Abstract for an Invited Paper
for the MAR09 Meeting of
The American Physical Society

Wrinkle to fold transitions: Stress relaxation in lipid monolayers and other elastic thin films

KA YEE C. LEE, The University of Chicago

Surfactants at air/water interfaces are often subjected to mechanical stresses as the interfaces they occupy are reduced in area. The most well characterized forms of stress relaxation in these systems are first order phase transitions. However, once chemical phase transitions have been exhausted, the monolayer undergoes global mechanical relaxations termed collapse. We have previously demonstrated that for lung surfactants, a mixture of lipids and proteins that coats the alveoli to reduce the work of breathing, collapse manifests itself as protrusions of folds into the subphase. These folds remain attached to the monolayer and reversibly reincorporated upon expansion. By studying different types of monolayers, we have shown that this folding transition in monolayers is not limited to lung surfactant films, but rather represents a much more general type of stress relaxation mechanism. Our study indicates that collapse modes are found most closely linked to in-plane rigidity. We characterize the rigidity of the monolayer by analyzing in-plane morphology on numerous length scales. More rigid monolayers collapse out-of-plane *via* a hard elastic mode similar to an elastic membrane, with the folded state being the final collapse state, while softer monolayers relax in-plane by shearing. For the hard elastic mode of collapse, we have further demonstrated experimentally and theoretically that the folded state is preceded by a wrinkled state, and similar wrinkle to fold transitions has been observed in elastic thin films ranging from 2 nm to 10 μm in thickness of completely different chemical nature (lung surfactant lipid monolayers, gold nanoparticle trilayers, and polyester sheets).