

Department of

Chemical and Environmental Engineering

2015—2016 Seminar Series

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9:30-10:30am

Winston Chung Hall 205/206



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## Chemical Reaction Engineering Using Nanoparticle Catalysts: Applications in Water

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. For one set of reactions (hydrodechlorination), the Au NPs act solely as a catalyst support for the Pd active phase. For another set of reactions (glycerol oxidation and nitrophenol reduction), the Au and Pd are both active phases, and the Pd-on-Au structure gives 10x higher activities. For these chemical reactions and others, a clear volcano-shape activity dependence on Pd surface coverage emerges. When properly applied, classical kinetics analysis can clarify the impact of mass transfer on observed reaction rates when carrying out three-phase chemical reactions. The Pd metal exists as surface atoms and ensembles, with the fraction of the latter increasing with calculated Pd surface coverage, as evidenced through x-ray absorption spectroscopy. The structure-property relationships identified for Pd-on-Au NPs provide opportunities to re-think bimetal catalyst structure design for other chemical reactions, for example, indium-decorated palladium (In-on-Pd) nanoshapes for catalytic nitrate reduction.

**Bio:** Dr. Michael S. Wong is Professor and Chair of the Department of Chemical and Biomolecular Engineering at Rice University. He is also Professor in the Department of Chemistry, Department of Civil and Environmental Engineering, and Department of Materials Science and NanoEngineering. He was educated and trained at Caltech, MIT, and UCSB before arriving at Rice in 2001. His research program broadly addresses chemical engineering problems using the tools of materials chemistry, with a particular interest in energy and environmental applications ("catalysis for clean water"). He has received numerous honors, including the MIT TR35 Young Innovator Award, the American Institute of Chemical Engineers (AIChE) Nanoscale Science and Engineering Young Investigator Award, Smithsonian Magazine Young Innovator Award, and in 2015, the North American Catalysis Society/Southwest Catalysis Society Excellence in Applied Catalysis Award. He is a Research Thrust Leader in the NSF-funded NEWT (Nanotechnology Enabled Water Treatment) Engineering Research Center. He is the 2016-17 Chair of the ACS Catalysis Science and Technology Division, and serves on the *Applied Catalysis B: Environmental* editorial board.