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Nanoscopic Building Blocks from Polymers, Metals and Semiconductors for Hybrid Architectures

This contribution summarizes some of our efforts in synthesizing building blocks of organic/polymeric materials, as Au colloids or as semiconducting quantum dots, for the construction of nanoscopic hybrid aggregates and architectures.

Firstly, polyphenylene dendrimers are introduced as shape-persistent organic building blocks with a strictly monodisperse particle size distribution within the nanometer range. The possibility for the introduction of different functionalities in the core, the scaffold or the periphery of the dendrimers offers their use as interesting modules for photonic, electronic or bioactive structures and supramolecular functional assemblies. Thus, dendrimers complement the available set of nanoscopic building blocks made from metals and semiconductors.

The next example concerns metallic nanostructures. Firstly, we focus on gold nanoparticles capped by unsymmetrical azobenzene disulfides that were synthesized in order to investigate the efficiency of photoisomerization on a colloidal gold surface. The average size of the particles was determined to be ~5.2 ± 1.3 nm from transmission electron microscope (TEM) images. The photoisomerization reaction of the azobenzene-capped gold nanoparticles was studied by UV-vis absorption spectroscopy in toluene. The reaction kinetics were identical to that of the free molecules with no deviations from a first-order plot for both trans-to-cis and cis-to-trans photoisomerization, suggesting no steric hindrance throughout the whole reaction process.

The last example concerns semiconducting nanoparticles, quantum dots (QDs), as another class of nanoscopic building blocks with interesting properties. We synthesized high-quality ZnxCd(1-x)Se nanocrystals at high temperatures by incorporating stoichiometric amounts of Zn and Se into pre-prepared CdSe nanocrystals. With increasing Zn content, a composition-tunable emission across most of the visible spectrum could be demonstrated by a systematic blue-shift in emission wavelength. The photoluminescence (PL) properties

for the obtained ZnxCd1-xSe nanocrystals (PL efficiency of 70-85%, fwhm = 22-30 nm) are comparable to those for the best reported CdSe-based QDs. In particular, they also have good PL properties in the blue spectral range. Moreover, the alloy nanocrystals can retain their high luminescence (PL efficiency of over 40 %) when dispersed in aqueous solutions and maintain a symmetric peak shape and spectral position under rigorous experimental conditions.

References:

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