

Thermal Expansion of Surface-Frozen Monolayers of Tricosane-Dodecane Mixtures

H. Kraack, E. Sloutskin, M. Deutsch (Bar-Illan U., Israel), B. Ocko (BNL), and E. Sirota (ExxonMobil)

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Beamline: X22B

Introduction: Alkanes, and a number of its derivatives, exhibit surface freezing, i.e. formation of a crystalline monolayer on the surface of the melt a few degrees above the bulk freezing temperature. The monolayer packing in alkanes is hexagonal, showing a single in-plane peak in grazing incidence diffraction (GID) measurements. We investigated the surface freezing of Tricosane-Dodecane mixtures and the effect of temperature and composition on their lattice constants using GID measurements. Since phase separation occurs, the surface monolayer is pure tricosane, and the only change that occurs upon increasing the dodecane concentration is a reduction of the freezing temperature. These mixtures offer, therefore, a unique opportunity to follow the lattice expansion over a very wide temperature range, which is not accessible for pure materials.

Experimental: Materials were >99% pure, and used as purchased from Aldrich. Measurements were carried out at the Harvard/BNL liquid surface diffractometer at beamline X22B.

Results: Fig.1 shows the measured GID peak position at three different temperatures. The scattering vector q is related to the lattice spacing d for hexagonal packing by $d=2\pi(4/3)^{1/2}/q$.

The lattice spacings d for the measured concentrations of Tricosane and temperatures are shown in Fig.2. The lattice expansion seems to be linear in temperature, with a resultant lattice expansion coefficient of $(dd/dT)/d=5.5\times 10^{-4} \text{ }^\circ\text{C}^{-1}$. No significant changes from a linear behavior with concentration can be observed, but the data is not reliable enough to rule out small slope changes with concentration. Indeed the lower concentration data, which could be measured over a broader temperature range, seems to imply a larger lattice expansion coefficient.

Conclusions: More data on different mixtures and pure materials are required to increase the insight into the expansion of surface frozen monolayers.

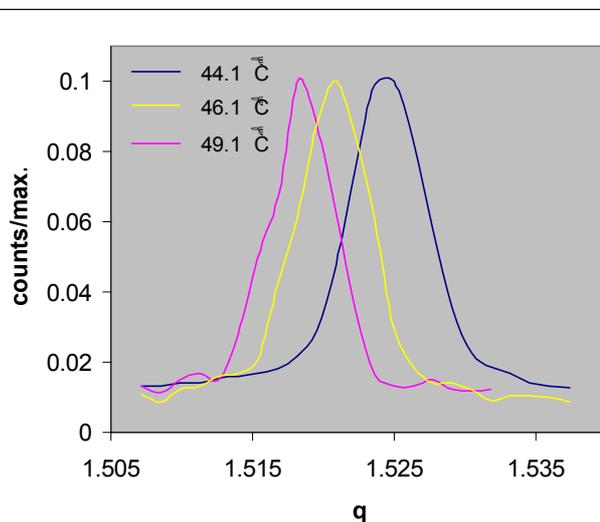


Fig.1

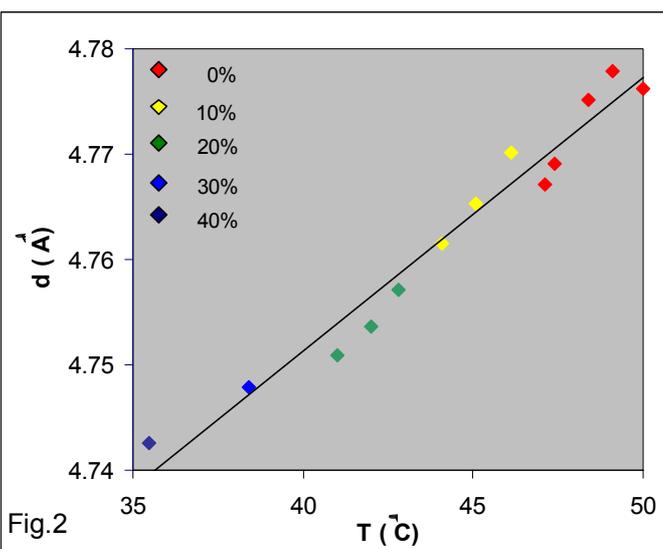


Fig.2