Materials Science & Engineering Seminar Series

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Structural Dynamics of Surface Reactions: Oxidation and Heterogeneous Catalysis

Judith C. Yang, Ph.D.
Department of Chemical and Petroleum Engineering
Department of Physics
University of Pittsburgh

ABSTRACT:
Transmission electron microscopy has proven to be a powerful tool to measure composition, chemistry and internal structure at the nanoscale and below. The two transformative developments in electron microscopy in the last two decades are (1) the emergence of aberration-corrected lenses that allow for unprecedented spatial and spectral resolution and (2) the rapid advances in *in situ* capabilities for observations of dynamic phenomena.
Recent and rapid developments of in situ transmission electron microscopy (TEM) has demonstrated it to be a transformative tool to gain unique dynamic processing/structure/property relationships of nanomaterials. Of particular interest are the structural changes occurring under "real" environmental conditions observable by environmental TEM (ETEM). The ETEM allows for dynamic studies for fundamental, atomic-level understanding of surface chemical reactions, such as oxidation and heterogeneous catalysis. The first part of my talk will focus on the dynamics of the initial and transient oxidation stages of metals. Using a ultra-high vacuum ETEM, we have demonstrated that the transient oxidation stage of Cu and its alloys bear a striking resemblance to heteroepitaxy, where the initial stages of growth are dominated by oxygen surface diffusion. The second part of my talk will focus on heterogeneous catalysis, which depends sensitively on the nano-sized 3-dimensional structural habits of nanoparticles (NPs) and their physicochemical structural sensitivity to the environment. My focus is on the development of integrated characterization and modeling tools and their applications appropriate for carrying out detailed studies on metallic nanoparticles (NPs) comprised of a few to as many as 100 metal atoms. The structures of small metal NPs do not behave like atoms or bulk material. For example, we have shown that Pt NPs may be both ordered and disordered, depending on its size, support and adsorbates. A statistical description of nanoparticles is more appropriate in understanding structure/property of nanoparticles and their surface reactions.

BIOGRAPHY: Professor Judith C Yang received her PhD in physics from Cornell University in 1993. She then went to the Max-Planck-Institute of Metallforschung, Stuttgart, Germany as a post-doctoral fellow. In 1995, she returned to the US as a post-doc and visiting lecturer to the Frederick Seitz Materials Research Laboratory, U. Illinois at Urbana-Champaign. In 1999, she joined the materials science and engineering faculty at U. Pittsburgh. She is the 2002 recipient of the NSF career award, 2004 B.P. America Faculty fellowship, and the 2005 Chancellor's Distinguished Research Award. Since 2010, she is the Nickolas A. DeCecco Professor in Chemical and Petroleum Engineering; she has a secondary appointment in physics. Her research areas include oxidation, heterogeneous catalysis, nano-materials, gas-surface reactions, and transmission electron microscopy, especially in situ.

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