Electrode Surfaces Tailored with Chemically Responsive Nanostructures

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The large surface-to-volume ratio and the fine-tunable interfacial nanochemistry of organic monolayer capped inorganic nanocrystals and their network assemblies are of increasing interest for tailoring electrode surface properties. The study of such interfacial composite nanomaterials could lead to potential applications where predictable and controllable interfacial reactivity, sensitivity and selectivity are important. One example is in the area of monitoring and removal of heavy metals from the environment, which has become a major focus of waste treatment and cleanup efforts. This presentation describes findings of an investigation of thin films assembled from monolayer-capped gold nanoparticles (2 10 nm) and carboxylic acid functionalized alkyl thiol linkers as a model system of interfacial metal-responsive nanostructure. The network assemblies have open frameworks in which void space forms channels with the nanometer sized cores defining its size and the monolayer shell structure defining its chemical specificity. The nanostructured thin films were investigated as responsive materials for the detection of metal ions and other chemical species. In addition to cyclic voltammetry, techniques such as electrochemical quartz-crystal nanobalance, surface infrared reflection spectroscopy and atomic force microscopy were used to characterize the interfacial redox reactivity, mass fluxes and structural properties of the nanostructured electrode materials. The nanostructure-tailored electrode showed large and reversible mass fluxes arising from incorporation of ionic species into the film. The determination of the diagnostic stretching bands of the carboxylic and carboxylate groups and the morphological changes of the nanostructured films provided important insights into assessment of the metal ion channeling and the ligand-metal ion reactivity. The correlation of the electrochemical activity with the pH-tuned nanostructure properties will also be discussed.