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Crystallization process of oil phase on oil-water interface in O/W emulsion system

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Introduction

Crystallization research on oil-in-water (O/W) emulsions has been studied for long time intensively because this system consists a basic structure for many kinds of foods, such as milk, whipped cream, ice cream etc., pharmaceuticals and cosmetics. In addition, it is intensified recently because of usefulness in various new applications. In the previous study [1], we reported that the hydrophobic emulsifier, polyglycerine-decastarate(DAS-750), sucrose palmitic ester(P-170) and dibehenoyl-glycerol (DB) which were insert into the oil phase of the oil-in-water (O/W) emulsion functioned as a template for the crystallization of oil phase. According to this study, it was suggested that DAS-750, P-170 and DB were mainly adsorbed to the oil-water interface, so that the surface heterogeneous nucleation occurred. Here, we report whether the template effect for crystallization of oil phase in O/W emulsion occurs or not by changing the chain length of the hydrophobic emulsifiers.

Materials and methods

Materials: *n*-hexadecane, the carbon number C_{16} , and Tween 20 (polyoxysorbitan monolaurate) were used as an oil phase and emulsifier, respectively. Even-carbon numbered monoacylglycerols, from C_{12} to C_{18}, whose concentrations were 1, 0.5 and 0.2 wt% for oil phase, were added in oil phase as additives for promoting crystallization of oil phase.

Methods: SAXS-WAXS-DSC simultaneous measurement was performed at BL-15A and BL-9C. The time-resolved X-ray diffraction study was performed in every 10 sec. DSC was operated on the cooling and following heating between 30 °C and –8 °C with the rate of ±2 °C/min.

Results and Discussion

Fig.1 shows the results of the SAXS, and WAXS and DSC measurement for *n*-hexadecane (C_{16}) emulsion with glycerol-monopalmitate (GMP), respectively. In both data of SAXS and WAXS, it seems that there is little difference between the results with and without additive. On the other hand, DSC data in Fig.1(c) shows the three exothermic peaks while no peak appeared in the result without additives. According to the previous study, these three peaks correspond to the crystallization of GMP at oil-water interface, that of *n*-hexadecane and the phase transition of the GMP template structure at 7.2, 4.2 , 1.1 °C, respectively. As for 0.41 diffraction peak in Fig.2, it only appeared with additives and also corresponded to the appearing the DSC exothermic peak at 1.1 °C. It means that this diffraction peak shows the phase transition of the GMP template structure. While the same kinds of DSC, SAXS and WAXS results were observed in the C18-additive, glycerol–monostearate (GMS), no difference appeared for the samples among without , with C12- and C14-additives.

These results suggest that the additives with hydrocarbon chains longer than C16 , at first, crystallize and, secondly, are play an important role as a template for the crystallization of n-hexadecane in each oil droplet.

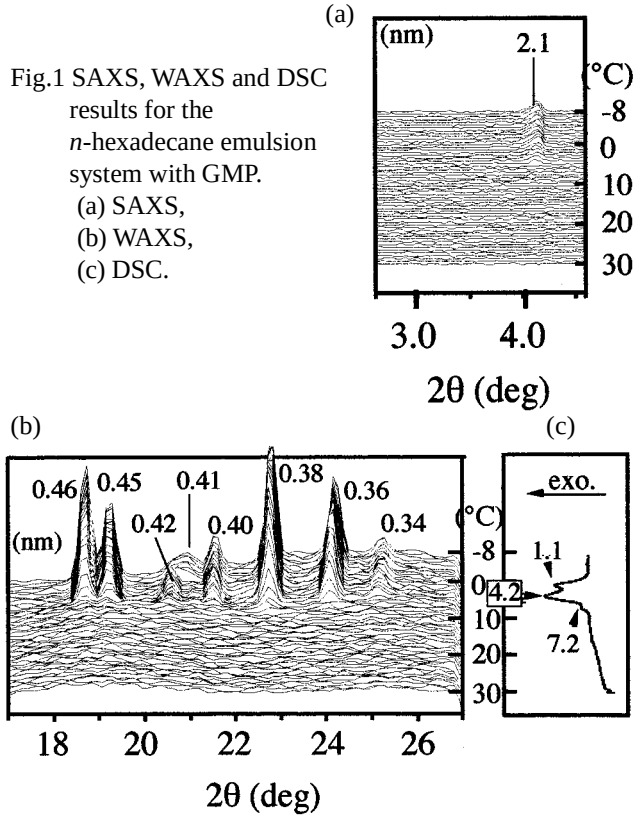

Fig.1 SAXS, WAXS and DSC results for the *n*-hexadecane emulsion system with GMP.
(a) SAXS,
(b) WAXS,
(c) DSC.

Reference

[1] S. Ueno et al., Crystal Growth & Design 3, 935 (2003).

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