Time resolved studies of inverse micellar cubic phases of lipids

Experiment SC 2533 report

During experiment SC 2533, ternary lipid mixtures comprising dioleoylphosphatidylcholine (DOPC) and dioleoylglycerol (DOG) and cholesterol, of molar ratios 1:2:1 and 1:2:2, in excess water were found to produce diffraction patterns which were not compatible with any previously reported inverse (type 2) lyotropic liquid crystalline phase.

The phase behaviour of both ternary mixtures was found to be very similar and over the temperature range 16-52 °C a novel series of diffraction rings were obtained as shown in Figure 1. This phase was also found to exist over a large range of pressures (1-3000 bar) and has been seen without excess cholesterol crystals. Although the positions of the Bragg peaks varied as a function of temperature and pressure within the unknown phase region, their ratios remained invariant showing that the diffraction peaks were all produced by a single phase. In addition, all these peaks reduced or increased in intensity at the same rate during pressure jump experiments further confirming their single phase origin.

The micellar cubic Fd3m phase has previously been reported in mixtures of DOPC and DOG in excess water[1] however the diffraction peaks observed during the current study were not compatible with any cubic space group. It was noted that there was a systematic absence of *hhl* and 00*l* reflections with odd *l* indices (in both cases) corresponding to the extinction symbol *P--c* and hence five possible space groups.

The diffraction pattern was indexed successfully as originating from a phase consisting of hexagonally close packed identical micelles with $P6_3/mmc$ symmetry as shown in figure 2. While this symmetry has previously been observed for a normal (type 1) lyotropic phase[2], this is the first time it has been observed in an inverse lyotropic system and indeed is the first new lyotropic phase to be found in the last 20 years.

A more detailed description of our findings from the experiment has recently been published in the Journal of the American Chemical Society[3].

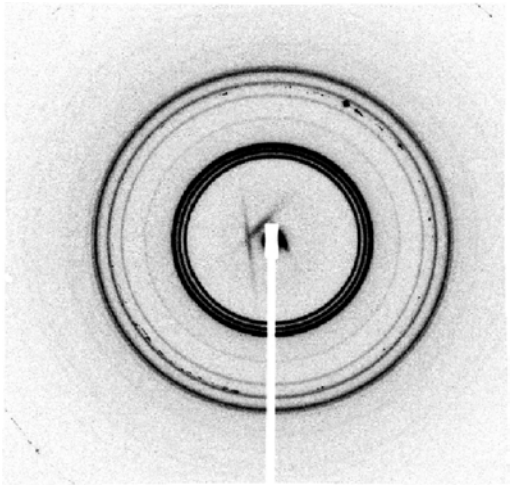

Figure 1

SAXS diffraction pattern of the 3-D hexagonal close-packed inverse micellar phase formed with DOPC/DOG/cholesterol 1:2:1 in excess water at 36.6 °C and 600 bar pressure.

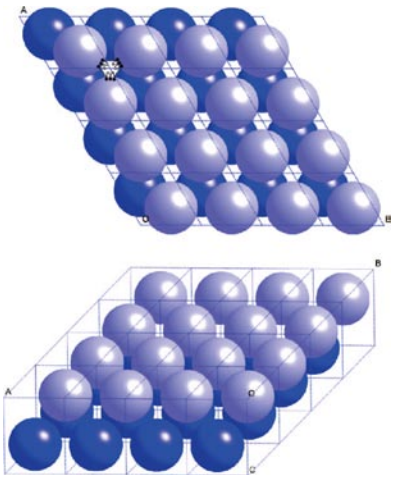

Figure 2

Plan and perspective views of the schematic structure of the $P6_3/mmc$ 3-D hexagonal inverse micellar phase.

References

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2 J. M. Seddon, *Biochemistry,* **1990**, *29*, 7997–8002.

3 G. C. Shearman, A. I. I. Tyler, N. J. Brooks, R. H. Templer, O. Ces, R. V. Law, J. M. Seddon, *J. Am. Chem. Soc.*, **2009**, 131, 1678-1679.