Microscopic structure and collapse of depletion-induced gels in vesicle-polymer mixtures

Ji Yeon Huh[1], Matthew L. Lynch[2] and Eric M. Furst[1]

[1] Department of Chemical Engineering, University of Delaware
[2] Corporate Research Division, Miami Valley Laboratory, The Procter & Gamble Company

Abstract: In this study, we report the behavior of depletion-induced gels in vesicle-polymer mixtures. The vesicle dispersion is prepared from a commercial-grade dichain cationic surfactant through a standard milling process (d_{mean} = 256nm and □= 0.46). To induce a depletion attraction between vesicles, we add the cationic polymer, poly(diallyldimethylammoniumchloride) (MW = 14.5kDa and R_g = 11.2nm). Vesicles (□= 0.05-0.3) are systematically mixed with polymer (Cp = 0.01-2.0wt%). As density gradients build, an interface develops between a turbid vesicle-rich phase and a polymer-rich phase up to Cp = 0.2wt%. Increasing the polymer concentration further forms a gel, which subsequently collapses. Height profiles of the gels are characterized by a slow initial rising for a finite delay time, a rapid collapse, and a slow final compaction to an equilibrium height. However, we observe a remarkably different polymer concentration dependence on the initial collapse rate. Unlike other colloidal gels, we find that the initial sedimentation velocity *increases* with increasing polymer concentration. We show that this surprising behavior can be accounted for by an increase in the permeability for solvent backflow, which is directly related to the characteristic pore area of the gel, obtained using confocal microscopy.