RBD PALM OLEIN IN A LAMELLAR LIQUID CRYSTALLINE STRUCTURE OF MIXED SURFACTANTS I. OPTICAL PATTERN AND DSC INVESTIGATION

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The optical pattern and thermal behaviour of refined, bleached and deodorized (RBD) palm olein in a lamellar liquid crystalline structure of mixed cationic surfactants were investigated using the polarizing microscope and differential scanning calorimetry (DSC).

The results indicate some perturbations in the amphiphilic organization and a reduction in transition enthalpy on the addition of RBD palm olein into the lamellar structure.

INTRODUCTION

The effect of a fourth component in a 3-phase system on the aggregational and organizational behaviour of ionic surfactants, mainly in micellar solution, has been studied in several cases (Friberg *et al.*, 1985). In our previous paper (Hamdan *et al.*, 1991) we presented experimental evidence concerning the effect of RBD palm olein, as the fourth component, on the molecular organization of amphiphiles in a lyotropic liquid crystalline structure containing only a single surfactant.

In the present comparative study among surfactants, we extend our previous work to the effect of RBD palm olein on the lamellar liquid crystalline structure of a binary mixture of surfactants.

A 3-phase diagram containing mixed cationic surfactants, tetradecyltrimethylammonium bromide and cetyltrimethylammonium bromide, in water and 1-hexanol at 30°C was recently constructed and studied (Hamdan *et al.*, 1994). The lamellar liquid crystalline phase was found at an intermediate composition of the three components. It is this region which was studied extensively on single surfactant systems, at 30% water content by Ekwall (1974), and in this paper it is studied for multicomponent systems. The significance of this composition was described previously (Hamdan *et al.*, 1991).

MATERIALS AND METHODS

Materials

The surfactants tetradecyltrimethylammonium bromide (TTAB) and cetyltrimethylammonium bromide (CTAB) were purchased from Sigma and Merck respectively and were of the highest purity (> 99 %). The RBD palm olein was obtained from the Palm Oil Research Institute of Malaysia (PORIM); the water used was doubly distilled.

Photomicroscopy

An Olympus camera (model OM-2) was attached to a Will (model V365) microscope and was used for photomicroscopy. Precleaned microscope slides and covers were selected, and then buffed with lint-free tissue immediately before use. A small sample was transferred from its tube on to the glass slide, sheared between the slide and the coverslip, and left for a few minutes for equilibration. The appearance of the sample was then observed between crossed polarizers. A representative region was then selected and photographed at a magnification of 100.

Differential Scanning Calorimetry (DSC)

Differential scanning calorimetric curves were recorded on a Scientific and Procter Instruments 910 DSC, equipped with a 990 temperature programmer. Samples (approximately 5 mg) were run at a flow rate of 50 ml/min and a range of 50 mV/cm. Indium was used as a reference in the calibration run.

RESULTS AND DISCUSSION

Mixtures of cationic surfactants and hexanol (7:3 by weight), with and without RBD palm olein, give a typical lamellar liquid crystalline structure at a water concentration of 30% by weight. The optical patterns at this composition observed under a polarizing microscope are shown in *Figures 1* to *4*.

The optical pattern of the mixed cationic surfactant and hexanol at 30% water (*Figure* 1), shows a typical lamellar liquid crystalline structure with an oily streak pattern. On addition of RBD palm olein a dislocation in the optical pattern was observed (*Figures* 2 to 4). After adding 5% of olein at

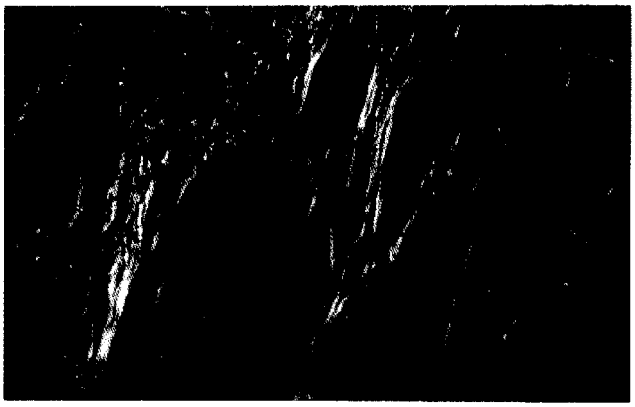

Figure 1. Optical pattern of mixed cationics and hexanol (7:3 by weight) at 30 per cent water content.

