5th Annual AIChE Midwest Regional Conference

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Session Th1B: 10:00am -11:30am, Thursday January 31, 2013 (Room 007)
Fuel Cell Technologies
Session Organizer: Shabbir Ahmed, Argonne National Laboratory
Session Chair: Shabbir Ahmed and Debbie Myers, Argonne National Laboratory

10:00am **Fuel Cell R&D: Where Are We and Where Will We Go**
Chinbay Q. Fan, Gas Technology Institute
The use of hydrogen as an energy carrier could help address our concerns about energy security, global climate change, and air quality. Fuel cells are an important enabling technology for the Hydrogen Future especially with low cost natural gas and have the potential to revolutionize the way we power our nation, offering cleaner, more-efficient alternatives to the combustion of gasoline and other fossil fuels. For over 55 years, GTI has been active in Hydrogen Energy research, development, and demonstration (RD&D). The Institute has extensive experience and on-going work in all aspects of the hydrogen energy economy, including production, delivery, infrastructure, use, safety, and public policy. This presentation summarizes the status of the fuel cell R&D, mainly; hydrogen production, hydrogen storage, and proton exchange membrane fuel cells (PEMFC) and solid oxide fuel cells (SOFC). Also this presentation will brainstorm the future of the fuel cells.

10:25am **Platinum and Platinum Alloy Electrocatalyst Degradation in Polymer Electrolyte Fuel Cells**
Debbie Meyers, X. Wang, N. Kariuki, S. Arisetty, S. DeCrane, T. Nowicki, R. Subbaraman, R. Ahluwalia, Argonne National Laboratory, M. Gummalla, Z. Yang, S. Zhitnik, United Technologies Research Center, S. Ball, J. Sharman, B. Theobald, and G. Hards, Johnson Matthey TC, P. Ferreira, D. Groom, S. Rajasekhara, University of Texas-Austin, D. Morgan, J. Gilbert, B. Puchala, L. Wang, E. Holby, University of Wisconsin-Madison, J. Meyers, P. Mathew, S. K. Kim University of Texas-Austin, Y. Shao-Horn, W. Sheng, B. Han, MIT
One of the primary challenges facing the development of polymer electrolyte membrane fuel cells (PEMFCs) for automotive and stationary power applications is the durability of the fuel cell materials, especially the platinum-based cathode catalyst. This presentation will discuss the results of a multi-institutional collaborative project focused on elucidating the effects of cathode catalyst and support physicochemical properties and cell operating conditions on the rates and mechanisms of cathode catalyst degradation. The primary reasons for the lifetime limitations of the cathode catalyst and a definition of the catalyst properties and operating conditions that allow fuel cell systems to achieve the lifetime targets for the automotive and stationary applications will be discussed.

10:45am **New Approaches to High-Efficiency Non-Platinum Group Metal Catalysts for PEM Fuel Cell Applications**
Di-Jia Liu, J.-L. Shui, D. Zhao, S. Ma, S. Yuan, C. Chen, G. Goenaga, S. Comment, B. Reprogle, A. Mason, Argonne National Laboratory, L. Grabstanowicz, T. Xu, Northern Illinois University
Oxygen reduction reaction (ORR) represents the most important electrochemical process in a proton exchange membrane fuel cell (PEMFC). An effective catalyst with improved active site design and support architecture could reduce the kinetic barrier, lower the electrochemical overpotential, and enhance the mass transfer as well as energy conversion efficiency. Conventional PEMFC cathode catalysts contain the platinum group metals (PGMs) which contributes significant fraction of the overall stack cost. We report herein our recent progress in developing low-cost, high-efficiency non-PGM catalysts for fuel cell using porous organic material (MOF and POP) based compounds as the precursors. New approaches to prepare the catalysts with high surface area and active site density are demonstrated, supported by the characterization studies.

11:05am **Optimization of Carbon Fiber Usage in Type-4 Hydrogen Storage Tanks for Automotive Fuel Cells**
Thanh Q. Hua, H-S Roh, R.K. Ahluwalia, Argonne National Laboratory
Analysis of carbon fiber requirement for the 5.6-kg 700-bar compressed hydrogen Type 4 tank is presented. Netting analysis is used to determine the optimal dome shape, winding angle, and initial estimates of the helical and hoop layer thicknesses for a given length-to-diameter ratio. Three dimensional finite element analysis using ABAQUS with the Wound Composite Modeler is then used to predict the performance of the composite tank subject to the operating requirements and design assumptions. Doilies are used to provide extra reinforcement of the dome section, which would reduce the number of helical layers wound through the cylindrical section of the tank. A new integrated end-cap vessel (IECV) is proposed as an advanced design for Type 4 tanks. For the 5.6-kg 700-bar compressed hydrogen tank, our finite element analysis of the IECV shows that the total amount of carbon fiber usage can be reduced by ~ 15%.