Small-Angle Neutron Scattering Study on Droplet Density Dependence of Static Structure in a Ternary Microemulsion System

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A mixture of AOT (Aerosol-OT; dioctyl sulfosuccinate sodium salt), D_2O, and oil forms stable water-in-oil droplet microemulsion in the vicinity of room temperature as shown in Figure 1. The arrow indicates the same water to AOT molar ratio line and it has been believed that the size of droplet is almost constant and only droplet concentration ϕ (the volume fraction of D_2O plus AOT) is different.[1] Seto *et al.*[2] investigated the static structure of the system by means of small-angle x-ray scattering (SAXS) technique in the droplet concentration region of $0.4 \leq \phi \leq 0.65$ with the water to AOT molar ratio of 40.8. They concluded that the mean droplet radius r and the polydispersity index became small with increasing ϕ. However, their analysis depended on the model of the structure factor $S(Q)$. Thus, their result on the droplet structure had an ambiguity. Small-angle neutron scattering (SANS) technique has an advantage in determining structures comparing with SAXS; the contrast variation method can be used. In general, an observed scattering intensity can be expressed by the product of $P(Q)$ and $S(Q)$;

$$I(Q) = nP(Q)S(Q) \qquad (1)$$

In the case of water-in-oil droplet structure, only the form factor is changed when deuterated oil (film contrast) is used instead of protonated oil (bulk contrast) while the structure factor is the same. In case of polydisperse droplets, $P(Q)$ can be written as,

$$P(Q) = \int F(Q,r)h(r)\,dr \qquad (2)$$

here, $h(r)$ is a distribution function and

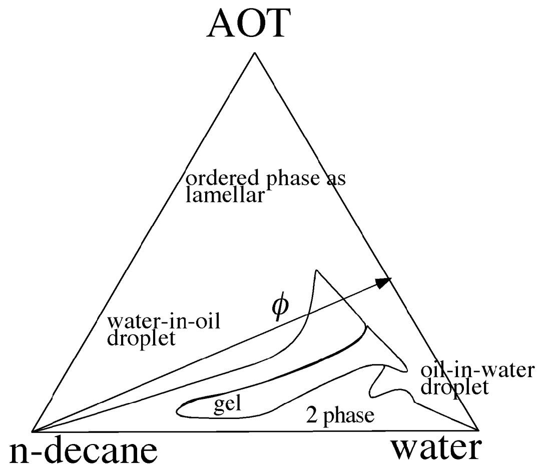

Fig. 1. A triangle phase diagram of AOT, D_2O, and n-decane system at ambient temperature and pressure.

$F(Q,r)$ is

$$F(Q,r_C) = \left\{\frac{4\pi}{3}r_C^3\Delta\rho f(Q\,r_C)\right\} \qquad (3)$$

for bulk contrast and,

$$F(Q,r_C) = \left\{\frac{4\pi}{3}\Delta\rho\Big[r_C^3 f(Q\,r_C) - (r_C+\delta)^3 f\{Q(r_C+\delta)\}\Big]\right\}^2 \qquad (4)$$

for film contrast. Q is momentum transfer, r_c and δ radius of droplet core and thickness of droplet shell, $\Delta\rho$ the neutron scattering amplitude density difference, respectively. The function $f(x)$ is

$$f(x) = 3\frac{\sin x - x\cos x}{x^3} \qquad (5)$$

References

[1] E.Y. Sheu*et al.*: Phys. Rev A **39** (1989)5867.
[2] H. Seto*et al.*:J. Chem. Phys. **115** (2001)9496.