

**Stony Brook University  
The Graduate School**

Doctoral Defense Announcement

**Abstract**

Synthesis, Characterization and Application of Noble-metal Nanoparticles and Their  
Langmuir Films

By

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Noble-metal nanoparticles and their Langmuir films have attracted remarkable research interest due to their unique properties and potential applications in catalysis, hydrogen storage materials, and optical, magnetic and electronic devices.

In order to understand the electronic and chemical properties of decanethiolate gold nanoparticles, a systematic comparison between the results obtained by different synthetic techniques, a one-phase method and a two-phase method, was conducted. The nanoparticles were compared in bulk and at the air-water interface by transmission electron microscopy (TEM), x-ray reflectivity (XR), extended x-ray absorption fine structure (EXAFS), x-ray powder diffraction (XRD), thermal gravimetric analysis (TGA), time-of-flight secondary ion mass spectrometry (TOF-SIMS), and Langmuir-Blodgett technique. The mean nanoparticles sizes obtained by EXAFS and XRD were found to be smaller than those by the TEM measurements. We explained these differences by the structural disorder and multiple twinning in the nanoparticles. The one-phase particles were found by EXAFS to be smaller and had higher grafting density of thiol chains than the two-phase particles. We attributed these differences to the enhanced disorder of the one-phase particles. At the air-water interface, the one-phase particles did not spread, while the two-phase particles spread and formed Langmuir films, which collapsed and folded into multilayer films upon further compression. The differences between the dodecanethiolate palladium nanoparticles synthesized by the same two methods were also investigated.

A seedless and templateless method was developed to synthesize palladium nanorods and nanocubes. The average length and aspect ratio of the nanorods can be tuned by varying the concentration of trisodium citrate. These nanoparticles were stable for months as colloids. However they were oxidized to form shells of 1.6-3.8 nm thick after exposure to air.

It has recently been suggested that oblate nanoparticles can form effective catalysts due to the many planes available to adsorption of the reacting species. We proposed to try these particle platelets in order to see if they would enhance the performance of PEM fuel cells where numerous catalytic processes take place. We found that these particles could

potentially enhance the power output by as much as 500%, provided that they are self-assembled into a monolayer.

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**Dissertation Advisor:** Miriam Rafailovich

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