Effects of Confinement on Self-Assembling Systems

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Systems in which amphiphilic particles (surfactants, lipids, and block-copolymers) can self-assemble into mono- or bi-layers form a variety of stable and metastable structures on the nanometer length scale. In the ordered structures (lamellar, hexagonal, and cubic phases), the translational and rotational symmetries are broken. For this reason, the geometrical and chemical properties of the confining surfaces have a particularly strong effect on such systems. We study lamellar and cubic phases in oil-water-surfactant mixtures within a generic semi-microscopic model, using a mean-field approximation. We focus on those effects of confinement which in simple fluids are absent; one example is a switch of the lamellar orientation when the wall separation is varied. We show how the structural changes of the confined fluid are reflected in the measurable solvation force between the confining walls and in phenomena analogous to capillary condensation. The dependence of the capillary lamellarization on elastic properties of the confined system and on the geometry of the confining walls is demonstrated.