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Session Type:90-Minute Symposium
Number:090-024
Title: Nanocatalysis for Clean Energy and Sustainability
Session Start/End Time: Sunday, Feb 17, 2008, 3:30 PM - 5:00 PM
Hotel: Hynes Convention Center, Second Level
Room: Room 207
Synopsis: Energy sustainability in a broad sense requires a more effective use of fuel resources and relies on the availability of low-cost catalytic materials that will facilitate the development of clean energy production technologies, such as fuel cells, and carbon dioxide–neutral liquid fuels. Catalyst design at the nanoscale for fuel processing, hydrogen production, and fuel cells aimed at "doing more with less" is the topic of this symposium. There is evidence now that doping certain oxides with trace amounts of transition metals is enough to create powerful and robust catalysts for several of the oxidation reactions involved in energy production. These may be viewed as analogs to homogeneous metal-ligand catalysts, whereby metal clusters with low nuclearity are anchored on oxide (ligand) sites. In parallel, new electrodes and electrocatalysts are being developed to reduce the amount of platinum group metals without loss of activity and with better resistance to poisons. Rational design of catalysts and electrocatalysts at the nanoscale involves the use of tools from catalysis, surface chemistry, in situ spectroscopies, computational chemistry, and nanotechnology. The effective combination of these disciplines is not a small task, but rapid progress is being made, as is presented in the symposium. The synthesis of heterogeneous nanocatalysts and electrocatalysts with the required functionality (activity, selectivity) may be realized with an up-to-now unprecedented structural control.

Organized by:
Maria Flytzani-Stephanopoulos, Tufts University, Medford, MA; D.Wayne Goodman, Texas A&M University, College Station, TX; Manos Mavrikakis, University of Wisconsin, Madison, WI; Thomas Mallouk, Pennsylvania State University, University Park, PA

Presentations:
Moderator--**Maria Flytzani-Stephanopoulos**, Tufts University, Medford, MA

Catalytically Active Gold: From Nanoparticles to Ultra-Thin Films--**D.Wayne Goodman**, Texas A&M University, College Station, TX

Near-Surface Alloys and Core-Shell Nanocatalysts for Reactions Involving Hydrogen--**Manos Mavrikakis**, University of Wisconsin, Madison, WI

Designing Catalysts for Visible Light Water Photolysis--**Thomas Mallouk**, Pennsylvania State University, University Park, PA

Title: Catalytically Active Gold: From Nanoparticles to Ultra-Thin Films
Authors: D.Wayne Goodman, Texas A&M University, College Station, TX
Abstract: The electronic, structural, and chemical properties of unsupported metal and mixed-metal surfaces prepared either as single crystals or thin films have been detailed and contrasted with the corresponding properties of supported metal [1,2] and mixed-metal nanoclusters [3,4]. The latter vary in size from a few atoms to many and have been prepared on ultrathin single crystalline oxide supports of TiO2, Al2O3, and SiO2. An array of surface techniques including reaction kinetics of carbon monoxide oxidation and vinyl acetate synthesis have been used to correlate catalytic function of these surfaces with their physical and electronic properties. Of special interest are the special physical and chemical properties that develop with metal cluster size reduction and/or metal-support interaction. Recent STM studies of mixed-metal catalysts prepared by alloying Pd with Au will be highlighted [5,6].
[1.] M. S. Chen and D. W. Goodman, Science, 306, 252 (2004). [2.] M. S. Chen and D. W. Goodman, Accts Chem. Res, 39, 739 (2006). [3.] M. S. Chen, D. Kumar, C.-W. Yi and D. W. Goodman, Science, 310, 291 (2005). [4.] M. S. Chen, Y. Cai, Z. Yan and D. W. Goodman, J. Amer. Chem. Soc., 128, 6341(2006). [5.] C. W. Yi, K. Luo, T. Wei and D. W. Goodman, J. Phys. Chem. B, 109, 18535 (2005).6. P. Han, S. Axnanda, I. Lyubinetsky, and D. W. Goodman, J. Amer. Chem. Soc., in press.

Title: Near-Surface Alloys and Core-Shell Nanocatalysts for Reactions Involving Hydrogen
Authors: Manos Mavrikakis, University of Wisconsin, Madison, WI
Abstract: Using first-principles methods, we have identified bimetallic and ternary alloys with specific nano-architecture and significantly improved catalytic properties for a variety of applications, including electrocatalysis for low temperature fuel cells. These near-surface alloys have been synthesized with atomic-layer thickness control in core-shell nanoparticles and, upon experimental testing, have demonstrated remarkable catalytic properties at low temperatures.

Title: Designing Catalysts for Visible Light Water Photolysis
Authors: Thomas Mallouk, Pennsylvania State University, University Park, PA
Abstract: Despite three decades of effort on the problem, there are no efficient catalytic systems for the direct photolysis of water using visible light. This talk will describe the issues in the design of such systems and progress on the problems of photochemical charge separation and water oxidation/reduction.