Size Dependent Studies of Small Core (< 8 kDa) Conducting Nanoparticles

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Metal nanoparticles are of considerable interest in the world of nanoscience and technology owing to, for example, their connotations in electronic, optical, magnetic, catalytic, and chemical sensing applications. Monolayer protected clusters (MPCs), the dimensionally smallest known category of metal nanoparticles, also exhibit size dependent electronic absorbance and fluorescence spectra and electronic core charging in electrolyte media, which we refer to as quantized double layer charging.

That the properties of metal and semiconductor nanoparticles are size dependent makes it of fundamental interest to isolate them according to size, so as to understand better the origin of property-size relations. This can mean devising synthetic routes that produce nanoparticles of uniform size (monodisperse), or deploying post-synthetic procedures capable of narrowing the size dispersion of an already prepared nanoparticle sample.

We employ the Brust reaction to synthesize monolayer protected gold nanoclusters, which is a simple nucleation, growth, and passivation process that produces a bulk core size of 140 Au atoms. The size of the Au core in the synthesis of the hexanethiolate-stabilized Au clusters can be adjusted by the Au:hexanethiolate ratio and the temperature at which the reaction is conducted. By changing to a low temperature at the addition of the reducing agent, and collecting an ethanol fraction after quenching the reaction, we have reduced the size of the core and collected fractions with core sizes in the range from 28-38 Au atoms.

The MPCs have been examined with several analytical tools. We use a recently developed HPLC method followed by absorption and electrochemical detection methods to successfully separate and characterize core sizes down to 38 Au atoms. Collected fractions have also been studied using cyclic voltammetry, differential pulse voltammetry, transition electron microscopy, and fluorescence spectroscopy which allows additional core size evaluation.