SES13-2013-000037

Abstract for an Invited Paper
for the SES13 Meeting of
the American Physical Society

Equilibrium and Dynamic Forces in Binary Colloid Mixtures

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The presence of nonadsorbed nanoparticles in a dispersion of larger "microparticles" can greatly alter the dispersion stability. The effects can be quite complex, as low concentrations of the nanoparticles can induce flocculation, while higher concentrations may actually promote stability. Not only are such binary mixtures found in nature, but nanoparticles can be used to carefully tune the interaction force between two microparticles for purposes of studying colloidal crystallization and melting, and can also be used to separate microparticles of different sizes or surface properties. In this talk I will describe a modeling and experimental study to better understand the nature of the forces in such systems. Direct measurements of the force between a single microparticle and a planar surface in a well-characterized system were obtained using colloidal probe atomic force microscopy. This includes both equilibrium forces, in which hydrodynamic interaction between the microparticle and surface was negligible, and forces measured at varying approach speeds to determine the impact of the nanoparticles on the separation-dependent mobility of the microparticle. The equilibrium measurements clearly show both attractive depletion forces and longer-range, oscillatory structural forces that result from ordering of the nanoparticles in the confined region between the microparticle and surface. The dynamic measurements shot that the effective viscosity experienced by the microparticle decreases at smaller separations as the average nanoparticle concentration in the gap region decreases. The impact of these forces on the stability of a dispersion of microparticles will also be presented.