Figure 2. Optical pattern of the mixed cationics-hexanol mixture after the addition of 5 per cent of RBD palm olein.

Figure 3. Optical pattern of the mixed cationics-hexanol mixture after the addition of 10 per cent of RBD palm olein.

Figure 4. Optical pattern after the addition of 15% of RBD palm olein.

30% water content (*Figure* 2), the optical pattern changed to another lamellar liquid crystalline structure characterized by the appearance of Maltese crosses. Further addition of RBD palm olein to 10% by weight changed the optical pattern to a typical striated type (*Figure* 3). The pattern maintained this texture after the addition of RBD palm olein to 15 % while maintaining the same water content. These optical patterns are found to exhibit the same behaviour as those of the constituent single component (Hamdan *et al.*, 1991). This could be an indication of the possibility that the longer hydrocarbon chain of CTAB dominates the overall lamellar liquid crystalline structure. If this is so, it is consistent with the recent findings of our work on micellar solutions of the mixed cationic surfactants (Hamdan *et al.*, 1994) which showed that the longer CTAB surfactant is geometrically favourable for the micelle formation. Further investigations using Small Angle X-ray Scattering (SAXS) should be used to confirm this result as the observation of the optical pattern is not a precise method.

The differential scanning calorimetry diagrams of lamellar liquid crystalline structures in mixed cationic surfactants in hexanol, with and without RBD palm olein, are shown in *Figure* 5: they indicate 'multiple melting' behaviour. The transition temperatures for both systems were found to be about 112°C and 255°C which are the decomposition temperatures for the lamellar liquid crystalline bulk phase and the mixed surfactants respectively. The DSC studies also indicated that the endothermic transition enthalpy for the lamellar structure decreases with increasing RBD palm olein content. This is shown by the reduction in the peak intensity at 112°C. The fact that the transition temperature is the same demonstrates an equal thermal stability of the lamellar structures. This was seen even after the addition of RBD palm olein, suggesting again the maintenance of the overall lamellar structures. The differences which occur are confined to the molecular reorganization. No change in the peak intensity was observed at 255°C. This is expected as the peak is due to the mixed surfactant components which are constant in all the measurements. Determination of the enthalpy change, ΔH, was not carried out in this work since it did not seem relevant to our main interest: They are mainly the transition temperature of the lamellar structure.

The dislocation pattern and the DSC investigation gave evidence that the effect of RBD palm olein lay on the molecular reorganization of the lamellar liquid crystalline structure of the mixed cationic surfactant. The authors again believe that the RBD palm olein is located between the methylene groups of the palisade layer which are hydrophobic in nature. Little penetration occurs as was found for the single surfactant system (Hamdan *et al* , 1993).

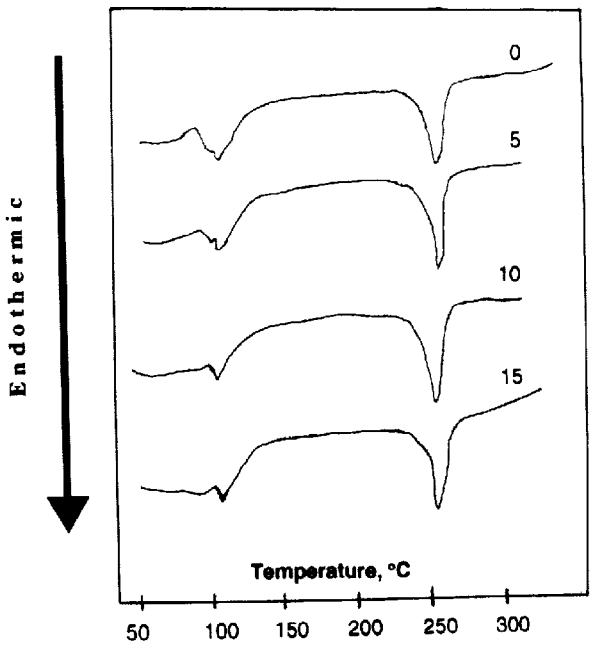

Figure 5. Differential scanning calorimetry containing different percentages of RBD palm olein at a 7:3 ratio of CTAB/hexanol.

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