Re-entrant Lamellar/Onion Transition with Varying Shear Rate in a Nonionic Surfactant (C_{14}E_5)/Water System

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Introduction

There have been reported many studies concerning the effects of shear flow on the structure of the lamellar phase. Among them, the most striking result may be the transition from the lamellar phase to the "onion phase" where all the space is filled by multilamellar vesicles alone [1]. Recently, we have reported the lamellar-to-onion transition with increasing temperature under a constant shear rate in the lamellar phase of a nonionic surfactant C_{16}E_7/water system (C_nE_m is an abbreviation of C_nH_{2n+1}(OC_2H_4)_mOH) by using simultaneous measurements of shear stress/small-angle light scattering and shear stress/small angle X-ray scattering (rheo-SAXS) [2, 3]. We have also found the re-entrant lamellar/onion (lamellar-onion-lamellar) transition with varying temperature at the shear rate of 3 s^{-1} in a C_{14}E_5/water system [4]. In the present study, we have performed rheo-SAXS experiments with a stepwise increase and decrease in the shear rate at constant temperature in the same system (C_{14}E_5/water) to find the re-entrant transition along another path.

Experimental

A rheometer AR550 (TA Instruments) is modified for rheo-SAXS experiments. Details of the cell have been reported previously [2]. Measurements were performed on the beamline 6A. The scattered beam was recorded using the CCD area detector covering the scattering vector range from 0.15 to 2.5 nm^{-1}.

Results and Discussion

Figure 1 shows time evolution of 2D SAXS patterns for the radial configuration (we have also measured SAXS in the tangential configuration), shear stress (a), and the diffraction-peak intensity for each direction (b) with a stepwise increase in the shear rate (see the scales on the right axis of (a)) in a C_{14}E_5/water system (35 wt%, 36°C). Photon Factory Activity Report 2012 #30 (2013)

![Fig. 1 Time evolution of 2D SAXS patterns for the radial configuration, shear stress (a), and the diffraction-peak intensity for each direction (b) with a stepwise increase in the shear rate (see the scales on the right axis of (a)) in a C_{14}E_5/water system (35 wt%, 36°C).](image)

These results suggest that the onion formation occurs only in the closed region in the temperature-concentration-shear rate diagram.

References


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