram as shown in Fig. 2. Since the threshold line corresponds to the helical pitch of each sample and the width of the stripe also agrees with the half pitch of the helix, the rugby and the stripe droplets should possess the helix whose axis is parallel to the substrate and that of the CC type droplets is perpendicular to the substrate, while the cross droplets has no helix.

The various Ch droplets had the various dynamical properties. When a thermal flow is given to cholesteric LCs along the helical axis, the director is known to show the unidirectional rotation, which is called Lehmann effect[2]. When we applied the temperature gradient perpendicular to the base of the hemisphere droplets, the cross ones showed no rotation, but the other three droplets all rotated in the same direction. The rotational velocity, however, was not the same among three. The rugby-type and the CC-type droplets rotate almost at the same speed, while the stripe-type ones rotate much slower. Moreover, the rotation speed of the stripe-type droplets significantly decreased with the droplet size, while the other two types of droplets showed the small dependence on the size (Fig. 3). At this stage, we may suggest that 1) the Ch droplets without helix (the one with the cross texture) cannot rotate on the solid substrate under the small heat flow; 2) the mechanism of the stripe-droplets rotation and that of the CC-type ones may be different.

References

* Fumiya Ito; E-mail: swallowtail@fuji.waseda.jp