One of the central tenets in the field of heterogeneous catalysis is the surface catalytic properties of a material are controlled by its nanostructure. By understanding the structure-property connection at increasingly fine detail, one can create materials with improved catalytic performance, at the synthesis level. In this regard, colloidal nanoparticles (NPs) are an interesting model material to study and probe water-phase catalytic reactions. I will discuss the synthesis of colloidally stable (i.e., suspended in water) bimetallic palladium-decorated gold (Pd-on-Au) NPs and the characterization results that confirm the metal-on-metal structure. The Pd metal exists as surface atoms and ensembles, with the fraction of the latter increasing as the calculated Pd surface coverage increases, as evidenced through x-ray absorption spectroscopy. For one set of reactions (HDC, hydrodechlorination), the Au NPs act solely as a catalyst support for the Pd active phase [1]. For another set of reactions (glycerol oxidation), the Au and Pd are both active phases, and the Pd-on-Au structure gives improved glyceric acid selectivities and yields [2]. For these chemical reactions (and others), clear volcano-shape activity dependence on Pd surface coverage is seen. When properly applied, classical kinetics analysis can clarify the impact of mass transfer on observed reaction rates and insights into the nature of the active site [2,3]. Time permitting, I will further discuss the prospects of carrying out catalysis in unconventional ways if materials can be properly designed and synthesized [4].


