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Effect of glycerol on monoolein self-assembly system

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Introduction

Monoolein is one of the biological lipids and it forms molecular self-assembly structure in aqueous media. Monoolein has been applied to crystallization of membrane protein in a bicontinuous cubic phase of monoolein/water systems [1], and to drug delivery systems using hydrated monoolein [2].

Glycerol is natural cryoprotectant. Some freeze-tolerant and freeze-avoiding insects accumulate glycerol in winter [3]. In order to get basic information for the discussion of the cryoprotective mechanism of glycerol, the effects of glycerol on the structure and phase behavior of hydrated monoolein were investigated by means of simultaneous SAXS/WAXS/DSC measurement.

Materials and Methods

Monoolein was obtained from Sigma Chemical Co. (St Louis, USA). Glycerol was purchased from Wako Pure Chemical Industries, Ltd. (Osaka, Japan). Simultaneous SAXS/WAXS/DSC measurement was performed at beamline 9C of the Photon Factory. The SAXS and WAXS data were collected simultaneously using two position sensitive proportional counters. The weight ratio of monoolein : glycerol solution was 65:35. In order to confirm the reproduction, we also carried out simultaneous SAXS/DSC measurement at beamline 15A.

Results and Discussion

Figure 1 shows SAXS/WAXS/DSC data for monoolein in the solution containing 12.5 wt% glycerol as a typical example. The transition from the lamellar crystal (Lc) phase to a liquid crystalline state take place at 21 °C. The phase assignments of the liquid crystalline state were carried out based upon the SAXA patterns. In the temperature range from 21 °C to 35 °C, the spacing ratio of the reflections was √3: √4: √7: √8: √10: √11, indicating that a bicontinuous cubic phase with a Ia3d space group. Above 35 °C, the spacing ratio of the diffraction was √2: √3: √4: √6: √8: √9, suggesting that a bicontinuous cubic phase with a Pn3m space group.

From the results obtained in this study, we draw the phase diagram of monoolein in glycerol/water mixture in temperature range from 5 °C to 90 °C (Fig.2) [4]. The increase of glycerol concentration reduces the Pn3m bicontinuous cubic phase region and expands the Lc phase and fluid isotropic (FI) phase regions. Furthermore, the lattice constant of the Pn3m cubic phase of monoolein becomes to smaller, as increasing the glycerol concentration. These results suggest that the change of lattice constant of the Pn3m cubic phase is related to the stability of the Pn3m cubic phase.

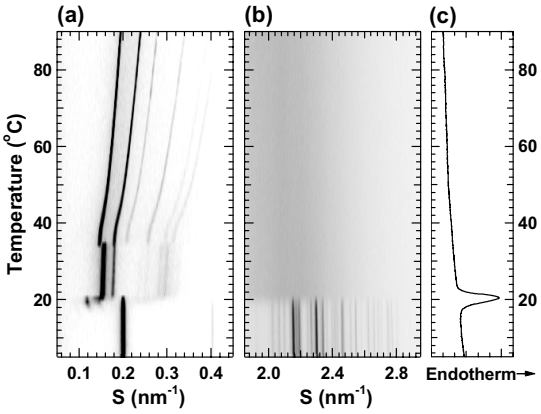

Fig. 1 Gray-level plots of X-ray scattering intensities for (a) the SAXS region and (b) the WAXS region and (c) DSC thermogram of monoolein in the solution containing 12.5 wt% glycerol.

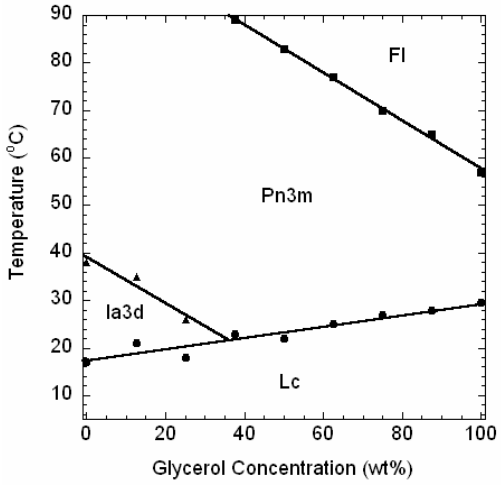

Fig. 2 Phase diagram of the monoolein/glycerol/water system.

References

[1] E. M. Landau & J. P. Rosenbusch., *Proc. Natl. Acad. Sci. USA* **93**, 14532 (1989).
[2] C. J. Drummond & C. Fong, *Curr. Opin. Colloid Interface Sci.* **4**, 449 (2000).
[3] K.B. Storey, *Phil. Trans. R. Soc. Land. B* **326**, 635 (1990)
[4] S. Abe & H. Takahashi, *J. Appl. Cryst.* **36**, 515(2003)
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