Chemistry

15A/2003G235

Simultaneous SAXS/Rheology Measurements on a Surfactant Lamellar Phase

Tadashi KATO*, Kyoko MIYAZAKI, Yuriko KOSAKA, Youhei KAWABATA
Department of Chemistry, Tokyo Metropolitan University
1-1 Minamiohsawa, Hachioji, Tokyo 192-0397, Japan

Introduction

In recent years, much attention has been paid to the effects of shear flow on the structure of a lamellar phase [1]. In our previous studies, we have measured small-angle neutron scattering (SANS) on the lamellar phase of a nonionic surfactant $C_{16}H_{33}(OC_2H_4)_7OH$ ($C_{16}E_7$) in D_2O (40-55 wt%) at 70 °C paying attention into the structural change in the relatively lower shear rate range, 10^{-3} - 30 s^{-1} [2]. When the shear rate increases from 0.1 to 1 s^{-1}, the repeat distance (*d*) is decreased significantly (down to about 40% of *d* at rest in the most significant case). This, together with other results including small-angle light scattering measurements, strongly suggests that water layers are excluded by shear flow and that the lamellar phase segregates into a concentrated lamellar region and a water-rich region. It has been also found that the repeat distance decreases discontinuously because two separated peaks are observed in the time-resolved SANS measurements. However, the segregation processes could not be elucidated because it takes about 5-10 min to obtain one SANS pattern. By using small-angle X-ray scattering (SAXS) with the CCD camera as a detector, on the other hand, a 2D scattering pattern can be obtained within a second. In the present study, we have constructed an apparatus for simultaneous SAXS /rheology measurements. The same sample as in the previous SANS studies were used to compare the SANS and SAXS measurements.

Experimental

A rheometer AR550 (TA Instruments) is modified for simultaneous SAXS/rheology experiments. Figure 1 shows schematic views of a sample cell. The cell consists of two concentric cylinders, both of which are made of polycarbonate. The diameter of the inner cylinder and the gap are 25 mm and 1 mm, respectively. The temperature of the sample is controlled by Peltier elements installed in the rheometer through the sample jacket made of cupper. To prevent sample evaporation, a vapor seal is incorporated in the cell.

SAXS measurements were performed on the beamline 15A. The scattered beam was recorded using the CCD area detector covering the scattering vector range from 0.015 to 0.25 $Å^{-1}$.

Results

Figure 2 shows 2-dimensional scattering patterns for the lamellar phase of a $C_{16}E_7$/water system (48 wt%, 70°C). These figures demonstrate that the repeat distance decreases discontinuously when the shear rate increases from 0.3 s^{-1} (left) to 1 s^{-1} (right).

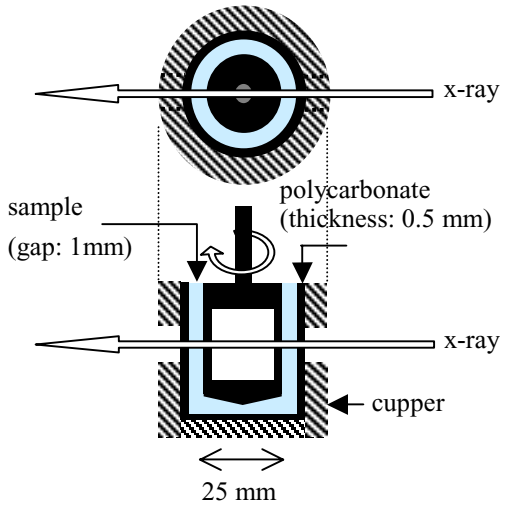

Fig. 1 Top (upper) and front (lower) views of a sample cell for simultaneous SAXS/rheoloby experiments.

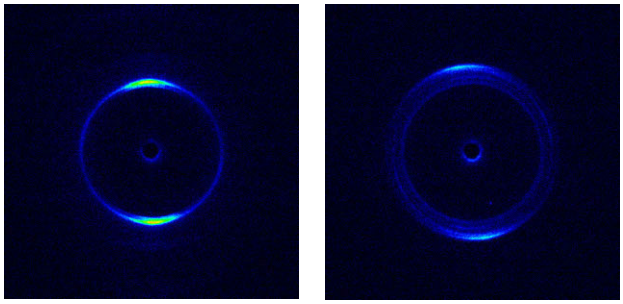

Fig. 2 2-D scattering patterns for the lamellar phase of a $C_{16}E_7$/water system (48 wt%, 70°C) at the shear rate 0.3 s^{-1} (left) and 1 s^{-1} (right). The flow direction is horizontal

References

[1] D. Roux, in "Nonequilibrium Dynamics, Metastability and Flow", M. E. Cates, M. R. Evans, and P. Osborne Eds, Institute of Physics Publishing, Bristol, Chap 7 (2000).
[2] T. Kato, K. Minewaki, Y. Kawabata, M. Imai, and Y. Takahashi, *Langmuir,* **20,** 3504 (2004).

* kato-tadashi@c.metro-u.ac.jp