Effects of Temperature on the Shear-Induced Structural Transition in the Lamellar Phase of Nonionic Surfactants

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In the past 10 years, much attention has been paid to the effects of shear flow on the structure of a lamellar phase owing to the development of the apparatus which enables us to determine their structures directly under shear flow. In the previous studies, we have measured small-angle neutron scattering (SANS) on the lamellar phases of a nonionic surfactant C16H33(OC2H4)7OH (C16E7) in D2O at 70C under shear flow with shear rate of 0.01 - 10 s-1 which is much lower than those for other studies reported so far. We have found anomalous decrease in the lamellar spacing for the shear rate of 0.1-1 s-1 suggesting local phase separation into concentrated lamellar and water-rich regions [1,2]. In the present study, we have investigated effects of temperature on these structural transition.

Measurements of SANS were carried out at the instrument SANS-U of Institute for Solid State Physics of University of Tokyo in JRR-3M at Tokai with a Couette shear cell [3].

Figure 1 shows temperature dependence of the repeat distance at 0, 1, and 3 s-1 for the velocity-gradient direction for the sample containing 48 wt% of C16E7. The repeat distance at 1 s-1 decreases discontinuously at about 68C. At 3 s-1, on the other hand, the repeat distance takes smaller values than at rest but suddenly increases at about 70C. In our previous SAXS study on the same system at rest, it has been found that the lamellae have water-filled defects in the lower temperature range and that the fraction of these defects decreases with increasing temperature and disappear above about 68C. So the present results suggest that the discontinuous decrease in the repeat distance by shear flow is strongly correlated with the existence of the water-filled defects.

References
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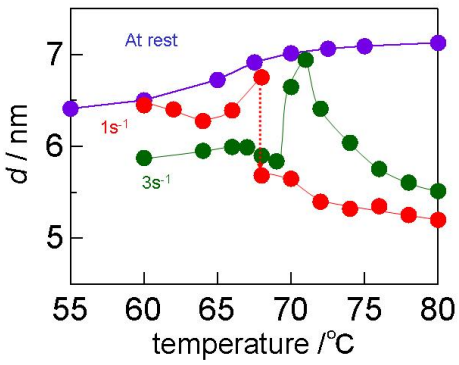

Fig. 1. Figure 1. Temperature dependece of the repeat distance at 0, 1, and 3 s-1 for the velocity-gradient direction for the sample containing 48 wt% of C16E7.