CORE-SHEATH SIZE OF NANOPARTICLE DISPERSIONS STUDIED BY SAXS AND COMPLEMENTARY TECHNIQUES

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Although many measurement methods exist for characterizing metal nanoparticles (*e.g.* gold, silver), applying a specific number to a nanoparticle size can be very uninformative. In the case of nanoparticles stabilized by ions or soft ligands, the core diameter has a definite size distribution, as measured by small-angle X-ray scattering (SAXS) or transmission electron microscopy (TEM). Although it is possible to analyze core-shell particles with SAXS, dynamic light-scattering (DLS) can reliably reveal the complete (core+ligand) size, even with low Z-contrast ligands. Thus it is advantageous to present parallel core measurement by SAXS (and TEM) with measurement by DLS [1], and by doing so we can elucidate the effects of surface functionalization on nanoparticle size and aggregation state. This method of core-shell study is of critical importance to many surface- and size-dependent nanoparticle applications. For example, nanoparticle-based drug-delivery of chemicals attached to gold nanoparticles depends both on the concentration of drugs attached to the surface of a nanoparticle and the particle's inherent size [2].

We will present results from these multiple measurement techniques which show the effects of surface-functionalization on nanoparticle size and aggregation. Direct synthesis of nanoparticles with surface functionalization [3], ligand exchange, and synthesis of particles with subsequent coating will be discussed. In some cases, the nanoparticle core remains unchanged, while in others there is measurable aggregation of the particles. Methods and experiments to possibly control the aggregation of nanoparticles will also be presented as well as discussion of possible mechanisms of aggregative growth. For example, gold nanoparticles below 10 nm exhibit aggregation during ligand exchange of thiols for amines, whereas direct attachment of thiols often leaves the size distribution unchanged.

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