DEPARTMENT OF CHEMISTRY & CHEMICAL BIOLOGY

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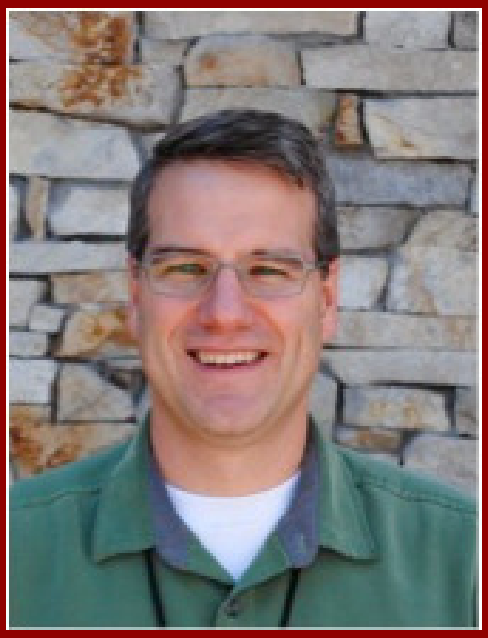
Tuning Reaction Kinetics and Thermodynamics to Control the Magnetic Properties of Nanoparticles



September 21, 2018
SMLC 102 - 4:00 PM

Traditional approaches to nanoparticle size control generally attempt to control size by controlling the nucleation step and varying the number of nuclei formed. I will present several approaches to nanoparticle size control and systematic variation that seeks to control and systematically vary nanoparticle size using identical nucleation events, but varying the nanoparticle growth. The approaches have in common the constant addition of nanoparticle precursor that leads to a steady state reaction, simplifying the kinetics of the nanoparticle formation reaction. This method, referred to as the Extended LaMer mechanism, leads to a linear increase in nanoparticle volume with time. The reaction can be extended for as long as the nanoparticles remain colloidally stable, allowing for systematic variation of nanoparticle sized through a wide range. The approach is general and can be applied to a range of synthetic systems to produce nanoparticles with exceptional reproducibility in size. One can also take advantage of the loss in colloidal stability to design a reaction that precipitates at a desired size. Since this loss of solubility is essentially a phase transition, the nanoparticle size is controlled by thermodynamics and not kinetics. This improves the ease of reproducibility of nanoparticle size with or without careful control of the reaction kinetics. A continuous reaction using this precipitation approach in magnetic nanoparticles will be discussed as will scale up and applications of these nanoparticles.