

Dynamics of lamellar gel bilayers at critical vesicle concentration below the Krafft temperature

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We have ever found the spontaneous vesicle formation in the polyoxyethylene-type nonionic surfactant C₁₆E₇ and C₁₈E₈ (C_nH_{2n+1}(OC₂H₄)_mOH) system below the Krafft temperature, which is the melting point of hydrophobic parts of surfactants. After the temperature-jump across the Krafft temperature, micelles are transformed to the lamellar gel phase (L_β) in excess water. The multilamellar domains are spontaneously closed to be a vesicle with a hollow including the excess water. The vesicle formation can be explained by the free energy by Shioi et al. They represented a sum of two energies, i.e., rim and bending energies of a disk formed bilayer. In order to discuss the vesicle formation with the free energy, it is important to estimate the bending modulus of the interdigitated bilayer below the Krafft temperature. In this report, we have investigated the fluctuation of the bilayer by means of neutron spin echo (NSE) to estimate the bending modulus.

Samples were prepared by mixing C₁₆E₇ or C₁₈E₈ with D₂O so that the concentration became 1 wt%. The sample temperature was controlled to be 8 and 22 °C for the C₁₆E₇ and C₁₈E₈ system, respectively. The NSE experiments were performed at NG-5, the National Institute of Standards and Technology (NIST). The covered q range was from 0.1067 to 0.1725 Å⁻¹, and the Fourier time was between 0.067 and 40 ns.

Figure 1 shows the intermediate correlation functions obtained for each system. The curves are the fitting results to a stretched exponential, which has been suggested by Zilman and Granek to describe fluctuation of membranes. As seen in Fig. 1, the fitting curves agree with the experimental results at the lower q , while they are not well explained by the above function at

the higher q . Taking the fitting results at the lower q into account, we could calculate the bending modulus of C₁₆E₇ and C₁₈E₈ systems to be about 25 k_BT. This value is 3.7 times larger than that estimated theoretically for the liquid crystal phase (L_α) of C₁₆E₄ system, which is 6.8 k_BT (Gentile et al., *J. Colloid and Interface Sci.*, 2012). This may be due to the interdigitated lamellar structures, and the hexagonal packing of the surfactant molecules in plane.

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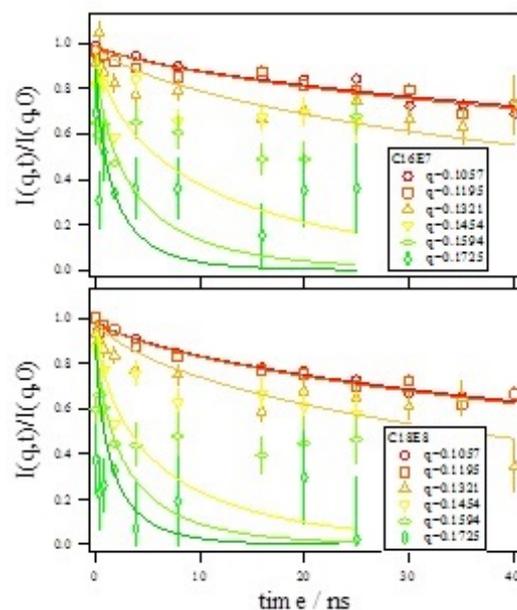


Fig. 1. Intermediate correlation functions obtained for each system.