CNS/CMET Seminar

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"Stimuli-Responsive Adsorption and Forces between Polymer Brush Nanoparticle-Coated Surfaces"

Polymer brushes have the ability to greatly reduce friction between sliding surfaces. Initial studies on non-ionic, polyelectrolyte, and polyzwitterionic brushes provided great insight into the lubrication mechanism and relationships between brush properties and sliding friction, enabling a number of low coefficient of friction lubricating strategies based on densely-grafted planar polymer brushes to be developed. However, planar brushes are limited in application by 1) the requirements for growing dense brushes, which often requires specific surface chemistry or reactive functional groups and 2) inability to repair damaged layers. Thus, a need exists for brush formation schemes that provide robust, reversible surface modification and self-healing capabilities. Our work studies polymer brush nanoparticles as surface active, lubricating agents. This broad class of soft material structures includes star polymers and brush grafted nanoparticles. Individual particles act as brush-like building blocks, and assembling particles on a surface provides a non-destructive method for generating pseudo-brush layers and imparting properties similar to those of homogeneous brushes.

This talk will highlight work done studying adsorbed layers of polyelectrolyte brush nanoparticles. 20-nm diameter silica nanoparticles are grafted with the weakly cationic poly[2-(dimethylaminoethyl methacrylate)] by atom-transfer radical polymerization to form brush-grafted nanoparticles (Si-*g*-PDMAEMA). pH is used to control the degree of protonation of DMAEMA monomers in the brush, enabling systematic investigation of the effect of charge characteristics (i.e. zeta potential), swelling behavior (i.e. hydrodynamic diameter), and solvent quality (i.e. lower critical solution temperature) on particle adsorption, layer conformation, and surface forces. Ellipsometry, QCM-D, and AFM imaging are used to measure particle adsorption, and colloidal probe AFM is used to measure normal and lateral force profiles between Si-*g*-PDMAEMA coated silica surfaces. Ultimately lubricated sliding of Si-*g*-PDMAEMA is strongly dependent on surface coverage, where bridging attraction at sufficiently low coverages results in stick-slip frictional behavior. Schemes for generating high-coverage, low friction layers will be presented. Finally, recent work on the synthesis and adsorption of a series of thermoresponsive di-block and tri-block star polymers with non-ionic, cationic, and zwitterionic constituents will be briefly discussed.