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Structural study on mixtures of ceramide 3 and stearic acid

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Introduction

The main lipids of the stratum corneum are composed of ceramide, free fatty acid and cholesterol. These lipids play an important role of the skin barrier to penetration of molecules through the skin. In the stratum corneum, these lipids embedded around keratin-filled corneocytes, arrange in a lamellar structure. In recent study, it has been found that binary systems of these lipids have eutectic phase diagram [1].

In mixtures of ceramide 3 and stearic acid, we studied miscibility and intermolecular interactions of these lipids using x-ray diffraction.

Materials and Methods

Ceramide 3 was a gift from Cosmoferm B.V. (Delft, The Netherlands) and Srearic acid was purchased from and Sigma Chemical Co. (St. Louis, MO, USA). The mixtures of ceramide 3 and stearic acid were first resolved in chloroform to mix them, then dried. The sample was placed in a capillary tube with diameter of 1mm. The temperature of the samples was controlled using a temperature regulater (SR-50, Shimaden Co., Tokyo, Japan).

Results and Discussion

Figure 1 shows the phase diagram of ceramide 3 and stearic acid which was constructed from transition temperatures on the base of DSC curves for various mixtures of ceramide 3 and stearic acid. The phase diagram is a typical for eutectic melting.

Figure 2 shows a contour map of small angle x-ray diffraction patterns of mixture of ceramide 3:stearic acid = 3:7 (in Figure 1, at 70 mol%) recorded during temperature scan at the rate of 5.0 ^{o}C/min. This figure is almost composed of the superposition of the diagram of ceramide 3 and that of stearic acid.

Figure 3 shows temperature dependence of integrated x-ray diffraction intensity. Fig. 3, (b) and (c) are γ and β form of stearic acid, respectively. (d) is that of gel state of ceramide 3. (a) is that of new state of ceramide 3 and/or stearic acid. The melting of stearic acid is related to a new state for ceramide 3, because integrated intensity at 0.257 nm^{-1} (see (d)) decreases at 65 ^{o}C. Further detailed analysis is now in progress to determine the structure in WAXD.

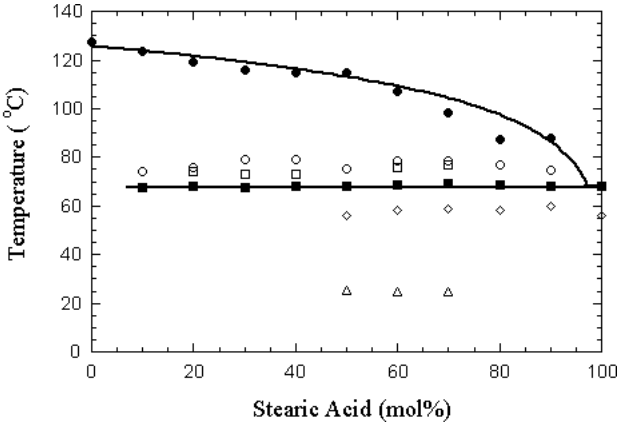

Figure 1. Phase diagram of mixtures of ceramide 3 and stearic acid. The lines represent the analyzed melting curves for ceramide 3.

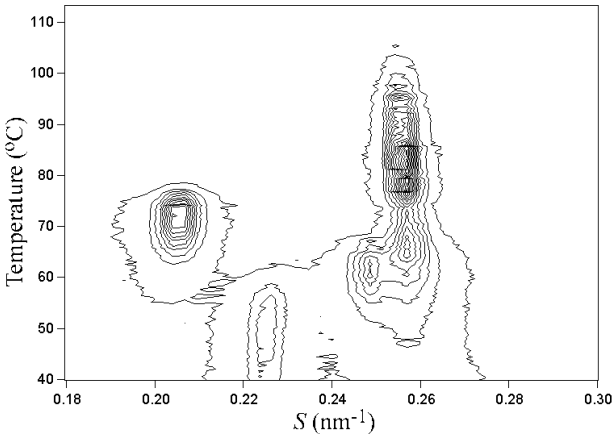

Figure 2. A contour map of x-ray diffraction intensity for ceramide 3:stearic acid = 3:7 for temperature vs scattering angle *S*.

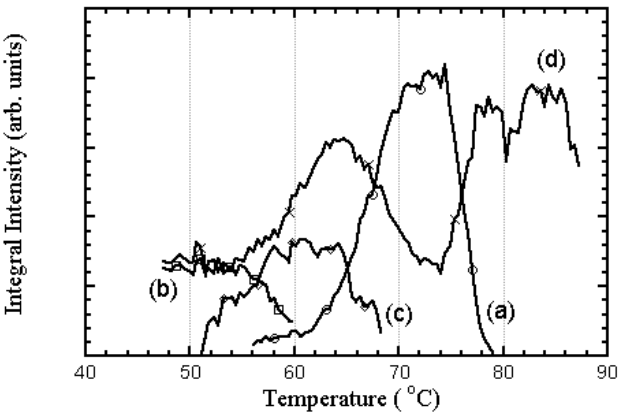

Figure 3. Temperature dependence of the integrated x-ray diffraction intensities for mixture of ceramide 3:stearic acid = 7:3; (a) S=0.205 nm^{-1} , (b) S=0.224 nm^{-1} ,(c) S=0.248 nm^{-1} , (d) S=0.257 nm^{-1}.

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Reference

[1] Reinhard N. et al., Chem. Phys. Lipid 89, 3 (1997).