

Isotropic-nematic phase transition of liquid crystals confined in nano-emulsions

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Liquid crystalline nano emulsions (LCNEs) consist of the tiny liquid crystalline core (~100nm) covered with the hydrophilic shell of surfactants such as PEG chains[1]. LCNEs can be designed as temperature-responsive drug carriers to control the hold and release of the drug molecules triggered by the isotropic-nematic (I-N) phase transition of the tiny LC core, because their stability and the mobility are greatly changed by the I-N phase transition. Since the LC order is confined in the isolated tiny spherical hydrophobic core, the size effect on the phase transition behavior is intrinsically important. In this paper, we introduced low molecular weight liquid crystals (LMWLCs) into the hydrophobic core, and controlled the radius of LCNEs by changing the ratio of LMWLCs to surfactants. Since LCNEs are uniformly dispersed in the water and randomly rotated by the thermally excited Brownian motions, the macroscopic anisotropy completely disappears, even if each LCNE has the finite LC order in the core. Then, the light scattering measurement was used to investigate the size effects on I-N phase transition.

We used 7CB, which exhibits the nematic phase below 42°C, and di-block copolymer of PEG and side-chain LC polymer (DiPEG-PLC) as LMWLCs and surfactants, respectively. We mixed 7CB and DiPEG-PLC with various weight ratios ϕ (LMWLC/Surfactant), and the LCNE was dispersed in water with the ratio of about 0.1wt%. We investigated the physical properties of LCNE in the dynamic and static light scattering measurements. In the polarized (VV) dynamic light scattering, the translational diffusion mode was observed, and the hydrodynamic radius of LCNE, a , can be estimated.

Figure 1 shows a as a function of ϕ . a becomes large with the increase in ϕ . In the depolarized (VH) static light scattering, the optical anisotropy was observed. Figure 2 shows the normalized scattered light intensity, I , as a function of temperature of two samples, whose radii are 150 and 480[nm] respectively. I of the LCNE whose radius is 480[nm] abruptly decreases near the N-I phase transition temperature of pure 7CB on heating. This suggests that Nematic phase confined in LCNEs with the large radius behaves as a bulk state. On the contrary, I of LCNE whose radius is 150[nm] gradually decrease but do not disappear even above the I-N phase transition temperature. This behavior is considered to be the confinement effect; the fact that the radius of LCNEs becomes large in proportion to the ratio of 7CB/DiPEG-PLC, thus the phase transition behavior shifts from the confined state to the bulk state. Similar behavior is confirmed in the pure thermotropic liquid crystals confined into parallel silica channels with 10nm diameter reported by A. V. Kityk et al.[2]. Since the confined dimension in our LCNEs is much stronger than the silica channels, the confinement effect much drastically influences to the I-N phase transition, which is important understanding for the design of the active drug careers.

1. M. Nishihara *et al.*, Chem. Lett. **37**, 12, 1214 (2008)
2. A. V. Kityk, *et al.*, Phys. Rev. Lett. **101**, 18, 187801 (2008)

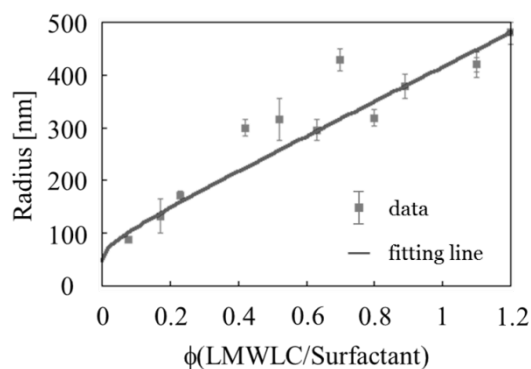


Fig.1 Radius of liquid crystalline nano-emulsions as a function of the concentration of liquid crystals.

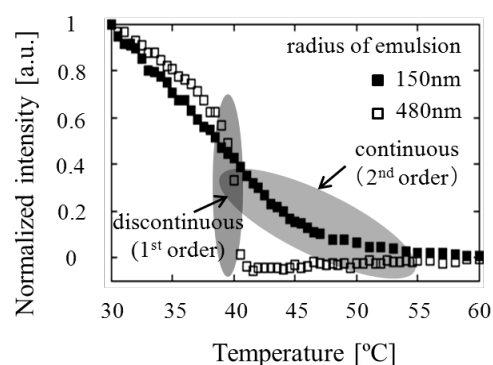


Fig. 2. Temperature dependence of normalized depolarized light scattering intensity of nano-emulsions.