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Structural Study of Organic Salts Effect on the Trimeric Surfactant Aggregates

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1 Introduction

Trimeric surfactants of quaternary ammonium bromide ($3C_n$trisQ, in which n represents hydrocarbon chain lengths), which consisted of three hydrocarbon chains and three hydrophilic groups connected by spacer chains, were successfully synthesized[1]. They show unique physicochemical properties, such as lower critical micelle concentration and higher efficiency in lowering the surface tension, compared with monomeric and gemini surfactants. Previouly, we investigated the aggregation behavior of $3C_{12}$trisQ in order to discuss the effect of spacer chain on the growth of micelles[2]. We observed a sphere-to-rod transition without adding salt at the low surfactant concentration[2]. In this study, we investigated the aggregation behavior of $3C_{12}$trisQ in the sodium salicylate (NaSal) solution using small-angle X-ray scattering (SAXS) and rheology measurements.

2 Experiment

The rheological experiments were performed on a stress control rheometer (MCR-501, Anton Paar, Austria) in a viscosity and viscoelasticity measurement mode.

SAXS experiments were performed on the BL-10C beamline at PF, Japan. The used wavelength is 1.488Å and the sample-to-detector distance was 1 m. The scattered X-rays were collected on a R-AXIS VII (RIGAKU).

3 Results and Discussion

Fig. 1(a) shows the share-rate dependence of the viscosity for $3C_{12}$trisQ with varying the ratio of NaSal (salt) and surfactant volume fractions (ϕ_S/ϕ_D) from 0 to 0.13 in $\phi_D = 0.0068$. At $\phi_S/\phi_D = 0$ to 0.04, the viscosity is the same value that for water. At $\phi_S/\phi_D = 0.05$, the viscosity was higher than that for water. At $\phi_S/\phi_D = 0.075$ to 0.1, the viscosity monotonically decreased with increasing the shear-rate, which is well-known as shear thinning. This behavior is typical in wormlike micelle solutions. These results indicate that $3C_{12}$trisQ shows a sphere-to-rod transition with increasing NaSal concentration. On the other hand, at $\phi_S/\phi_D = 0.13$, the viscosity decreases. This behavior is a typical behavior for vesicle systems.

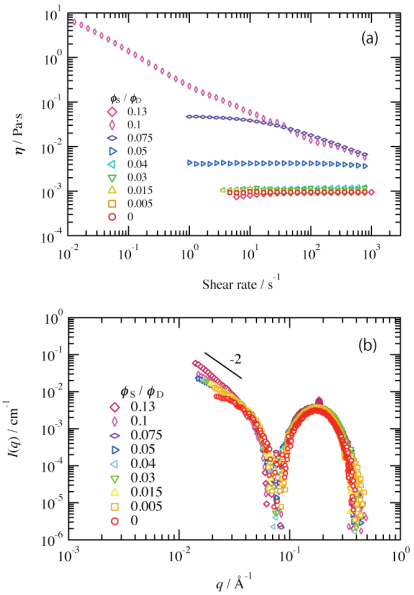

Fig. 1: (a) The shear rate dependence of viscosity and (b) the SAXS profiles for $3C_{12}$trisQ in NaSal solution

Fig. 1(b) shows NaSal concentration dependence of SAXS results for $3C_{12}$trisQ in $\phi_D = 0.0068$. At $\phi_S/\phi_D = 0$ to 0.13, scattering intensity increases with increasing NaSal concentration (ϕ_S) in the q-range of 0.01 Å^{-1} < q < 0.04 Å^{-1}, which indicates that the size of aggregates formed by $3C_{12}$trisQ increase with NaSal concentration. At $\phi_S/\phi_D = 0.13$, SAXS profiles show an asymptotic behavior of q^{-2} in the q-range of 0.01 Å^{-1} < q < 0.04 Å^{-1}. The SAXS results indicate that $3C_{12}$trisQ forms vesicles.

References

[1] T. Yoshimura *et al*., Langmuir, **28**(25), 9322-9331 (2012)

[2] T. Kusano *et al*., Langmuir, **28**, 16798-16806 (2012)

Research Achievements

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ポスター発表　学生奨励賞受賞

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