UW Chemical Engineering

Spring 2012 Seminar Series

Reversible Nanoclusters from Nanoparticles: Colloid Science Fundamentals and Applications in Protein Drug Delivery and Bioimaging

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A major challenge in nanoparticle engineering is to devise a flexible and robust synthetic strategy to pack sufficient multifunctionality into nanoparticles smaller than ~100 nm, even below 50 nm. A novel approach is to build nanoparticle clusters from primary nanoparticles, instead of from atoms, based on tuning colloid interactions. A key objective will be to control nanocluster size and particle spacing within the clusters by manipulation of the particle concentration pathways and the total interaction potential between particles. The interaction potential, which depends upon the electrostatic, van der Waals, steric and depletion forces, governs either thermodynamic self-assembly or kinetically-controlled aggregation and particle morphology. This “bricks and mortar” interfacial dynamic assembly technique allows essentially unlimited flexibility choosing and mixing the nanoparticle building blocks in any proportion to engineer desired function. Concentrated protein nanoclusters are assembled from protein monomers by tuning the colloidal interactions. A hierarchy of intracluster and intercluster interactions may be controlled to provide colloidal stability, low viscosities, and stable protein for drug delivery. A general paradigm for engineering multifunctional biodegradable nanoclusters is presented which has the potential to revolutionize fundamental nanoscience and nanotechnology. The biodegradation of nanoclusters into primary nanoparticles can overcome the major roadblock in nanotechnology that is toxicity upon accumulation in humans and in the broader environment.