Phase Diagrams of Langmuir Monolayers of a Family of Long-Chain Esters

J. Ruiz-Garcia and D. Valdez-Pérez
Instituto de Fisica
Universidad Autónoma de San Luis Potosi
"Manuel Sandoval Vallarta"
Alvaro Obregon 64
San Luis Potosi
S.L.P. 78000, México

There have been several reports of phase diagrams of Langmuir monolayers of single chain amphiphilic molecules. It is known that increasing the length of the hydrocarbon chain, while keeping constant the size of the head group in a family of amphiphilic molecules, has the effect of shifting the π-T phase diagram towards higher temperatures and pressures. However, no study has been reported about the effect on the phase diagrams of changing the size of the head group while keeping constant the length of the hydrocarbon chain. In the present work, we report such a study. We present the phase diagrams of Langmuir monolayers of methyl-, ethyl-, propyl-, and butyl octadecanoate. In order to obtain the phase diagrams, we first obtained several isotherms for each molecule, in the range of 3 - 47.5 °C. The isotherms were obtained using a Langmuir-Blodgett balance and a water subphase with a pH = 7. We did a careful analysis of each isotherm, and considered that subtle changes in slope were due to a phase transition, specially at lower temperatures. However, we considered those slope changes as phase transitions only if those changes were present consistently in several isotherms close in temperature, in such a way that they would allow us to trace the equilibrium lines between phases.

The phase diagrams of each of the four molecules studied resembled each other, showing a total of 13 different phases. One is the well known liquid expanded phase (LE) and 12 liquid condensed (LC) phases: $CS^{'}$, $S^{'}$, $LS^{'}$, CS, S, LS, $L_2^{''}$, S^{*}, L_2^{*}, $L_1^{'}$, L_{2h}, and L_{2d}. The last five LC phases of the list have not been reported previously for these molecules. In addition, we found that as the size of the head group increases, the phase diagrams are shifted to lower temperatures and surface pressures, but all of the phases remained present.