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Characteristics of AOT Microemulsion Structure: a Small Angle X-ray Scattering Study

Jun Cheng LIU[1], Gan Zuo LI[1]*, Bu Xing HAN[2]

[1]Key lab for colloid and interface chemistry of State Education Ministry,
Shandong University, Jinan 250100
[2]Center for Molecular Science, Institute of Chemistry, Chinese Academy of Science,
Beijing 100080

Abstract: The method of synchrotron radiation small-angle X-ray scattering (SR-SAXS) has been used to obtain structural information on the system of bis (2-ethylhexyl) sulfosuccinate (AOT)/ H_2O/isooctane. By using the Guinier plot (Ln I (q) *versus* q^2) on the data sets in a defined small q range (0.03-0.06Å^{-1}), the gyration radius at different water/surfactant molar ratio, W_0, was obtained. With the increase of W_0, the gyration radius (R_g) increased at the range of 23.2~52.7 Å

Keywords: Bis(2-ethylhexyl)sulfosuccinate(AOT), microemulsion, gyration radius, small angle X-ray scattering.

The structure of micelles has attracted renewed attention during the past decade years due to the widespread use of microemulsions in technology[1] and life science[1,2]. To obtain information of the micellar structure, using X-ray scattering (SAXS) whose wavelength is close to the size of the micellar aggregates is one of the most direct method[3-5] and SAXS has been proved to be very sensitive for the change of micellar composition[6,7]. SAXS experiments have been carried out to compare the structural feature of AOT-reversed micelles with a variety of W_0.

Experimental

Sodium bis (2-ethylhexyl)sulfosuccinate (AOT) was supplied by Sigma Company. Isooctane (AR.grade) was purchased from Beijing Chemical Reagent Company. The water used in the experiments was double distilled water and the molar ratios of water-surfactant, W_0, were 5, 15, 20, 25, 35 and 40 respectively. The concentration of AOT was 0.1 mol/L.

Small-angle X-ray scattering (SAXS) experiments were carried out by using a SAXS spectrometer installed at the synchrotron radiation source in High Energy Physical Institute, Beijing, China. The sample solution was placed in a self-made cell with a Kapton membrane, which does not absorb X-rays with wavelength of 1.54 Å The distance from sample to imaging board was 1.52 m and the exposure time was 300 s for each sample.

The following standard analysis was carried out. By using the Guinier plot (LnI (q) *versus* q^2) on the data sets in a defined small q region (0.03-0.06Å^{-1}), the values of both zero-angle scattering intensities I(0) and gyration radius R_g were calculated by using the following equation:

$$I(q) = I(\theta) \exp(-q^2 R_g^2 / 3) \quad (1)$$

$$LnI(q) = Ln\, I(\theta) - q^2 R_g^2 / 3 \quad (2)$$

Where $q = 4\pi n / \lambda$ is the scattering wave vector, $n = \sin(\theta / 2)$ is the refractive index of the micellar solution, θ is scattering angle and λ is the X-ray wavelength.

Results and discussion

Figure 1 shows the effects of W_0 on the X-ray scattering intensities (I (q)) of the water/AOT/isooctane system with AOT concentration of 0.1 mol/L. As shown in **Figure 1**, in the small q region, the X-ray scatter intensities increased with the increase of W_0 value. These changes of the scattering curves well reflect an enhancement of the micellar dimension with the increase of W_0.

Figure 1 Scattering functions of 0.1 mol/L AOT-reversed micellar solutions depending on q with a variety of W_0

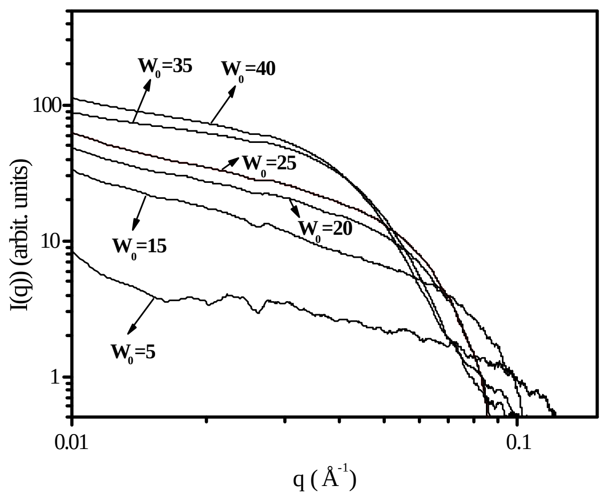

Figure 2 illustrates the dependence of In (q) on q^2 in the small angle region. The curves conformed with Guinier approximation at small angle region of 0.03-0.06Å^{-1}: the straight relation of LnI(q) to q^2 under the different W_0 was shown in **Figure 2**. So based on the slope of the curves at small angle region, the gyration radii were easily calculated according to the equation 2. On the other hand, the good straight relation at relatively

wider small angle region proved that the shapes of the reversed micelles aggregates are spherical and have good uniformity of dispersion. The results of gyration radius, which calculated according to slope of **Figure 2** trailing different W_0 at the range of small angle region (0.03-0.06Å^{-1}) were shown in **Table 1**. As shown in **Table 1** the gyration radius of the reversed micelles increased at the range of 23.2~52.7 Å with the increase of W_0.

Figure 2 Scattering functions of 0.1 mol/L AOT-reversed micellar solutions depending on q^2 with the variety of W_0

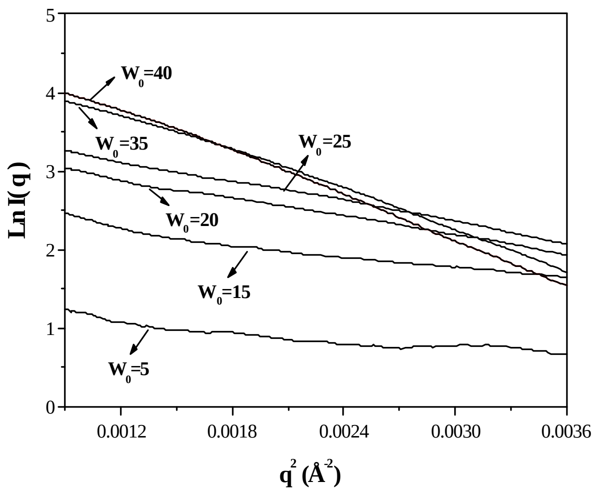

Table 1 Effect of W_0 on the gyration radius (R_g) at small angle region (0.03~0.06Å^{-1})

W_0	R_g (Å)
5	23.2
15	28.8
20	34.1
25	35.7
35	49.2
40	52.7

Acknowledgment

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