Title: Nanostructured Catalysts for Energy Sustainability and Medical Diagnostics

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Abstract: The surface atomic structure of metal nanoparticles, in concert with their electronic structure and ensemble (bi-functional) effects, is known to impact their surface activity towards a number of industrially relevant electrochemical reactions. The role of molecular morphology in controlling bulk activity in polymeric membrane catalysts is less well understood. In this presentation, we will discuss the synthesis and characterization of fundamental reaction mechanisms of both types of catalysts when applied to address key problems in the areas of sustainable energy and human health.

We will begin by describing the synthesis of highly dispersed Pt_2Bi alloy nanoparticles for use in direct dimethyl ether fuel cells (DDMEFC). DME has properties similar to propane and is recognized as a promising bridge fuel toward the hydrogen economy. Pt_2Bi bulk alloy has been shown to be among the most active and durable catalysts for DME electro-oxidation. However, synthesis in highly dispersed form is required for scaleability and has previously not been realized. Our group uses inorganic stannous chloride as a capping agent for colloidal synthesis of Pt_2Bi alloy in an all-aqueous process. Dynamically-resolved Mossbauer spectroscopy is used to follow the formation of a previously unrecognized Sn-Bi complex that forms during nanoparticle synthesis. Catalyst nanostructure is shown to drive 50% greater power generation in DDMEFC as compared to state-of-the art electrocatalysts.

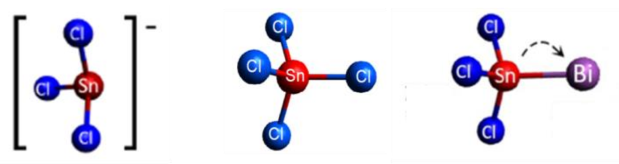

Figure 1. Structure of Sn sites in nanoparticle synthesis mixture identified during the deconvolution of Mossbauer spectra: pyramidal stannous chloride site **A**, tetrahedral stannic chloride site **B**, distorted pyramidal site **C**.

We will next discuss the use of perfluorosulfonic acid (PSA) membranes such as Nafion as solid-state catalyst to drive colorimetric reactions for chemical sensing applications. The activity of these materials is shown to be controlled by organic reagent mass transport and immobilization in previously unrecognized nanoscale phases of the membrane. In particular, SAXS and SANS data demonstrate that unlike water, the transport of organics occurs within an intercrystalline fluoroether phase between hydrophilic PSA clusters. The selectivity, sensitivity, and time resolution of these optodes permits their potential use as non-invasive exhaled breath monitors for real-time assessment of biomolecular transport through lung tissue. We will show how mathematical modeling of the resultant data can provide insight on lung physiology for diagnosis of diseases such as pulmonary edema.

Biography: Dr. Angelopoulos started his career at the University of Cincinnati in the College of Engineering and Applied Science 14 years ago and is currently Professor and Head of the Department of Chemical and Environmental Engineering. He holds a Ph.D. degree in Chemical Engineering from Princeton University and M.S. and B.S. degrees in Chemical Engineering from Tufts University. He began his professional career as a research assistant at the U.S. Army Materials Technology Laboratory where he evaluated the transport of chemical warfare agent (CWA) simulants through polymeric barrier materials. He subsequently gained industry experience as a staff engineer for electroless printed circuit fabrication at the IBM Corporation in Endicott, NY and as a senior materials scientist at the General Motors General Motors Fuel Cell Research and Development Center in Honeyoe Falls, NY. Between these industrial positions, Dr. Angelopoulos was also appointed Assistant Professor in Polymer Chemistry at the University of Massachusetts-Lowell. Dr. Angelopoulos has 15 patents on the use of nanostructured catalysts, coatings, and membranes for electronics, sustainable energy, and chemical sensing—research areas in which is his group is currently active.