Hysteresis of bicelle/ULV transition in long- and short-chain lipid mixture

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In the aqueous solutions of dimyristoylphosphatidylcholine (DMPC) and dihexanoylphosphatidylcholine (DHPC) mixture, bilayered-micelle, so called bicelle, were formed at low temperature. These bicelles fuse into large uni-lamellar vesicles (ULVs) above the chain melting temperature, T_c, of DMPC molecules (about 24°C) when lipid membranes were charged [1]. Although these disk-fused ULVs usually fissure into small disk micelles below T_c, the ULVs are stable even below T_c when the lipid concentration is very low [2]. However, the mechanism of the stable ULV formation has not been clarified yet.

In this study, we observed the structure in the lipid mixture system below and above T_c by SANS, and quantitatively discussed the stability of ULVs. The experiments were performed at 20°C and 50°C with changing lipid concentration. DMPC and DHPC were mixed in the molar ratio of [DMPC]:[DHPC] = 4.6:1, and dissolved in the D_2O solution of 3 mM $CaCl_2$. The SANS experiments were carried out at SANS-U, JRR-3M, JAEA, Tokai, Japan [3].

Figure 1 shows the temperature dependence of SANS profile with changing lipid concentration. While no hysteresis was observed at high lipid concentration (2.11 wt.%), the SANS profiles at low lipid concentration (0.35 wt.%) show the hysteresis as shown by previous study [2]: the profile of bicelles at 20°C changed to ULVs with increasing temperature up to 50°C, and the profile of ULVs remained even after decreasing temperature down to 20°C. Although such the hysteresis was observed even at intermediate lipid concentration (1.06 wt.%), large bicelles appeared instead of ULVs after annealing. In this case, the volume of bicelle evaluated by the fitting is almost same to that of ULV shell. This means that one ULV at high temperature phase opened to one bicelle with decreasing temperature. Therefore, bicelles after annealing is larger than before annealing, since some small bicelles fuse into one ULV at the ULV formation. This new histeresis would be a important help to understand the mechanism of the hysteresis of bicelle/ULV transition.

References

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[3] S. Okabe *et al.*, *J. Appl. Cryst.*, **38** (2005) 1035.

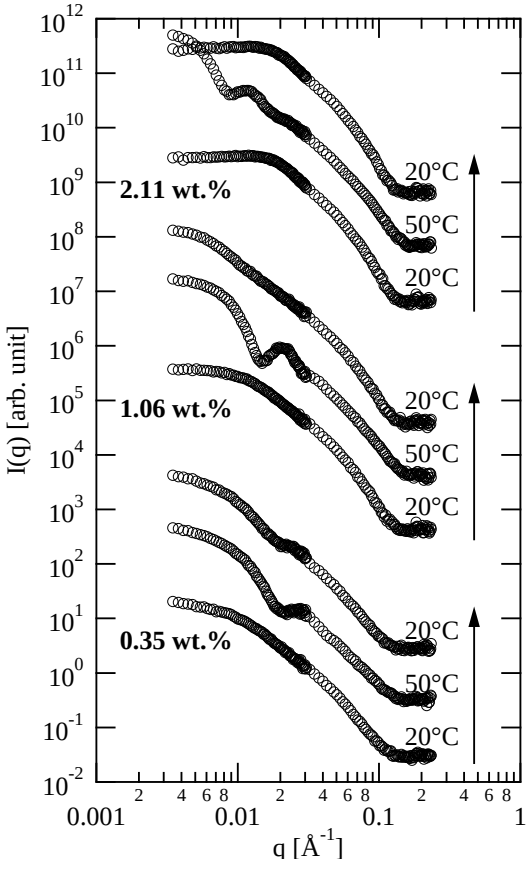

Fig. 1. Temperature dependence of SANS profile with changing lipid concentration. Temperature sequence is indicated by the arrows.